Species Status Assessment Report for the

Yuma Ridgway’s Rail (*Rallus obsoletus yumanensis*)

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This document was prepared by Nichole Engelmann (U.S. Fish and Wildlife Service), Sheena Girner (U.S. Fish and Wildlife Service), Dr. Courtney Conway (U.S. Geological Survey), Eamon Harrity (Sky Islands Alliance), Ashley Lauria (Arizona Game and Fish Department), Sharon Lashway (Salt River Project), and Tice Supplee (Audubon Southwest [retired]).

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Table of Contents

TABLES

FIGURES

Chapter 1. Introduction

This report summarizes the analytical phase of a **Species Status Assessment** [1](SSA) for the Yuma Ridgway's rail (*Rallus obsoletus yumanensis*). The Yuma Ridgway's rail is a small-medium sized marsh bird that occurs in wetlands from the Ciénega de Santa Clara in Mexico, north to the Las Vegas Wash in Nevada, east along the lower Gila and Salt Rivers in Arizona, and west to the Salton Sea Basin in California. **Extant** populations occur throughout this range. The Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531 et seq.) defines "species" to include "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature." However, in this document, when referring to the Yuma Ridgway's rail, we use the term "subspecies" to distinguish when we have information specific to *R. o. yumanensis* versus a related **congener**. Further, in this document, the terms **wetland** and **marsh** will be used interchangeably.

The SSA framework uses the three biological principles of **resiliency**, **redundancy**, and **representation** to assess the species' **viability** or its ability to persist over time (U.S. Fish and Wildlife Service 2016, Smith et al. 2018). Within the SSA, we present a synthesis of our current understanding of the subspecies' ecology and the factors that influence it to evaluate the current status and to predict the future status of its resources and condition. This report intends to provide biological support for a status review and recovery plan for the Yuma Ridgway's rail; it does not represent any opinion or decision by the U.S. Fish and Wildlife Service. Instead, the document provides a review of the best available information related to the biological status of the Yuma Ridgway's rail.

Federal History

The Yuma Ridgway's rail (*Rallus obsoletus yumanensis*)[2] was listed as a **subspecies** in danger of extinction in the United States (U.S.) on March 11, 1967, pursuant to the Endangered Species Preservation Act of 1966 (32 FR 4001, March 6, 1967). It was listed as a subspecies threatened with extinction throughout its range (U.S. and Mexico) under the Endangered Species Conservation Act of 1969 (35 FR 18319, August 25, 1970) and this endangered status was carried forward automatically under the Endangered Species Act (ESA) of 1973 (as amended). In 1983, a recovery plan was published (U.S. Fish and Wildlife Service 1983). In the 1988 publication of the official list of species listed under the ESA, the entry for Yuma Ridgway's rail was changed to remove Mexico from the listed range (50 CFR § 17.11, 1988 edition, p. 104). After the release of the Draft First Revision to the Recovery Plan in 2009 (U.S. Fish and Wildlife Service 2009), the U.S. Fish and Wildlife Service reviewed this decision and determined the removal of Mexico from the listed range was an administrative error and should be corrected. On

[1] Working definitions for **bolded** terms can be found in the Glossary.
[2] The American Ornithological Union reclassified the Yuma clapper rail (*Rallus longirostris yumanensis*) to the Yuma Ridgway's rail (*Rallus obsoletus yumanensis*) in 2014. The list of Endangered and Threatened Wildlife (50 CFR 17.11) was revised in 2021 with the new scientific and common names (86 FR 67352).

November 26, 2021, we published a correction (86 FR 67355) that restores Mexico to the listed range of the subspecies.

SSA Framework

This report is a summary of the Species Status Assessment analysis, which entails three assessment stages (Figure 1):

Species Ecology. An SSA begins with a compilation of the best available biological information on the species (taxonomy, life history, and habitat) and its ecological needs at the individual, population, and species levels based on an understanding of how environmental factors act upon the species and its habitat.

Current Species Condition. Next, an SSA describes the current condition of the species' habitat and demography and the probable explanations for past and ongoing changes in abundance and distribution within the species' ecological settings (i.e., areas representative of the geographic, genetic, or life-history variation across the species' range).

Future Species Condition. Lastly, an SSA forecasts the species' response to probable future scenarios of environmental conditions and conservation efforts. As a result, the SSA characterizes the species' ability to sustain populations in the wild over time (viability) based on the best scientific understanding of current and anticipated future abundance and distribution within the species' ecological settings.

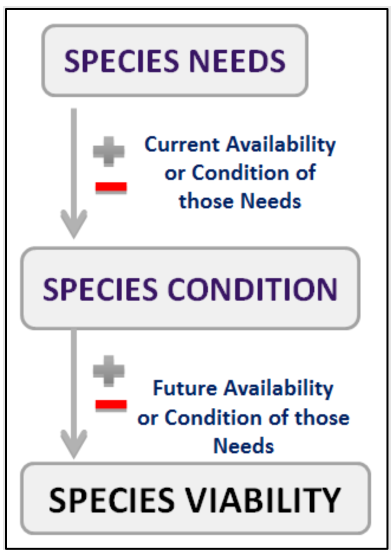

Figure 1. Species Status Assessment framework (U.S. Fish and Wildlife Service 2016, p. 6).

For this SSA, we define the term **population** to mean a group of potentially interbreeding individuals within a defined area ("Definition of population in Oxford Dictionaries (British & World English)" 2013). Because Yuma Ridgway's rails are partial migrants with documented dispersal among populations, it is possible that all Yuma Ridgway's rails could interbreed. Given this knowledge, when we use the term "population," we are using it broadly to describe geographic segments of the subspecies across its range. Otherwise, for the three assessment stages of this SSA, we will use the term "analysis unit" in two specific contexts:

- When referring to the Yuma Ridgway's rails that breed in any of the distinct regions within its range, we will refer to the "**Regional Analysis Unit**" or RAU.
- Within each region, numerous breeding sites exist, or areas of habitat that are distinct based on landownership and management. We will refer to these areas as "**Local Analysis Units**" or LAU.

Throughout the assessment, the SSA uses the conservation biology principles of resiliency, redundancy, and representation (collectively known as the "3Rs") as a lens to evaluate the current and future viability of the species. Resiliency describes the species' ability to withstand **stochastic disturbance** events, an ability associated with population size, growth rate, and habitat quality. Redundancy describes a species' ability to withstand catastrophic events, which is related to population number, distribution, and resilience. Representation describes a species' ability to adapt to changing environmental conditions and relates to the breadth of genetic and ecological diversity within and among populations. Together, the 3Rs—and their core **autecological** parameters of abundance, distribution, and diversity—comprise the key characteristics that contribute to a species' viability or ability to sustain populations in the wild over time. When combined across populations, they measure the condition of the species (Smith et al. 2018 pp. 306–308).

Summary of New Information

This report uses information obtained from a variety of sources. The main sources of new (since 2010) information are reports or studies from partner agencies monitoring the populations and habitat of the Yuma Ridgway's rail.

Uncertainties and Assumptions

This report incorporates the best available information through reports, peer-reviewed literature, and communication with subspecies experts. The use of the name "Yuma Ridgway's rail" refers to *Rallus obsoletus yumanensis*, previously known as the Yuma clapper rail, *Rallus longirostris yumanensis*. When information is not available at the subspecies level, we sometimes use closely related congeners as surrogate species but are always careful to make this clear throughout the report. For instance, some assumptions are made using the life history of the Ridgway's rail (*Rallus obsoletus; R. o.*) or other *R. o.* subspecies, as well as other marsh bird species like the Virginia rail (*Rallus limicola*) or king rail (*Rallus elegans*). Although deemed reasonable, we recognize this approach incorporates inherent uncertainties.

Chapter 2. Species Ecology

This chapter provides biological information about the Yuma Ridgway's rail, including its **taxonomic** history and genetic relationships, **morphological** description, life-history traits, and individual and population habitat needs.

TAXONOMY

At the time of its listing in 1967, the Yuma Ridgway's rail was assigned as a subspecies of the clapper rail (*Rallus longirostris*) with the designation of *Rallus longirostris yumanensis* by the American Ornithologists' Union (AOU) (1957 p. 154). This was the official assignment through 2014, when the AOU accepted the change proposed by Maley and Brumfield (2013) to reorganize the clapper rail (*R. longirostris*) and king rail (*R. elegans*) species complex and create five distinct species (Chesser et al. 2014 p. CSv). Under the newly accepted taxonomy, the Yuma clapper rail was renamed the Yuma Ridgway's rail (*R. obsoletus yumanensis*).

The changes to the taxonomic and common names have no impact on the listed entity of the Yuma Ridgway's rail. Rather, the change applies to the former *Rallus longirostris obsoletus* group as a whole and considers them all as subspecies of *R. obsoletus*. There is no change in relationships among subspecies and no changes in distribution of any subspecies. Nothing in Maley and Brumfield 2013 (entire) or Chesser et al. 2014 (p. CSv) changes the validity of the five currently recognized *R. obsoletus* subspecies. In short, the subspecies *yumanensis* remains unchanged.

We note that some authors recognize the Sonora (*R. o. rhizophorae*) and San Blas *(R. o. nayaritensis*) Ridgway's rails as part of the *yumanensis* subspecies (Ripley and Lansdowne 1977 p. 127, Eddleman and Conway 1998 p. 4). For this Species Status Assessment, associated Recovery Plan and Implementation Strategy, we consider the listed subspecies *R. o. yumanensis* to encompass Ridgway's rails in the Salton Sea and Lower Colorado River basin in the U.S., and the Colorado River Delta area in Mexico. We do not include the Sonora and San Blas Ridgway's rails that occur along the Mexican coasts of Kino Bay, Sonora and San Blas, Nayarit. We maintain this separation of the subspecies based on the original description of the *yumanensis* subspecies by Dickey (1923) as breeding in fresh-to-brackish water cattail (*Typha*) or bulrush (*Schoenoplectus*) marshes, whereas *R. o. rhizophorae* and *R. o. nayaritensis* are associated with coastal mangrove stands along the saltwater coast (Dickey 1930 p. 235, Wilbur and Tomlinson 1976 p. 22, Todd 1986 pp. 21, 23). More information is needed on the genetic structure of this subspecies as **telemetry** data from the Colorado River Delta show individuals migrating farther south than previously expected.

We have carefully reviewed the available taxonomic information and conclude that *R. o. yumanensis* is a valid taxon. The currently accepted classification is shown in Table 1:

Table 1. Yuma Ridgway's rail taxonomy.

Class	***Order***	***Family***	***Genus***	***Specific Epithet***	***Subspecies***
Aves	Gruiformes	Rallidae	*Rallus*	*obsoletus*	*yumanensis*

GENETICS

We have very limited information on the genetic structure of the Yuma Ridgway's rail throughout its range (Fleischer et al. 1995 p. 1235, Maley 2012 pp. 1–2). We assume that the Yuma Ridgway's rail population historically was centered in the marshes of the Colorado River Delta in Mexico. The expansive tracts of marshes and other wetlands would have allowed for gene flow throughout the entire area (MacDougal 1906 pp. 10–11, 13), likely providing a robust **panmictic** population.

Dispersal from the Colorado River Delta up the mainstem of the lower Colorado River has likely been continuous, with rails being present along the lower Colorado River and elsewhere in low densities because habitat was more interspersed (Todd 1986 p.12). In the early 1900s, following the creation of habitat from dams and diversions (Anderson and Ohmart 1985 p. 123), habitat became less dynamic and more abundant and allowed for an increased density of individuals. This continuing dispersal, coupled with increased habitat, established more robust populations along the lower Colorado River and likely took place over several decades. We assume that genetic exchange continues among geographic segments of the population because of the migratory behavior exhibited by the subspecies. We note that the current genetic structure of current populations remains unknown and there is a critical gap in developing conservation goals.

Species Description

The Yuma Ridgway's rail is one of the smaller subspecies of rails, with adult males having a standing height of 20-23 centimeters (cm) (8 inches [in]) and weighing 266.8 grams (g) (9.3 ounces [oz]) on average (Todd 1986 p. 3-4). Females are slightly smaller, averaging around 226.2 g (8.0 oz) (Todd 1986 p. 4). The height of females is not known. Sexes can be distinguished using combinations of external measurements (Eddleman 1989 p. 66, Harrity et al. 2021 pp. 470–471).

Natal Plumage

Between April and July clapper rail chicks, including the Yuma Ridgway rail pictured, and associated subspecies hatchlings, are covered with jet-black down with a greenish gloss on top and **anteriorly,** and a clove-brown on the abdomen (Figure 2; Harrity and Conway 2019b p. 1). There may be between 1 and 30 white **neossoptiles** along the bottom abdominal region of the ventral tract (Wetherbee and Meanley 1965 p. 500, Meanley 1985 p. 64). Most natal plumage is gone by week 5, although the head typically still has some downy feathers at this stage (Harrity and Conway 2019b p. 4).

Figure 2. A Yuma Ridgway's rail chick with downy black feathers. Bill is **pied**, and legs are dark. Photo by Eamon Harrity.

Juvenile Plumage

From June to August, juvenile rails have a generally duller, and less defined appearance than adults (Figure 3; Harrity and Conway 2019b p. 6). The underbelly is typically greyish and a paler cinnamon, and the face is paler with feathers on the chin and on the sides of the **occiput** being a lighter more defined greyish white. Sides and flanks are also a nondescript grey with irregular greyish-white barring. Blackish feathers along the sides may be retained in this stage. Juvenile plumage begins to grow in around week 3-4, and all juvenile feather tracts have grown in by week 6 (Harrity and Conway 2019b pp. 3, 5). By week 7-8 juveniles are typically independent from adults, though flight feathers are still growing.

Figure 3. Juvenile plumage of *yumanensis*. Head and face are duller than adults, but color definition is starting in the breast and neck. Mandible is shorter and lighter in color than adults. Photo by Eamon Harrity.

Adult Plumage

Adult Yuma Ridgway's rails of both sexes are similar in plumage (Figure 4); they possess a long, slightly **decurved** bill, a laterally compressed body, and relatively long legs and toes compared to body size. The upper mandible (bill) is dark grey, fading to orange at the base and the tip. The head and scapular (shoulder) area are grey, with browns and oranges appearing on the sides of the neck and under the head (Harrity and Conway 2019b p. 8). The chin and upper throat are white, and there is a light eyebrow stripe extending from above the eye to the upper mandible. The breast is tawny to burnt-orange in the male, and a brick-orange in breeding females. The upper body is light grey to dark brown, becoming blotchy and dominant on the rump and distally on the wings. The underside and flanks forward of the legs are dark grey with vertical white stripes. The tail is dark brown above and white below. Legs are unfeathered and orange in color (Todd 1986 pp. 3–4).

Figure 4. Adult plumage of *yumanensis*. Head and face are brighter in color. Mandible is longer and orange in color. Photo by Eamon Harrity.

Molting

Hatchlings retain their black down for about a month then **molt** into juvenile plumage. During this stage, young often resemble the eastern congener of clapper rails (Ridgway and Friedmann 1941 p. 91). The second body molt takes 6 to 7 weeks, with the juveniles obtaining the buffy adult ventral plumage. Juveniles are difficult to distinguish from adults after September; however, mandibles typically remain duller and rump feathers are typically darker grey than those of adults (Eddleman 1989 pp. 66–67).

Adult rails have a basic pre-body molt in May-August, with the simultaneous molt of **rectrices** and **remiges** which impact flight. Flightless birds are found between mid-July and the end of September. A second, pre-alternate molt, which does not include flight or tail feathers, occurs from September to December (Eddleman 1989 p. 6, Eddleman and Conway 2020).

Life History

Life history information presented in this section was limited to the basic information needed to assess recovery objectives, criteria, and specific recovery tasks. More detailed information can be found in the references cited in this section.

Behavior

Yuma Ridgway's rails are secretive birds that are more often heard than seen. Their bodies are laterally compressed and they are highly agile, which enables them to move efficiently through cattails and other emergent vegetation. Yuma Ridgway's rails walk upright with a deliberate step and may twitch their tails. When alarmed, they will run into vegetative cover with their bodies held horizontally (Todd 1986 p. 65). Yuma Ridgway's rails do not usually perch above the ground; however, an individual may climb into a shrub or tree (Todd 1986 p. 63).

Despite a lack of webs between their toes, adult Yuma Ridgway's rails are good swimmers, sitting high in the water with their head held up. The swimming motion is mildly irregular, likely due to the continued "walking" motion of the legs used for propulsion. Individuals are known to dive underwater and may hold onto submerged vegetation to stay down in response to threats or use their wings to "swim" through the water (Ripley and Lansdowne 1977 p. 126, Todd 1986 p. 65). Todd (1986 p. 67) noted that Yuma Ridgway's rails do not swim for long distances as he rarely saw an individual swim channels more than 30 meters (m) (100 feet [ft]). Downy chicks are unable to float or swim and are susceptible to drowning when their down gets wet (Pettingill 1938 pp. 412–413, Bennett and Ohmart 1978 pp. 48–49). The availability of areas with stable shallow or no standing water for the chicks to move across and forage in is an important consideration for human-related changes in water levels in occupied marshes.

Food Habits

Yuma Ridgway's rails are sight-feeders with an excellent sense of smell (Eddleman and Conway 1998, p. 7). Prey items are taken by **surface gleaning** or shallow probing on open mudflats, shallow (7.5 cm [3 in]) open waters, vegetated areas with low densities of emergent stems, and the water/emergent vegetation interface (Todd 1986 p. 70, Eddleman and Conway 1998 p. 7). During periods of low prey availability, rails can undertake daily foraging movements that span a larger area (Conway et al. 1993 p. 287).

Overall, the diet of Yuma Ridgway's rails is dominated by crayfish, with small fish, tadpoles, clams, and other aquatic invertebrates also being consumed (Ohmart and Tomlinson 1977, Anderson and Ohmart 1985 p. 123, Todd 1986 p. 69, Eddleman 1989 pp. 90–95, Conway 1990 pp. 34, 41). Crayfish (*Procamberus clarki* and *Orconectes virilis*) are not native to the lower Colorado River basin and were introduced to the basin around 1968 for aquatic weed control and to provide food for sport fish (Inman et al. 1998 p. 3). The spread of crayfish in the lower Colorado River was likely pivotal to the expansion of Yuma Ridgway's rail, as crayfish provided a more abundant and secure food supply (Ohmart and Tomlinson 1977 p. 336). The abundance of crayfish and another prey species, freshwater prawn (*Palaemonetes paludosus*), varies significantly depending on microhabitat. Crayfish, for instance, are most abundant in moderately to very dense cattail and bulrush (Smith 1975 p. 21, Bennett and Ohmart 1978 p. 38) while prawns are most abundant at the vegetation/open water interface (Eddleman 1989 p. 91). Abundances can also shift seasonally. For example, the abundance of crayfish in the Salton Sea Basin was found to be the highest in late April to mid-May and lowest during the winter (Bennett and Ohmart 1978 pp. 26, 28). On the lower Colorado River, highest abundances were found in the early breeding through post-breeding periods (March through October), depending on location (Eddleman 1989 pp. 93–95). These fluctuations in prey abundances correspond to Yuma Ridgway's rails moving within a marsh, or even to adjacent marsh systems (Bennett and Ohmart 1978 pp. 51-53, Eddleman 1989 p. 95, Conway et al. 1993 pp. 286–287).

Breeding

While we have general insight into the ecological conditions suitable for reproduction, subspecies-specific information is limited, and any significant interspecific variation is unknown.

For instance, we do not know age of sexual maturity for Yuma Ridgway's rails, but we assume that it is around 1 year of age based on other subspecies (Eddleman and Conway 1998 p. 18). We also do not know the **sex ratio** of populations; Eddleman documented surplus males, which could indicate that the sex ratio may be skewed towards males (1989 p. 59). At the start of breeding season (February-March), male Yuma Ridgway's rails will give "kek" calls. If males are successful in attracting a female, pair bonding occurs shortly thereafter (Eddleman and Conway 1998 p. 13). Once paired, the bond lasts at least until the end of the breeding season. We do not know if the same birds bond in subsequent years (Eddleman and Conway 1998 p. 13). Nesting begins in March with a peak in mid-May on the lower Colorado River (Eddleman 1989 p. 64) and from May to June in the Salton Sea Basin (Abbott 1940 pp. 264–265, Bennett and Ohmart 1978 p. 22). We do not know date range, or peak time, for the population along the lower Gila River but we assume that it is more like the lower Colorado River than the Salton Sea Basin because of the difference in elevation. This is supported by annual unpublished surveys done in and around the lower Gila River area that began at the end of March and extend into mid-May.

Nests are generally constructed by weaving grasses and sedges into a platform with a bowl-shaped depression. The location of a nest can vary but nests are commonly built on stable substrates such as emergent vegetation mats (dead or alive), or around the bases of emergent plants or trees. Nests may be near the shore in shallow water, or in the interior of marshes over deeper water (Abbott 1940 p. 264, Bennett and Ohmart 1978 p. 40). In both cases, nests tend to be elevated several centimeters above the water to protect them from water-level fluctuations (Smith 1975 p. 18, Todd 1986 pp. 77–78, Eddleman 1989 p. 58). Nests over deeper water may have an access ramp (Bennett and Ohmart 1978 p. 40, Todd 1986 p. 78). For nests nearshore, or within the interior of marshes, overhead cover is sought. Cover can be from trees, woody vegetation, or cattail and bulrush stems (Eddleman 1989 pp. 57–59). Males may build multiple nests that can be used for incubation and provide alternate sites if predators or changing water levels disturb the primary nest (Conway and Eddleman 2000 p. 280). Based on a study of the light-footed rail (*Rallus obsoletus levipes*), a breeding pair may build 2 to 3 nests per season including at least one incubation nest and one brood nest, with the possibility of a second nest to lay a second clutch if the first one fails (Zembal et al. 2016 p. 32). If a second incubation nest site is needed, adults are capable of moving the eggs from one nest to another (Pettingill 1938 pp. 411–412). Initially, it was not believed that Yuma Ridgway's rail adults would re-nest (Eddleman 1989 p. 57), but Ridgway's rails in general are known to re-nest following nest failure (Eddleman and Conway 1998 p. 19). More information on re-nesting by the Yuma Ridgway's rail is needed to evaluate nesting success for demographic modeling.

Once a nest is constructed, the Yuma Ridgway's rail lays clutches of eggs. Clutch size can range from 5 to 10 eggs (Bennett and Ohmart 1978 p. 41, Eddleman 1989 p. 55), and incubation lasts 23-28 days (Figure 5). Eddleman (1989 p. 59) documented that males generally incubate at night and females during the day. We do not know the rate of hatching, but for other rail species eggs hatch over several days. Based on observations, hatching success is about 90 percent. However, chick mortality is high and estimated at approximately 80 percent (Bennett and Ohmart 1978 p. 42). After hatching, adults remain with the chicks for about 7 to 8 weeks, protecting them at night in brooding nests/platforms and accompanying them on foraging trips (Eddleman and Conway 1998 pp. 17–18). Because chicks are unable to float or swim due to their downy feathers, adult Yuma Ridgway's rails may carry chicks to protect them from adverse conditions

(Pettingill 1938 pp. 412–414, Bennett and Ohmart 1978 pp. 48–49). It is assumed that chicks will molt into juvenile plumage after a month, and that juveniles will molt into adult plumage after 6 to 7 weeks (Figure 5).

Definitive information on the lifespan of the Yuma Ridgway's rail is not available. Information from a 1970s record of a clapper rail (*Rallus longirostris*) indicate that the lifespan could be at least seven and a half years (Eddleman and Conway 1998 p. 19).

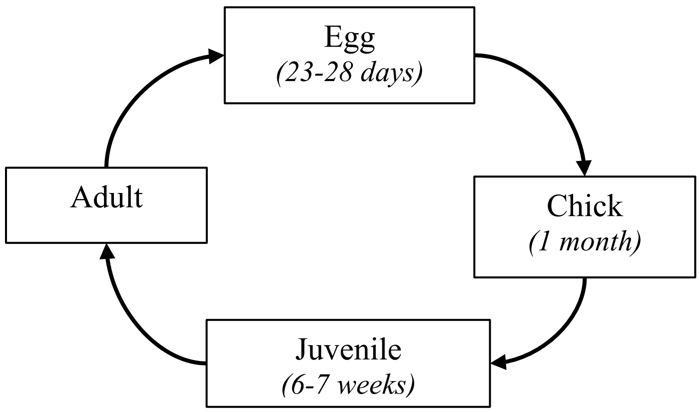

Figure 5. Life cycle of the Yuma Ridgway's rail from egg to chick, to juvenile, and finally to adult. These stages occur within 7 months.

Range and Distribution

Information on habitat needs, preferences, range, and distribution began in the mid-1970s. In 2020, results from a **telemetry study** on how the Yuma Ridgway's rail moves within its range was published and has contributed to improving our understanding of the subspecies (Harrity and Conway 2020). Our intent for this section is to provide the necessary information needed to assess the current and future status of the subspecies. References cited in this section contain more detailed information. Where we need to make assumptions, we try to use information from other freshwater marsh *Rallus* species.

Habitat

The Yuma Ridgway's rail is a marsh bird and needs freshwater marsh vegetation and marsh systems to complete important life stages (Table 2, Figure 9, Figure 10) which are more fully addressed in the Individual Rail Needs section. Freshwater marshes used by the Yuma Ridgway's rail are predominantly cattail (*Typha* sp.) and bulrush (*Scirpus* ssp.) with silt-dominated substrates and low turbidity. Observations indicate that optimal habitat consists of a mosaic of emergent vegetation (dominated by cattail and/or bulrush) averaging greater than 2 m (6 ft) high, and channels of water of various depths. Ideal habitat appears to have at least 40 percent open water with 50-70 percent vegetation that has at least 40 percent "greenness" (Tomlinson and Todd 1973 p. 179, Conway et al. 1993 p. 288, Eddleman and Conway 2020, Villagomez 2024a p. 30). Although previous studies have stated that Yuma Ridgway's rails prefer cattail and emergent vegetation in generally low stem densities (less than 75-80 stems/m^2) and low residual vegetation coverage (Smith 1975 p. 20, Bennett and Ohmart 1978 pp. 35, 38, Anderson and Ohmart 1985 pp. 123–124, Conway et al. 1993 p. 288), it is more likely that rails prefer moderate **interstitial spacing** between cattail or bulrush stalks (Conway et al. 1993 p. 288). This is likely because the Yuma Ridgway's rail forages by surface gleaning or shallow probing (Todd 1986 p. 70, Eddleman and Conway 1998 p. 7), and this moderate interstitial spacing allows for such foraging and navigating within cattail and bulrush stands. This optimum interstitial spacing occurs when cattail and bulrush are in the early **successional stages**. Cattail and bulrush marshes in later successional stages may have lower living-stem densities but have little if any interstitial space because of dead stalks and leaf cover. Low interstitial spacing limits movement and foraging opportunities within late-successional stands. Water appears to be the next key habitat factor with rails selecting bulrush and cattail stands with surface water (Anderson and Ohmart 1985 pp. 123–124). Water depths typically range from shallow (1-15 cm [6 in.]) to deep (61-183 cm [2-6 ft]) with a mix of stem densities (Smith 1975 p. 20, Bennett and Ohmart 1978 pp. 35, 38, Anderson and Ohmart 1985 pp. 123–124, Conway et al. 1993 p. 288). Fluctuations of water depth can occur during the breeding season, often with beneficial effects, if those fluctuations are gradual as opposed to sudden (Anderson and Ohmart 1985 p. 121, Eddleman 1989 pp. 79–87). Suitable marsh conditions also include open water areas either as channels or pools with low to moderate daily water fluctuation (Tomlinson and Todd 1973 p. 179, Gould 1975 p. 8). Areas with these conditions also contain open dry ground or mud flats (slightly higher than the water level) between water, vegetation, or marsh edge, which allows for foraging and movement (Smith 1975 p. 20; Eddleman 1989 pp. 87-88; Conway et al. 1993 p. 288). In some areas, a mix of riparian tree and shrub species (*Salix exigua*, *S. gooddingii*, *Tamarix* spp., *Tessaria serica*, and *Baccharis* spp.) along the shoreline of the marsh provides additional value by providing shade and additional cover from predators (Gould 1975 p. 6, Anderson and Ohmart 1985 p. 119, Todd 1986 pp. 42–43, Eddleman 1989 p. 74).

Optimum vegetation growth in freshwater marshes has a direct relationship with a 5-to-10-year disturbance regime. These disturbances, which were historically flooding events, washed out old decadent cattail, created mudflats, and reset water channels (Conway et al. 2010 p. 2031). With the absence of seasonal floods, prescribed fire currently helps remove old decadent cattail. Prescribed fire does not, however, remove root balls, or redistribute sediment to create mudflats and reset water channels (Conway et al. 2010 p. 2031). The timing of prescribed fire to have the best results, based on observations following wildfire events in the Ciénega de Santa Clara, appears to be in late fall (November), to late winter (February). In contrast, fires between spring (March) and mid-fall (October) have negative effects on the species. Fires in the late spring and early summer could burn nests and hatchlings; and in the late summer and early fall, adults and juveniles may be flightless and unable to escape the burns (Villagomez 2024b, 2025). Hydrological conditions that allow water to be present in a marsh when, or after, a fire occurs, is key to ensuring positive outcomes, regardless of time of year (Villagomez 2024a pp. 34–35).

Home range size varies spatially and temporally based on habitat quality. Home ranges are generally smallest during the early and late breeding seasons (March through July) at 7 to 8 ha (17- 20 ac) and largest in the post-breeding season (August through October) at 15 ha (37 ac) and late winter (January through February) at 24 ha (59 ac) (Conway et al. 1993 p. 287). Both sexes have similar home range sizes except in the post-breeding season, when females averaged about 21 ha (51 ac) and males 9 ha (22 ac) (Eddleman 1989 p. 36). These figures are significantly larger than those from previous studies, which ranged from 0.12 to 3.59 ha (0.29 to 9.5 ac) (Smith 1975 p. 22; Bennett and Ohmart 1978 pp. 43-44; Todd 1986 pp. 75-76). These earlier studies were conducted only during the breeding season while Eddleman (1989) and Conway et al. (1993) considered the entire year.

As discussed in greater detail below in the Migration and Dispersal section, we now know that, on average, 40 percent of adult Yuma Ridgway's rails migrate from their breeding habitats in the U.S. south to either the Ciénega de Santa Clara or even as far south as Sinaloa, Mexico (Harrity and Conway 2020 p. 305). The vegetative structure, prey components, and size of area needed within these wintering habitats are unknown. However, based on telemetry, some over-wintering Yuma Ridgway's rails depend on coastal mangrove wetland systems (Harrity and Conway 2020 p. 304).

Importantly, marshes are transitory environments that require either natural flooding or active management to reinvigorate the health of the vegetation and prevent areas from becoming dryland. In summary, the habitat features that are most important to the Yuma Ridgway's rail, based on our understanding of its life history and ecology, include:

1) Moderate interstitial spacing between cattail or bulrush stalks to allow for movement and foraging (Harrity pers. comm 2025).

2) Surface water varying in depth from shallow (1-15 cm [6 in.]) to deep (61-183 cm [2-6 ft.]) with gradual fluctuations during the breeding season, and saturated substrate. Optimal percentages appear to be at least 40 percent of open water to 60 percent vegetation (Smith 1975 p. 20, Bennett and Ohmart 1978 pp. 35, 38, Anderson and Ohmart 1985 pp. 123–124, Conway et al. 1993 p. 288).

3) A mosaic of vegetation, mudflats, and open water interfaces. Microhabitats support different life stages of the rail by providing protection from predators and diversity of prey resources. (Tomlinson and Todd 1973 p. 179, Conway et al. 1993 p. 288, Eddleman and Conway 2020, Villagomez 2024a p. 30).

4) Prey availability. The presence of crayfish, clams, and other aquatic invertebrates is important to provide food to the rail. These prey species can vary significantly depending on microhabitat (Ohmart and Tomlinson 1977, Anderson and Ohmart 1985 p. 123, Todd 1986 p. 69, Eddleman 1989 pp. 90–95, Conway 1990 pp. 34, 41).

5) Coastal mangroves. Some over-wintering Yuma Ridgway's rails in Sonora and Sinaloa, Mexico, depend on coastal mangroves (Harrity and Conway 2020 p. 305).

6) Vegetation mats. In areas of deep water, residual vegetation allows rails to utilize marshes by creating nesting platforms, facilitating movement, and foraging (Abbott 1940 p. 264, Bennett and Ohmart 1978 p. 40).

Historical Range

The historical distribution of the Yuma Ridgway's rail within the U.S. prior to 1900 is poorly understood. Prior to the early 1900s, the lower Colorado River was a free-running river that experienced very high, and very low, flows within a single year. Although marshes likely developed in and around backwaters and swales within the floodplain, their persistence was dependent on the flow of the river. During high flows, marshes could be eroded out or filled in with deposited materials; and if a connection to the river was lost then the marsh would dry out. Grinnell, during his biological surveys in 1908 and 1910 between Needles and Yuma, documented very little marsh vegetation along the river corridor, and did not document any rails (Grinnell 1908, 1914 pp. 72–73). This lack of documentation from Grinnell has led some to believe that the Yuma Ridgway's rail was not present in the lower Colorado River prior to dam construction (Ohmart and Smith 1973 p. 5). However, we disagree with this belief because of documentation of clapper rails in 1884 in Mohawk Valley, and then in 1902 near Yuma, Arizona (Todd 1986 p. 12). Because of the similarity of appearance, and belief that rails were not associated with freshwater marshes, these reports attributed these birds to "wandering light-footed" rails when they were likely the Yuma subspecies (Todd 1986 p. 12). Therefore, we assume that the Yuma Ridgway's rail was present along the lower Colorado River in low densities prior to the construction of dams because the habitat was more interspersed and dynamic compared to current conditions. We believe that the Colorado River Delta supported the largest densities of the subspecies prior to dam construction.

Current Range

The current range of the Yuma Ridgway's rail within the U.S. is thought to be a result of the construction of smaller water diversion structures (e.g., Laguna, Imperial, Palo Verde) and large water storage dams (e.g., Parker, Davis, and Hoover Dams). The presence of these dams and diversion structures controlled flooding and provided a constant water level that promoted sediment distribution. This spreading out of water and sediment in areas supported the growth of marshes within 10 to 15 years after dam construction, depending on the local sediment load and height of the dam (Grinnell 1914 p. 61, Ohmart and Smith 1973 pp. 5–6, U.S. Fish and Wildlife Service 1983 p. 4). This belief is supported by Yuma Ridgway's rails being captured around various dams within this timeframe (U.S. Fish and Wildlife Service 1983 pp. 4–5, 2009 p. 5). Over the course of the next few decades following dam construction, rails were documented by Laguna Dam (1921), the Salton Sea Basin (1931), the Cibola Valley (1950), near Bill Williams River Delta (1954), Topock Marsh (1966), and near Phoenix (1970s). By 1986, Yuma Ridgway's rails were detected in Las Vegas Wash by Lake Mead, and in 1998 rails were detected in the Virgin River above Lake Mead (U.S. Fish and Wildlife Service 2009 pp. 5–6). In contrast, the dams and water diversions that facilitated the spread of marshes in the U.S. resulted in the considerable loss of emergent marsh within the Colorado River Delta (Glenn et al. 1996 pp. 1777–1778, Hinojosa-Huerta et al. 2000 p. 7). However, the Colorado River Delta with the Rio Hardy Wetlands and Ciénega de Santa Clara, remains a critical portion of the Yuma Ridgway's rail range and population. Indeed, the Ciénega de Santa Clara is now the largest marsh in the region after being incidentally restored by agricultural run-off in the 1980s and 1990s from the Wellton-Mohawk Valley and Main Outlet Drainage Exit (MODE) (Glenn et al. 1996 p. 1181, Hinojosa-Huerta et al. 2000 p. 8, Carrillo-Guerrero et al. 2013 p. 88). Similarly, the Rio Hardy Wetlands has been restored with agricultural runoff from the Mexicali Valley (Glenn et al. 1996 p. 1181, Hinojosa-Huerta et al. 2000 p. 8).

In 2009, the estimated area of habitat throughout the Yuma Ridgway's rail range was 9,647 ha (23,838 acres [ac]) (U.S. Fish and Wildlife Service 2009 pp. 6–7). This estimate is no longer applicable due to changes in hydrology and habitat management. Therefore, we summarize the current range of the Yuma Ridgway's rail in terms of latitudinal and longitudinal scope.

Latitudinally, the current range of the Yuma Ridgway's rail extends from the Rio Hardy, Ciénega de Santa Clara and El Doctor wetlands in Mexico to the upper end of Lake Mead, and Pahranagat Valley in Nevada. Longitudinally, the Yuma Ridgway's rail's range is from the Salton Sea Basin in southern California, to the greater Phoenix area in Arizona.

We used environmental data, Yuma Ridgway's rail occurrence data from across the subspecies' range, and migratory information to develop Regional Analysis Units (RAU; Figure 6) because we do not have a clear population differentiation based on genetic evidence. We further subdivided each RAU into Local Analysis Units (LAU) based primarily on land ownership or mitigation projects. We do not include an RAU, and therefore analysis, of wintering habitats between the Ciénega de Santa Clara and Sinaloa, Mexico (Harrity and Conway 2020 p. 305). We acknowledge that these habitats are valuable to the species and those individuals that migrate; however, not enough is known about the needs of the Yuma Ridgway's rail in those areas or their vegetative structure. Thus, the RAUs described below were delineated around known breeding habitats. General boundaries for each RAU were applied to result in the following:

- Colorado River Delta RAU: South of the U.S. border to the Gulf of Santa Clara.
- Salton Sea RAU: Eastern extent is Imperial County S-34, western extent is Highway 86, northern extent is Interstate 10, and southern extent is the U.S.-Mexico border.
- Yuma RAU: Eastern extent is Citrus Valley, western extent is Imperial County S-34, northern extent is Interstate 10 by Blythe, and southern extent is the U.S.-Mexico border.
- Mid-Lower Colorado River RAU: Both eastern and western extents are the Lower Colorado River floodplain, northern extent is Laughlin, and southern extent is Interstate 10 by Blythe.
- Central Arizona RAU: Eastern extent is Roosevelt Lake; western extent is Citrus Valley. Both northern and southern extents are the lower Salt, Hassayampa, and Gila River floodplains.
- Nevada RAU: Southern extent is Laughlin. All other extents are within the Clark, southern Lincoln, and southern Nye Counties within Nevada.

We provide descriptions of these Regional Analysis Units, the habitat within them, and estimates of abundance within them below. Both RAUs and LAUs can include different land ownerships, and designations that have varying management responsibilities. This information was included where practicable. Finally, the estimates on rail abundance and habitat association information used in this document are from surveys conducted using the National Marsh Bird Protocol (Conway 2011 entire). Autonomous Recording Units (ARUs) have been experimentally deployed in some areas and have been successful at recording Yuma Ridgway's rails. These ARUs could be tools for future research, including the development of a protocol to complement survey efforts.

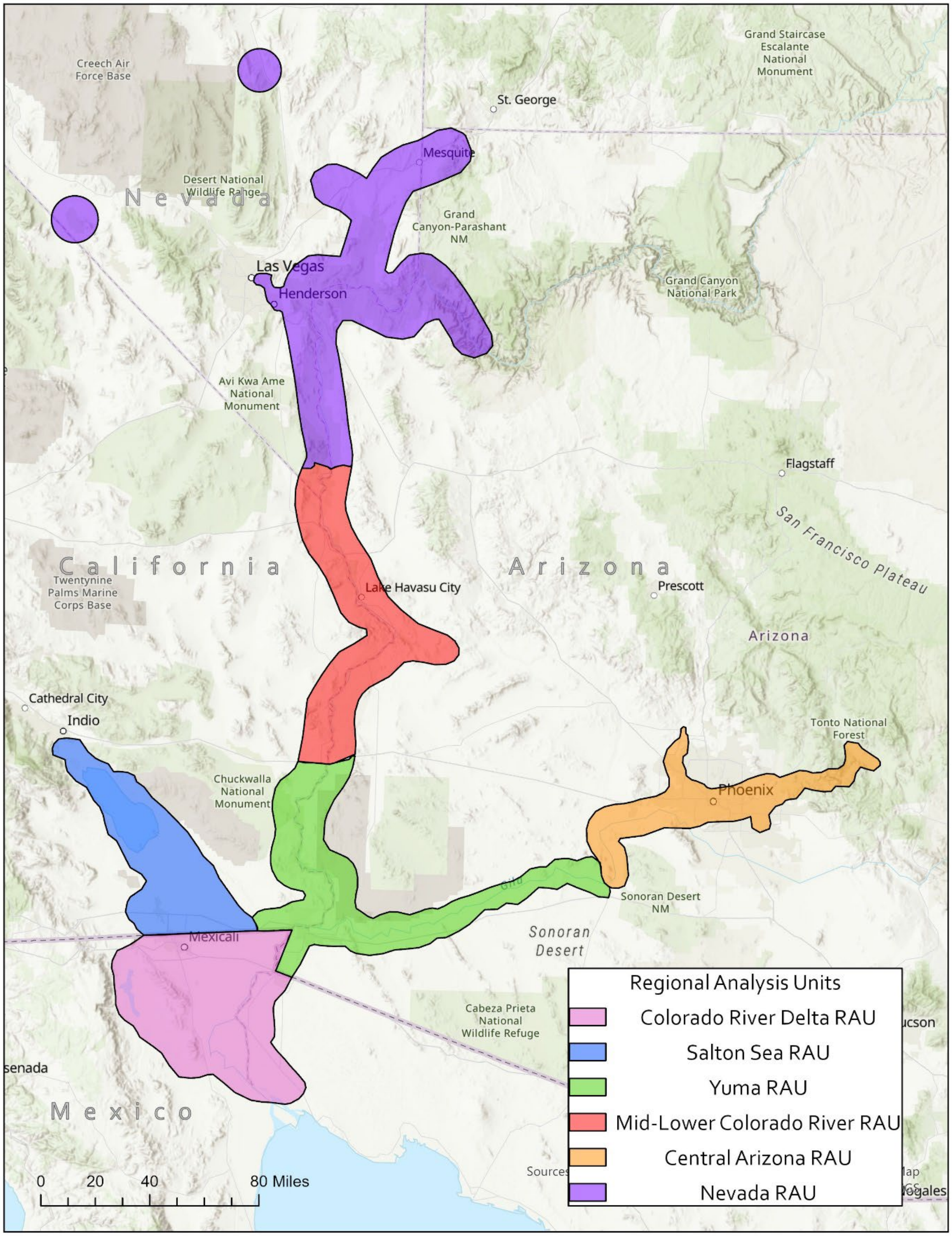

Figure 6. Range of the Yuma Ridgway's rail with pink, blue, green, red, orange, and purple geographical areas representing the Regional Analysis Units.

Colorado River Delta Regional Analysis Unit

The Colorado River Delta RAU is entirely in Mexico and includes the area east of the Cocopah Mountains to the eastward extent of the Colorado River floodplain that encompasses the historical extent of the Delta. Within this area, the Mexicali Agricultural Valley (Irrigation District 014-Río Colorado) encompasses 277,443 ha (685,283 ac) (Villagomez 2024b). This valley's agriculture is supported by most of Mexico's annual 1.5-million-acre feet (maf) Colorado River allocation. Within this valley, the riparian corridor along the Colorado River and the Rio Hardy has approximately 35,500 ha (87,722 ac) of marshes, and the Ciénega de Santa Clara comprises around 18,000 ha (44,460 ac) (Carrillo-Guerrero et al. 2013 p. 84). Both the Rio Hardy Wetlands and the Ciénega de Santa Clara are largely supported by agricultural return flows and seepage from unlined canals. There is no population estimate for the Rio Hardy Wetlands, but based on projections done by researchers, there could have been an estimated 5,974 (95 percent CI = 4,698–7,482) Yuma Ridgway's rails supported by the Ciénega de Santa Clara in 2006 (Hinojosa-Huerta et al. 2008 p. 72). This projection assumed a 100 percent response rate, as well as a consistent density of 1 rail/ha over the 5,800 ha (11,900 ac) of marsh within the Ciénega de Santa Clara (Hinojosa-Huerta et al. 2008 p. 72). This projection is not believed to be accurate, with likely detection rates between 30 and 75 percent depending on survey period and year. Because of this, the 2008 projection likely underestimated the true number of rails. As a result, this area is still believed to support the largest concentration of Yuma Ridgway's rails within the species' known range.

Conservation actions to protect existing, and develop new, marshes in this region involve cooperation and agreements among governmental and non-governmental agencies in the U.S. and Mexico.

Ciénega de Santa Clara

The Ciénega de Santa Clara is the largest wetland habitat within the Colorado River Delta RAU. The construction of the Wellton-Mohawk Main Outlet Drain Extension (MODE) canal by the Bureau of Reclamation to meet Salinity Control Act requirements resulted in saline drain water from the Welton Mohawk Irrigation District flowing into the previously dry, relict floodplain. Flows out of the MODE began in 1977, and within a few years, the Ciénega's wetlands had expanded to 18,000 ha (44,460 ac) (Carrillo-Guerrero et al. 2013 p. 84).

Currently, the Ciénega supports 5,800 ha (11,900 ac) of marsh and approximately 12,2000 ha (301,468.5 ac) of mud flats and open water (Villagomez 2024b). In the flooded areas, the dominant vegetation consists of emergent species such as cattail (*Typha domingensis*), bulrush (*Schoenoplectus spp*.), and common reed (*Phragmites australis*), while in the mudflat areas, vegetation is sparse, but halophytic plants can be found, including saltgrass (*Distichlis spicata*) and salt cedar (*Tamarix ramosissima)* (Zengel et al. 1995a p. 13). The Ciénega is part of the Biosphere Reserve Area (Flessa 2012 p. 3) and was also recognized as a Wetland of International Importance by the Ramsar Convention, a site of the Western Hemisphere Shorebirds Reserve Network and an Important Bird Area (Hinojosa-Huerta et al. 2007 p. 8). Within the Ciénega, 26 survey-routes with 5 counting stations each are consistently surveyed. These surveyed routes cover approximately 7 percent of the Ciénega de Santa Clara (Villagomez 2024b).

Rio Hardy Wetlands

The Rio Hardy is supported by agricultural drain flows from a portion of the Mexicali Agricultural Valley augmented with outflows from the Las Arenitas Wastewater Treatment Wetland, a 101 ha (250 ac) wetland system. Plans to construct a second 101 ha (250 ac) wetland to fulfill treatment requirements have been on hold since 2013 (Zamora 2013). If this project advances, an additional 12,000 acre-feet of water could be dedicated to the Rio Hardy. These additional flows would not only benefit the Rio Hardy, but could reconnect the lower Colorado to the sea, improving estuarine habitat in areas upstream of the river's mouth (Zamora 2013). Overall, flow from agricultural drains and the treatment wetlands supports over 18,314 ha (45,255 ac) of salt cedar, cattail, common reed, and bulrush within the Rio Hardy Basin (Villagomez 2024b). Some active management in the area is occurring, with an estimated 100 ha (247 ac) of area restored from salt cedar to cattail-bulrush marsh (Hinojosa-Huerta et al. 2004 p. 4). The Rio Hardy area also includes El Mayor and the Rio Pescadero, which drain into it.

Currently, the habitat in and around the Rio Hardy is not managed for the Yuma Ridgway's rail. Within the Rio Hardy Wetland, 161 counting stations are consistently surveyed. These surveyed routes cover almost 100 percent of the Rio Hardy wetlands (Villagomez 2024b).

Salton Sea Regional Analysis Unit

The Salton Sea RAU is the furthest west section of the Yuma Ridgway's rail within the U.S. and includes areas in and around the Salton Sea Basin in California. Within this area there are approximately 202,343 ha (500,000 ac) of irrigatable agricultural land. The Salton Sea RAU is entirely in California and includes the Sonny Bono Salton Sea National Wildlife Refuge, Imperial Irrigation District (IID) managed wetlands, the Imperial Wildlife Area-Wister, and the Coachella Valley which supports the Dos Palmas Preserve. Agriculture in the area is supported by 3.1 maf of Colorado River allocation, and the primary water inflow into the Salton Sea is from agricultural drain water. The evaporation rate exceeds the amount of inflow causing the Salton Sea to recede. As the Salton Sea recedes cattail and bulrush vegetation develop on the newly exposed dry playa around agricultural drains.

Within the Salton Sea RAU various programs, projects and agreements have been developed to create, manage, and mitigate for the changes in water use and allocations. Of note, the IID Managed Marsh, and the Imperial Wildlife Area-Wister are mitigation properties that must be maintained into perpetuity. There is also the proposed Coachella Valley Multiple Species Habitat Conservation Plan (CVMSHCP), which is a landscape-level conservation plan aiming to implement a shared regional vision for balanced growth to conserve Coachella Valley's natural resources. Implementation of this plan would conserve, create, and manage 259 ha (641 ac) of habitat at the Dos Palmas Conservation Area and approximately 23 ha (56 ac) of habitat at the Coachella Valley Stormwater Channel and Delta Conservation Area. This conservation goal is to conserve and manage about 94 percent of the available rail habitat in the CVMSHCP area.

As mentioned above, as the Salton Sea recedes due to evaporation and water conservation and transfer programs, agricultural drain water that is draining onto the dry playa is creating incidental habitat for the rail. This habitat is not managed for the rail and is not included in protocol surveys, although rails are known to occur within these areas. Estimates of the total available marsh supported by the refuge and agricultural return flows range from 1,445 ha (3,569 ac) to 2,210 ha (5,461 ac) (U.S. Fish and Wildlife Service 2023 pp. 38, 39, 42, 59, 2024 pp. 2, 6).

Sonny Bono Salton Sea National Wildlife Refuge

The Sonny Bono Salton Sea National Wildlife Refuge was established for migratory birds and, historically, the majority of the land established as the Refuge was submerged (U.S. Fish and Wildlife Service 2014 p. 1-12). As the Salton Sea dries, these areas are becoming exposed and, as a result, developing incidental marsh vegetation. The units under intentional management are on lands leased to U.S. Fish and Wildlife Service by the Imperial Irrigation District (IID) and California's Department of Fish and Wildlife (CDFW) (U.S. Fish and Wildlife Service 2014 pp. 1–12). The 2014 Sonny Bono Salton Sea National Wildlife Refuge Comprehensive Conservation Plan lays out the management actions for the next 15 years that include goals for management of habitat conditions for a suite of migratory and resident bird communities that were the focus of Refuge establishment.

To date, the Sonny Bono Salton Sea National Wildlife Refuge has managed up to 99 ha (245 ac) of wetland cells for Yuma Ridgway's rails (Anderson 2015 p. 1). However, under the 2014 CCP, the Yuma Ridgway's rail habitat would be a minimum 73 ha (180 ac), a reduction of 27 percent. The CCP acknowledges the need for all water-dependent habitat management to have an adequate water supply from IID to support the bird communities and marshes for Yuma Ridgway's rail (U.S. Fish and Wildlife Service 2014 pp. 3–5, 6, 9). The CCP does not describe the prioritization process for which bird communities are managed; however, clauses within the CCP allow the Sonny Bono Salton Sea National Wildlife Refuge to prioritize which areas are managed and for what bird communities (U.S. Fish and Wildlife Service 2014 pp. 16–19). Overall, the Salton Sea shows high occupancy, though the location of marsh vegetation and survey routes has shifted over time. Within the last 3 years approximately 10 routes have been consistently surveyed. These surveyed routes cover approximately 134 ha (332 ac) of 235 ha (581 ac) of available marsh, or 57 percent of the Refuge.

Wister

The Imperial Wildlife Area-Wister Unit (IWA-Wister) was established to provide waterfowl habitat and now supports a variety of wetland bird communities (Thompson and Nicol 1989 p. 1). In its management plan (Thompson and Nicol 1989 p. 76), IWA-Wister identified approximately 450 ha (1,120 ac) encompassing seven wetland cells as priority areas for Yuma Ridgway's rail. IWA-Wister has an enhancement goal to manage an additional 40 ha (100 ac) of land that could be leased from IID for wildlife management (Thompson and Nicol 1989 p. 51). The 1989 management plan for IWA-Wister also acknowledged the need for both basic maintenance and ongoing reconstruction of the physical infrastructure to maintain the integrity of the managed cells (Thompson and Nicol 1989 pp. 1, 25–30, 71–73). It is unknown how many routes are consistently surveyed within the IWA-Wister, and what proportion of the unit is therefore covered. Regardless, this wildlife area will remain an important breeding, foraging, and dispersal habitat for the Yuma Ridgway's rail.

Dos Palmas Preserve

Dos Palmas Preserve is located on the northeast side of the Salton Sea and is managed by the Bureau of Land Management's Palm Springs-South Coast Field Office. Dos Palmas Preserve supports both intentional and incidental habitat for Yuma Ridgway's rails. The Dos Palmas Preserve supports about 61 ha (150 ac) of emergent marsh managed for several species of conservation concern (e.g., California black rail). These marshes are managed in a series of interconnected units characterized by emergent marsh vegetation (e.g., *Typha* spp., S*choenoplectus* spp.) and water depths generally <1 m. These marshes are supported by groundwater supplemented with about 4,850 acre-feet per year of Colorado River water as required mitigation to offset loss of marsh vegetation associated with the Coachella Canal Lining Project (Final EIS/EIR April 2001). The mitigation water supports at least 49.4 ha (122 ac) of marsh. Within the Stormwater and Delta area, these habitats are maintained by water drained upstream into the channel. Further, there is a 10(a)(1)(B) permit that requires these habitats be conserved in perpetuity, regardless of funding.

Yuma Regional Analysis Unit

The Yuma RAU is the furthest south section of the Yuma Ridgway's rail within the U.S. and includes areas in and around Yuma, Arizona. Approximately 99,147 ha (245,000 ac) of irrigatable land that receives mainstream Colorado River water exist within this area. This agriculture is supported by the 1.3 maf of agricultural entitlements provided annually which is a part of the 7.5 maf of the Lower Colorado River allocation. The NWRs within this regional unit (Imperial and Cibola NWRs) also hold entitlements to the consumptive use of 23,000 and 16,793 ac-ft of Colorado River water, respectively. The agricultural and refuge entitlements support approximately 1,011 ha (2,498 ac) of marsh. While the agricultural entitlement water is not allocated to marsh areas, the return flow of water utilized on those lands which passes through habitat areas is considered system water, resulting in the additional presence of water beyond the 39,793 ac-ft of entitled water that can be consumptively used within the Refuges. Overall, within this regional unit, approximately 1,714 ha (4,235 ac) of marsh is supported by the Refuges, agricultural return flows, active water pumping, system water and backwaters, especially following flood events.

Conservation actions to protect existing, and develop new, marshes in this region involve intentional management by state and federal partners. Management of incidentally created habitat involves, or will need to involve, cooperation and agreements among governmental, non-governmental, and private partners in the area.

Arizona Game and Fish Department-Southwest

The Arizona Game and Fish Department, Region IV, is responsible for numerous survey routes within the Yuma RAU. Of the 25 historically surveyed routes, 17 are surveyed with relative consistency. These routes include the Quigley-Achee and Mittry Lake Wildlife Management Areas (WMAs), which are designated as Important Bird Areas and support about 1,100 ac (445 ha) of open water and marshlands. Of these 17 routes being surveyed, 11 are located within the Mittry Lake WMA, and 1 is located in the Quigley-Achee WMA. The remaining routes are situated along the Lower Colorado and Lower Gila rivers. Monitoring of routes in the limitrophe zone of the Lower Colorado River has ceased due to habitat loss and security concerns. Along the Lower Gila River, monitoring of certain routes has also stopped, primarily due to habitat loss caused by drought, upstream water diversions, and cessation of irrigation.

The Restoration of Tacna Marsh Project at the Quigley-Achee WMA began in September of 2022 and involves removing non-native vegetation and the creation of two ponds that will provide approximately 4.5 ac (1.8 ha) of open water surrounded by marshland. The first pond was completed in June of 2023 and is successful in supporting wildlife with marsh birds, waterfowl, and mule deer observed benefiting from the pond's habitat. Additional marsh vegetation growth will be supported at the southern end of Pond 2 by allowing overflow conditions to occur.

Current threats to habitat in the Mittry Lake WMA include:

1. Environmental change and drought.
2. The invasion of non-native species such as tamarisk (*Tamarix* spp.) and common reed, which have overtaken much of the riparian area and established colonies in several parts of the lake.
3. Wildfire due to historical fire suppression.
4. Accumulation of agricultural and forestry effluents.

Current management strategies focus on:

1. Maintaining fire breaks to prevent catastrophic wildfires in native habitat.
2. Use of prescribed burns to reduce fuel loads.
3. Removal of **invasive species** and restoration of native plants.
4. Enhancement of wetland habitat to restore natural function.

Adjacent land use changes, primarily the cessation of irrigation, have resulted in the loss of marsh vegetation at the Quigley-Achee WMA.

Lower Colorado River MSCP Conservation Areas

Within this RAU, the Bureau of Reclamation is not only the land manager for the Imperial and California River Channels but also implements the Lower Colorado River Multi-Species Conservation Plan (LCR MSCP). According to current Bureau of Reclamation materials, 18 Conservation Areas have been established under the LCR MSCP to date (Dewar et al. 2024), though the 2004 HCP anticipated up to 30 total Conservation Areas once fully implemented (LCR-MSCP 2004 p. 5-20). Of the 18 established Conservation Areas, 10 have marsh vegetation, 7 of which are within this RAU. These include 4 within either Cibola or Imperial National Wildlife Refuges, the Yuma East Wetlands, Yuma Meadows, and the Laguna Division Conservation Area. All 7 of these LCR MSCP Conservation Areas, and the Imperial and California Channels, support approximately 311 ha (769 ac) of marsh in the region.

Yuma East Wetlands

The Yuma East Wetlands was established between Arizona and California in 2014 as a part of a multi-party land use agreement. It is composed of a variety of tree species. The predominant vegetation established in this Conservation Area is cottonwood (*Populus* *fremontii*)-willow (*Salix* spp.); however, 38 ha (94 ac) of marsh serve as valuable breeding, foraging, and dispersal habitat for the rail.

Yuma Meadows

The Yuma Meadows was identified as a conservation area in 2018 for a combination of disconnected backwaters and rearing ponds for razorback suckers and bonytail chub. There are approximately 49.8 ha (123 ac) of these disconnected backwaters. While this Conservation Area is not managed for the Yuma Ridgway's rail and marsh vegetation, there are incidental pockets of marsh along the edges of these backwaters. The amount of incidental rail habitat is unknown, but it can serve as valuable foraging and dispersal habitat for the rail.

Laguna Division Conservation Area

The Laguna Division provides an area for larger-scale riparian and marsh restoration and enhancement opportunities. Geographically, it is a relatively wide area with several low linear depressions from previous Colorado River meanders. These legacy meanders were used to maximize restoration design potential. As a result, this Conservation Area is intended to satisfy a portion of the LCR MSCP Habitat Conservation Plan requirements with approximately 150 ha (370 ac) of marsh.

Cibola National Wildlife Refuge

The Cibola National Wildlife Refuge (Cibola NWR) was designated as a national wildlife refuge in 1964 through Public Land Order 3442 to specifically mitigate the impacts from the channelization of the Lower Colorado River below Parker Dam in the Blythe, California, area. The refuge is dedicated to the management and protection of migratory birds, wintering waterfowl, and resident wildlife and bird species. Through mitigation of the Lower Colorado River channelization, Cibola NWR provides marshes, backwaters, and meanders as habitat for wildlife. Cibola NWR currently supports approximately 398 ha (983 ac) of marsh (including some open water in units such as the Old River Channel and Hart Mine Marsh) habitat within the region (U.S. Fish and Wildlife Service 1994 pp. 184–198). Of this, approximately 236 ha ([584 ac]; the Island Unit, Cibola Lake, and Hart Mine Marsh units specifically) of marsh is actively managed for the Yuma Ridgway's rail through prescribed fires, water pumping, and chemical/mechanical treatments for invasive plant species. Of the eight fixed, permanent routes historically surveyed on Cibola NWR, all of them are currently surveyed with relative consistency and cover the main marsh areas on the refuge (approximately 398 ha [983 ac]). This allows for at least 90 percent of available marsh to be routinely assessed for rails.

In 2007, a land-use agreement was signed between the U.S. Fish and Wildlife Service and the Bureau of Reclamation to allow the Bureau of Reclamation to create and maintain 387 ha (956 ac) within the refuge. Known as Unit #1, the area was converted to cottonwood-willow land cover. In 2018 the agreement was amended to expand the conservation area to 1,008 ha (2,492 ac) for additional acres of cottonwood-willow.

Imperial National Wildlife Refuge

The Imperial National Wildlife Refuge (Imperial NWR) was designated as a wildlife refuge in 1941 for the purposes of providing habitat and breeding areas for migratory birds. The portion of the Lower Colorado River that flows through this refuge includes the last un-channelized section of the river before it enters Mexico. Decreasing marsh productivity and net marsh loss are ongoing processes affecting the backwater system at Imperial NWR (U.S. Fish and Wildlife Service 1994 pp. 67–68). These processes are most prevalent in marshes no longer receiving direct flow from the river. Sedimentation from the river has filled former channels connecting these marshes to the river. Evaporative water loss in these marshes often exceeds recharge through subterranean flows, resulting in increased salinity and decreased productivity. It is hypothesized that water depth is decreasing due to high rates of evaporative water loss and the annual deposition of organic detritus from algal and plant die-offs. Several backwaters which used to be open water have become dense stands of cattail.

In 2002 the Biological and Conference Opinion on the Lower Colorado River Operations and Maintenance was amended to enhance the shallow backwater pond established by Ducks Unlimited in 1997 (U.S. Fish and Wildlife Service 2002 p. 5). A subsequent Land Use Agreement was established between the Bureau of Reclamation and the U.S. Fish and Wildlife Service to allow the Bureau of Reclamation to enhance and maintain the Imperial Ponds Conservation Area in Arizona. These ponds are within a portion of the refuge known as the Martinez Lake Management Unit and include approximately 5 ha (12 ac) of marsh in the southeast corner of the intensive management area. In 2002 a similar agreement was also signed to allow the enhancement and maintenance of McAllister Lake. McAllister Lake is a 16 ha (40 ac) isolated floodplain lake and is not currently actively managed for the Yuma Ridgway's rail. However, it is surveyed by Imperial NWR staff and these surveys indicate that the Yuma Ridgway's rail uses this area for breeding, foraging and dispersal.

Imperial NWR currently supports approximately 613 ha (1,515 ac) of marsh within the region. Of this, 81 ha (201 ac) of marsh is actively managed for the Yuma Ridgway's rail through prescribed fires, water pumping, and mowing. Starting in Fiscal Year 2025 the Lower Colorado River Marsh Burn Project will add an additional 222 ha (550 ac) of marsh that will be actively managed through rotational prescribed burns. This brings the total to 306 ha (757 ac) of actively managed marsh for Yuma Ridgway's rail. Of the 9 routes historically surveyed on the Refuge, eight are currently surveyed with relative consistency, allowing for 49 percent of available marsh to be routinely assessed for the rail.

Mid-Lower Colorado River Regional Analysis Unit

The Mid-Lower Colorado River RAU is the central-most section of the Yuma Ridgway's rail distribution within the U.S. and includes areas in and around the Havasu, Arizona area. Agriculture is prevalent in the area, but approximations of the hectares of irrigatable land and agricultural water entitlements are not available. The National Wildlife Refuges within this regional unit (Bill Williams River and Havasu NWRs) also hold entitlements to the consumptive use of 4,000 and 6,000 ac-ft of Colorado River water, respectively. Approximations on the amount of marsh supported by these refuge entitlements are unknown. Although agricultural entitlement water is not allocated to marsh areas, the water that returns from agricultural use flows through habitat and is treated as system water, adding to the water available beyond the Refuge's consumptive entitlement. Total approximations of available marsh supported by the Refuges, agricultural return flows, active water pumping, system water and backwaters are roughly 1,818 ha (4,492 ac) (Pers. comm Harrity, 2025).

Conservation actions to protect existing, and develop new, marshes in this region involve intentional management by state and federal partners. Management of incidentally created habitat involves, or will need to involve, cooperation and agreements among governmental, non-governmental, and private partners in the area.

Bill Williams River National Wildlife Refuge

The Bill Williams River National Wildlife Refuge (Bill Williams River NWR) was established in 1941 and expanded in 1977, encompassing 6,100 acres transferred from Havasu Lake NWR. Located at the confluence of the Bill Williams River and the Colorado River, this refuge protects one of the last remaining intact riparian forest ecosystems in the Lower Colorado River region (U.S. Fish and Wildlife Service 1994 p. 180). The refuge includes diverse habitats such as cottonwood-willow forests, cattail marshes, and uplands interspersed with saguaros (*Carnegiea gigante*a) and mesquite (*Prosopis* spp.). These habitats are essential for the Yuma Ridgway's Rail, which relies on dense marsh vegetation for nesting, breeding, and foraging. Key challenges to habitat sustainability at Bill Williams River NWR include sedimentation, invasive species such as tamarisk, and hydrological alterations caused by upstream water diversions. Sedimentation reduces water flow to wetlands, while tamarisk displaces native vegetation, negatively impacting habitat quality. Management strategies at the Bill Williams River NWR focus on restoring riparian habitats by removing tamarisk, maintaining water flow to critical wetlands, and mitigating sedimentation impacts. These efforts are guided by the National Wildlife Refuge System Improvement Act of 1997 and align with the LCR MSCP (U.S. Fish and Wildlife Service 1994 p. 181).

The Bill Williams River Delta contains 285 ha (705 ac) of marsh. This marsh is actively managed for the Yuma Ridgway's rail through prescribed fire.

Havasu National Wildlife Refuge

Havasu National Wildlife Refuge (Havasu NWR) was established in 1941 by Executive Order 8647 under President Franklin D. Roosevelt to conserve critical migratory bird habitats. Spanning 37,515 acres along the Lower Colorado River, the refuge contains a variety of habitats, including open water, backwaters, riparian corridors, and uplands (U.S. Fish and Wildlife Service 1994 p. 52).

In 2001, a land-use agreement was signed between the U.S. Fish and Wildlife Service and the Bureau of Reclamation to allow the Bureau of Reclamation to create and maintain the Beal Lake Conservation Area. This Conservation Area includes approximately 91 ha (225 ac) of backwaters for native fish. Although this Conservation Area is not managed for the Yuma Ridgway's rail and marsh vegetation, it contains approximately 40 ha (94 ac) of incidental pockets of marsh that serve as valuable foraging and dispersal habitat for the rail.

In 2010 and 2012, funds were provided by the Bureau of Reclamation to the U.S. Fish and Wildlife Service to build a pumping platform and to establish a long-term fund for maintenance of the canal and pump system. This infrastructure will help to maintain the 1,619 ha (4,000 ac) of habitat within Topock Marsh. Topock Marsh is a key feature of the refuge and provides vital habitat for the Yuma Ridgway's rail. The marsh is actively managed through water-level manipulation, prescribed burns where possible, and invasive species control to maintain its ecological productivity. Because of the expanse of habitat and backwater locations, surveys within these areas are difficult. Topock Gorge is also a part of the refuge and provides vital habitat for the Yuma Ridgway's rail. However, information to quantify the possible area of marsh habitat in Topock Gorge is not available.

The refuge faces challenges including sedimentation, invasive species such as tamarisk, and recreational pressures from nearby urban developments. Climate variability and reduced water availability further stress wetland habitats. Management strategies at Havasu NWR include rotational prescribed burns where possible, adjustments to water levels from water releases and pumps, and invasive species removal to ensure the health and productivity of Topock Marsh. These actions align with the National Wildlife Refuge System Improvement Act and regional conservation objectives to support migratory bird populations along the Pacific Flyway (U.S. Fish and Wildlife Service 1994 p. 173-178). An estimate of the total area of potential marsh is not currently available.

Lower Colorado River MSCP Conservation Areas

As described above, the LCR MSCP included the establishment of twenty conservation areas, ten of which have marsh vegetation. Three of which are within this RAU and include the Planet Ranch, Mohave Valley Conservation Area, and Section 26 Conservation Area. In total, these combined areas support an estimated 52 ha (128 ac) of backwater areas that will support an unknown amount of incidental marsh vegetation.

Planet Ranch

In 2008, land and water resolutions were approved which authorized the Bureau of Reclamation to enter into negotiations with the Byner cattle company (a subsidiary of Freeport McMoRan) to lease the property and to maintain a 2,245 hectare-feet (5,549 acre-feet) of water entitlement to be used for conservation activities at Planet Ranch. The property is now managed by the Arizona Game and Fish Department and encompasses approximately 1,383 ha (3,418 ac) of land including an estimated 23 ha (58 ac) of backwater habitat being created and managed by the LCR MSCP in collaboration with the Arizona Game and Fish Department. While these backwaters are managed to support native fish augmentation, it is expected that marsh vegetation associated with these backwaters will also support the Yuma Ridgway's rail. The amount of this incidental rail habitat is unknown, but it serves as valuable foraging and dispersal habitat for the species.

Mohave Valley Conservation Area

The Mohave Valley Conservation Area is a habitat restoration site created for the benefit of threatened and endangered species, specifically endangered native fish like the razorback sucker. Construction began in 2017 and is currently ongoing. Once completed, this Conservation Area will include 20 ha (50 ac) of connected backwaters. It is expected that marsh vegetation will establish within these backwaters to support habitat for the Yuma Ridgway's rail. The expected amount of this incidental rail habitat is unknown, but it serves as valuable foraging and dispersal habitat for the species.

Section 26 Conservation Area

In 2017, 39 ha (97 ac) were selected for the creation of the Section 26 Conservation Area. This conservation area will contain backwater habitat that will connect to the Colorado River. Once completed, this Conservation Area will include 9 ha (23 ac) of connected backwaters. It is expected that marsh vegetation will establish within these backwaters to support habitat for the Yuma Ridgway's rail. The expected amount of this incidental rail habitat is unknown, but it will serve as valuable foraging and dispersal habitat for the species.

Central Arizona Regional Analysis Unit

The central Arizona range includes the Gila, Hassayampa and Salt River watersheds. The primary occupied habitat includes the mainstem of the rivers, local agricultural drains that divert from and feed back into the rivers, and isolated wetlands. This area is prone to wildfires, and recruitment of cottonwood and willow following these fires is limited. The available cattail habitat on the mainstem of the rivers are incidentally managed through high flow events upstream in the watershed and subsequent water releases from the various dams. Arizona Game and Fish Department owns and manages several sections of the Gila River and removes invasive vegetation species to revitalize the riparian vegetative community. The control of water primrose (*Ludwigia hexapetala*) and giant reed (*Arundo donax*), which can quickly become dominant and outcompete cattail, remains a need. Several city-managed and private property wetlands also contribute to the overall occupied and suitable habitat for the rail. The Important Bird Area (IBA) within this RAU was established in 2002, covers 14,830 ha (36,646 ac), and includes a variety of land ownerships. This IBA supports an estimated 77 ha (190.3 ac) of marsh (Pers. comm Harrity 2025). Yuma Ridgway's rails within this RAU are less dense than other units within the subspecies' range. However, the rails within this unit appear to have unique behavioral adaptations, including increased migration behavior. These adaptations are believed to be tied to the stochastic nature of the wetlands and marshes in the area and could indicate a greater resiliency to environmental changes. Therefore, maintaining a persistent population and habitat within this unit is necessary for the redundancy and representation of the species for its continued resiliency into the future.

Tres Rios and Rio Salado

Three Safe Harbor Agreement areas currently exist within the Central Arizona RAU. These include the City of Tempe's Rio Salado Habitat Restoration Project, the City of Phoenix's Rio Salado Habitat Restoration Area, and the City of Phoenix's Tres Rios Environmental Restoration Area. The City of Tempe entered into a Safe Harbor Agreement in 2008 for the Rio Salado Project, which was amended in 2018. In 2019, an estimated total of 0.81 ha (2 ac) of potentially suitable marsh vegetation is available within the project area (Nicholson 2019 p. 6). The City of Phoenix's Rio Salado Safe Harbor Agreement, signed in 2011 and amended in 2016, had an original baseline of zero acres of rail habitat. However, a 2019 habitat assessment identified

13.35 ha (33 ac) of marsh vegetation that occurred in various sized patches within the Safe Harbor Agreement area (Balluff 2024a p. 2). The City of Phoenix entered into another Safe Harbor Agreement for their Tres Rios Restoration Area in 2011, and which was amended in 2019 to account for an adjustment in the enrolled area. In 2023 there was an estimated 23 ha (57.3 ac) of marginal rail habitat and 1.42 ha (3.5 ac) of potential breeding habitat for the Yuma Ridgway's rail (Balluff 2024b p. 3). Included in this estimate is the 5.66 ha (14 ac) of general wetlands and ponds that were designed and constructed to further treat wastewater from the 91st Avenue Wastewater Treatment Plant, and which are now consistently being treated with prescribed fire to maintain the health of the habitat. Annual marsh bird surveys within and around these Safe Harbor Agreement areas occur annually or semi-annually, allowing for nearly all areas where there is marsh vegetation to be routinely assessed.

Arizona Game and Fish Department

The Arizona Game and Fish Department coordinates numerous survey routes within the Central Arizona RAU which include several Arizona Game and Fish Commission owned Wildlife Management Areas (WMAs). Of the 32 routes historically surveyed by the Arizona Game and Fish Department and partners, 20 are currently surveyed with relative consistency. The WMAs within this unit that support the Yuma Ridgway's rail include the Base and Meridian WMA, Arlington WMA, and Robbins Butte WMA. These WMAs support an approximate 184 ha (455 ac) of marsh in the region.

Base and Meridian Wildlife Management Area

The Base and Meridian WMA is located at the southwest corner of the Phoenix metropolitan area at Avondale Boulevard (formerly 115th Avenue) and the Gila River within Maricopa County, Arizona. It was established in 1973 with cooperation from county, state, and federal agencies. The total area of this WMA is approximately 423 ha (1,045 ac) along the north bank of the Gila River near the confluence with the Salt River and the Tres Rios Conservation Area. The Arizona Game and Fish Department, Bureau of Land Management, U.S. Fish and Wildlife Service, Maricopa County Department of Transportation, and the Flood Control District of Maricopa County work together to be involved in this area. A draft agreement between the Arizona Game and Fish Department and the City of Phoenix for 20 acre-feet per day from the 91st Avenue Water Treatment Plant for effluent water was prepared in 1973. This conveyance was never finalized. The current, and future, operations of the Tres Rios Conservation Area are, and will be, critical for water availability to the area. The overall vegetative structure within this WMA is composed of tamarisk, saltbush *(Atriplex* spp.), palo verde (*Parkinsonia* spp.), and mesquite in the uplands, and Fremont's cottonwood (*Populus fremontii*), Goodding's willows (*Salix gooddingii*), cattail, and grasses within the river corridor. The presence, and expansion, of the water primrose in this area is likely hindering the establishment of new stands of cattails. Because of this, and variability of flows within the river channel, marsh vegetation within this WMA is variable and an estimate on available marsh is unavailable. However, approximately 0.85 river mile, or 46 ha (114 ac), occur in this WMA where marsh vegetation has been most frequently surveyed. However, possible rail habitat pockets likely exist along the whole corridor, but access to these areas is a limiting factor. Yuma Ridgway's rails have been consistently detected within this WMA since 1996, and one route routinely surveyed goes along both the north and south banks of various braids of the mainstem of the lower Gila River for approximately 2.5 miles.

Arlington Wildlife Management Area

The Arlington WMA is located along the floodway and west bank of the Gila River approximately 3.5 miles south of Arlington and 15 miles southwest of Buckeye in Maricopa County. It was first established in 1950 but has had multiple land acquisitions up until 2009. The total area for this WMA is currently 785 ha (1,941 ac) and is located just north of the historical Gillespie Dam. The overall vegetative structure within this WMA is comprised of both riparian floodway and upland terrace along the lower Gila River. Terrace soils are deep and fine, silty in most places, and sandy in others. Most of the uplands and much of the floodway are large salt cedar stands with saltbush or seepweeds (S*uaeda* spp.) as dominant shrubs. Within this WMA are Arizona Game and Fish Department-owned agricultural fields. Half of the current acreage used for agricultural crops for small game birds is non-operational due to lack of water infrastructure. Installing a new irrigation ditch through the center of the fields to provide water to both the eastern and western fields and regrading the fields to a 2-degree slope, are goals under the Arlington Wildlife Area In-Lieu Fee Mitigation Project (A. Lauria pers. comm 2025). Under this project, the Arizona Game and Fish Department will create and restore approximately 84 ha (208 ac) of emergent wetlands and xeric-riparian mesquite bosque habitat. Also within this area are actively managed ponds. These ponds are the only part of the property that use pumped groundwater and irrigation tail water from adjacent lands to maintain waterfowl and marsh bird habitat. These pockets of marsh, including the Arlington Wildlife Area 7.6 ha (19 ac), Arlington drain which is 0.44 miles long. Each of these pockets has a survey route associated with it that is consistently surveyed. Active management of constructed marsh cells within this WMA occurs using prescribed fire. Yuma Ridgway's rails have been detected within this WMA since 2006, with fluctuations in the numbers detected depending on habitat maintenance and water availability.

Robbins Butte Wildlife Management Area

The Robbins Butte WMA is located approximately 7 miles southwest of Buckeye in Maricopa County. It was established in 1954 to protect and manage wildlife populations within the Gila River corridor. The Arizona Game and Fish Department currently manages the area through habitat restoration and public recreation. The total area for this WMA is 4,258 ha (10,522 ac). The Arizona Game and Fish Department, Bureau of Land Management, U.S. Fish and Wildlife Service, Maricopa County Department of Transportation, and the Flood Control District of Maricopa County work together in this area. This WMA contains terraced zones of deep fertile soils which are actively managed with plantings of native vegetation and crops for wildlife use. General natural vegetation in the area includes creosote bush (*Larrea tridentata*), wolfberry (*Lycium* spp.), bursage (*Ambrosia* spp.), saltbush, and seepweed in particularly saline areas. Within the river corridor, marsh vegetation is most consistent along 0.85 miles, or 46 ha (114 ac) of the lower Gila River. However, possible marsh pockets are likely to exist along the whole corridor, but access to these areas is a limiting factor. Yuma Ridgway's rails have been detected here as early as 2001 and have had nearly annual detections since. There is one survey route within this WMA that is consistently surveyed.

Lower Gila River Valley

There are agricultural drain outflows, isolated ponds, and river confluences that are a critical component to the continued persistence of pockets of marsh vegetation within the lower Gila River Valley. These areas of incidentally created marsh tend to be linear stands of cattail within drains, or immediately within the outflow into the lower Gila River. There is often dense overstory of willow and tamarisk in these outflow areas. Because of these factors, we do not have an accurate estimate of how much marsh is supported. It is unknown how many acre-feet of water is discharged via drains. As loss of agricultural land to development, and changes in water delivery occur, these unsecured marshes are at increasing risk of losing their water sources.

Citrus Valley

Citrus Valley is the furthest west section of the Central Arizona RAU. This area, while historically surveyed, is not consistently surveyed currently. The town of Gila Bend is 10.5 miles east of the nearest survey point. Marshes, and historically surveyed locations, were more prominent north and south of Sisson Road to the west of 419th Avenue. However, pockets of potential marsh are likely available throughout this area because of agricultural drain outflows. Because of the lack of consistent surveys, habitat monitoring, and private land, the status of both marsh availability and occupancy of rails within this area is unknown. It's likely that changes in water delivery and fallowing of agricultural land contribute to available rail habitat that is at increasing risk of dewatering and desiccation.

Southern Nevada Regional Analysis Unit

The Southern Nevada RAU includes the Colorado River from Davis Dam to Hoover Dam (including both Lakes Mead and Mohave), the Muddy and Virgin Rivers in Nevada and the Virgin River in Arizona, and relict wetlands on river systems in the area. The first documented report of a Yuma Ridgway's rail in the area was in 1959 (Alcorn 1988, p. 126). More consistent documentation occurred in the 1990s, however densities remain low. This is likely because marshes remain small and dispersed in this RAU. For occupied Yuma Ridgway's rail habitats in southern Nevada, the two National Wildlife Refuges (Ash Meadows and Pahranagat) have their own water rights that are not associated with the Colorado River, and while there is a continuing effort by Clark County and Las Vegas to secure additional surface and groundwater rights from surrounding areas, the presence of endangered and threatened species on these Refuges provides a measure of protection for those rights. Other locations, like the Overton WMA, have water rights for its ponds from the Muddy River. Otherwise, the Las Vegas Wash conveys treated wastewater back to Lake Mead for return-flow credits, and the wash restoration program is likely to continue into the future. The Southern Nevada RAU also includes the lower Grand Canyon in Arizona which is subject to water level fluctuations due to hydropower releases from Glen Canyon Dam. An estimate of the total existing marsh in this RAU supported by the Refuges, WMAs, or incidental flows is not currently available. Behaviorally, rails within this RAU, specifically those at Ash Meadows NWR, appear to have lower migration levels. The reason for this is unknown, but it could be in relation to water temperatures currently being milder than at lower elevations where other populations are found.

Ash Meadows National Wildlife Refuge

The Ash Meadows National Wildlife Refuge (Ash Meadows NWR) was designated as a wildlife refuge in 1984 for the purpose of protecting rare, threatened and endangered species. In 1986, Ash Meadows NWR was listed as a Wetland of International Importance by the Ramsar Convention, an international treaty of 154 countries. Since its establishment, the Service has put considerable effort toward restoring the springs, wetlands, marshes, and upland desert that supports at least 26 endemic species, 12 of which are federally listed. The Refuge encompasses over 9,307 ha (23,000 ac) of spring-fed wetlands and alkaline desert uplands, of which 53 ha (132 ac) is emergent marsh. Because of the historical presence of marshes in this area, it is likely that the Yuma Ridgway's rail has utilized this habitat for breeding, foraging, and dispersal. However, based on information available, the first documented rail occurred in 2007 at Peterson Reservoir. Since then, rails have been documented in low densities.

Pahranagat National Wildlife Refuge

The Pahranagat National Wildlife Refuge (Pahranagat NWR) was designated as a wildlife refuge in 1963 for the purposes of protecting migratory birds, especially waterfowl. The designation protects 2,177 ha (5,380 ac) of marshes, wet meadows, lakes, and desert uplands. Because of the historical presence of marshes in this area, it is likely that the Yuma Ridgway's rail has used this habitat for breeding, foraging, and dispersal. However, based on information available, the first documented rail occurred in 2013. Since then, rails have been documented in low densities. Overall, Pahranagat NWR currently supports approximately 350 ha (865 ac) of marsh. This marsh is actively managed. There are two survey routes on Pahranagat NWR that were consistently surveyed from 2013 through 2021.

Las Vegas Wash and Clark County Wetlands Park

The Las Vegas Wash is a formerly ephemeral channel that now conveys more than 200 million gallons per day (greater than 310 cubic feet per sec) of treated wastewater, urban runoff, and shallow groundwater to Lake Mead. An estimated 9 km (5.5 mi) portion of the wash flows through 1,175 ha (2,900 ac) of Clark County Wetlands Park. Since 1998, Southern Nevada Water Authority has led a multi-stakeholder effort to stabilize and enhance this reach following decades of erosion, creating more than 55 ha (135 ac) of wetlands. Clark County has created about 16 ha (40 ac) of off-channel wetlands in the park. The Southern Nevada Water Authority (SNWA) conducts surveys of potentially suitable habitat within the Clark County Wetlands Park annually. Detections were rare but have become regular since 2021, with at least 5 Yuma Ridgway's rails identified per year.

Nevada Department of Wildlife

The Nevada Department of Wildlife owns and manages two Wildlife Management Areas (WMA) within this RAU, the Key Pittman WMA, and Overton WMA. The Nevada Department of Wildlife has also surveyed and is deploying ARUs in Oasis Valley and in marsh around Laughlin.

Key Pittman Wildlife Management Area

The Key Pittman WMA was established with the primary goal of protecting wetlands and waterfowl and is composed of an estimated 539 ha (1,332 ac). The Key Pittman WMA is located in the northern end of the Pahranagat Valley. Because of the historical presence of marshes in this area, it is likely that the Yuma Ridgway's rail has used this habitat for breeding, foraging, and dispersal prior to surveys. Overall, Key Pittman WMA currently supports approximately 26 ha (64 ac) of marsh, however this amount has changed over time given water level fluctuations. There is a survey route on the WMA that has been consistently surveyed since 2013.

Overton Wildlife Management Area

Overton WMA was established in 1953 following the construction of the Hoover Dam and subsequent filling of Lake Mead with the goal of protecting wetlands and creating waterfowl hunting opportunities. The approximately 6,980 ha (17,250 ac) WMA is located at the northern end of the Overton Arm of Lake Mead National Recreation Area where the Muddy River flows towards Lake Mead. An estimated 77 ha (190 ac) of marsh vegetation was calculated in 2015 (Pers. comm C. Klinger 2015). This estimation did not include additional occupied habitat in and around the Muddy River Delta and Lake Mead. This estimate is therefore likely conservative. While survey points occasionally change with habitat conditions, the WMA has been consistently surveyed since 2013. Trespass cattle issues pose ongoing threats to habitat quality to most of the marsh in the WMA.

Oasis Valley

Oasis Valley is in southwestern Nevada and encompasses the town of Beatty. The perennial, though often subsurface, Amargosa River supplies water to the valley in the form of natural and developed springs. Much of the riparian land in Oasis Valley is privately owned, with a substantial amount acquired by The Nature Conservancy in recent years. One Yuma Ridgway's rail was recorded on eBird in 2017 (no photo or recording) at the water treatment ponds just south of Beatty. In 2024, an ARU on nearby Bureau of Land Management land recorded a Yuma Ridgway's rail. Ongoing ARU monitoring by the Nevada Department of Wildlife is exploring additional potential habitat in Oasis Valley to determine the extent of use by Yuma Ridgway's rails and other marsh bird species.

Laughlin

At the very southern tip of Nevada, the city of Laughlin sits on the lower Colorado River just downstream from Davis Dam. Bends and backwaters of the river have created marsh, most notably Laughlin Lagoon, Big Bend Conservation Area (owned by the Southern Nevada Water Authority), and Big Bend of the Colorado State Recreation Area. Positive Yuma Ridgway's rail detections were recorded in the area in 1986 and 2015. In 2024, an ARU recorded fifty straight days of kek-burr calls. Ongoing ARU monitoring by the Nevada Department of Wildlife is investigating the extent of the Yuma Ridgway's rail use of the area.

Migration and Dispersal

Shortly after the species was listed as endangered, limited responses to taped calls indicated possible migratory behavior (Tomlinson and Todd 1973 pp. 181–182, Smith 1975 pp. 13–14, Bennett and Ohmart 1978 p. 26, Todd 1986 p. 119). It was believed that migrating rails wintered in the **brackish** marshes along the eastern shore of the Gulf of California (Banks and Tomlinson 1974 p. 334). The connection between the mangrove-dwelling rails and the cattail marsh-dwelling rails was first suggested by documentation of individuals suspected to be the *yumanensis* subspecies migrating from the lower Colorado River and Colorado River Delta to wintering grounds along the coast of the Gulf of California (Tomlinson and Todd 1973 pp. 181–182, Bennett and Ohmart 1978 p. 50).

However, Eddleman, who fitted 99 of 122 captured Yuma Ridgway's rails with radio transmitters, documented that at least 70 percent of telemetered birds were resident in the study areas along the lower Colorado River (Eddleman 1989 pp. 28–31). Yuma Ridgway's rails near Phoenix, Arizona along the Middle Gila River were not studied, but anecdotal evidence suggested that this population may be more migratory than that of the lower Colorado River (Corman and Wise-Gervais 2005 p. 162). Eddleman (1989 p. 32) suggested that the increasing amount of suitable habitat with a stable food source during the winter (e.g., crayfish [*Procambarus* spp.]) may support more resident individuals.

This assumption that Yuma Ridgway's rails were primarily residents was challenged in 2010 with the opportunistic findings of Yuma Ridgway's rail fatalities at solar facilities in upland desert habitat (Kagan et al. 2014 p. 8, Kosciuch et al. 2020 pp. 11–12). To understand if these mortalities were the cause of random dispersal or more standard movements, a satellite transmitter study was conducted to ascertain the frequency of seasonal movements away from breeding marshes (Harrity and Conway 2020 pp. 301–302). This study, which attached satellite transmitters to 89 Yuma Ridgway's rails from 13 study sites, found that overall, 40 percent (20 of 50) of adult rails, and around 21 percent (3 of 14) of juvenile rails migrated in the fall. The proportion of migrating birds differed by location within the range. Roughly 75 percent of radio-marked rails migrated from sites in the Mid-Lower Colorado River (Havasu and Bill Williams River National Wildlife Refuges), 63 percent of radio-marked rails migrated from the Colorado River Delta, 50 percent of radio-marked rails migrated from Central Arizona (the middle Gila River), and 38 percent of rails migrated from the Lower Colorado River (Harrity and Conway 2020 p. 304). In subsequent studies, only around 6 percent of transmitted rails migrated from the Salton Sea Basin between 2020-2023 (Yost et al. 2023 pp. 24–25). Another novel finding was that the routes of migrating Yuma Ridgway's rails were, predominately, direct flights over large expanses of desert rather than along river corridors (Figure 7). Of these migration flights, 98 percent occurred at night (Harrity and Conway 2020 p. 307). The migration time windows also varied. This study also shed needed light on migration windows. For the fall, the migration window was from September 6th to November 3rd, with ±3.9 days around October 4th as the average. The average duration of the migration flight was 12.7 ± 4.7 days. For the spring migration, which only has data from 3 returning birds, the migration window was from April 20th to April 28th, with an average of ±2.6 days around April 22nd. The duration for this migration however was ≤ 5 days. Finally, this study showed that some rails exhibit strong regional and site fidelities, with 2 rails returning within 29 and 32 km (18 and 20 mi) respectively, and 1 rail returning to within 200 m (656 ft) of its original capture location (Harrity and Conway 2020, p.

304). Overall, this telemetry study reaffirmed the original hypothesis that the Yuma Ridgway's rail is migratory, and its findings have altered our understanding of a key part of the Yuma Ridgway's rail's life history.

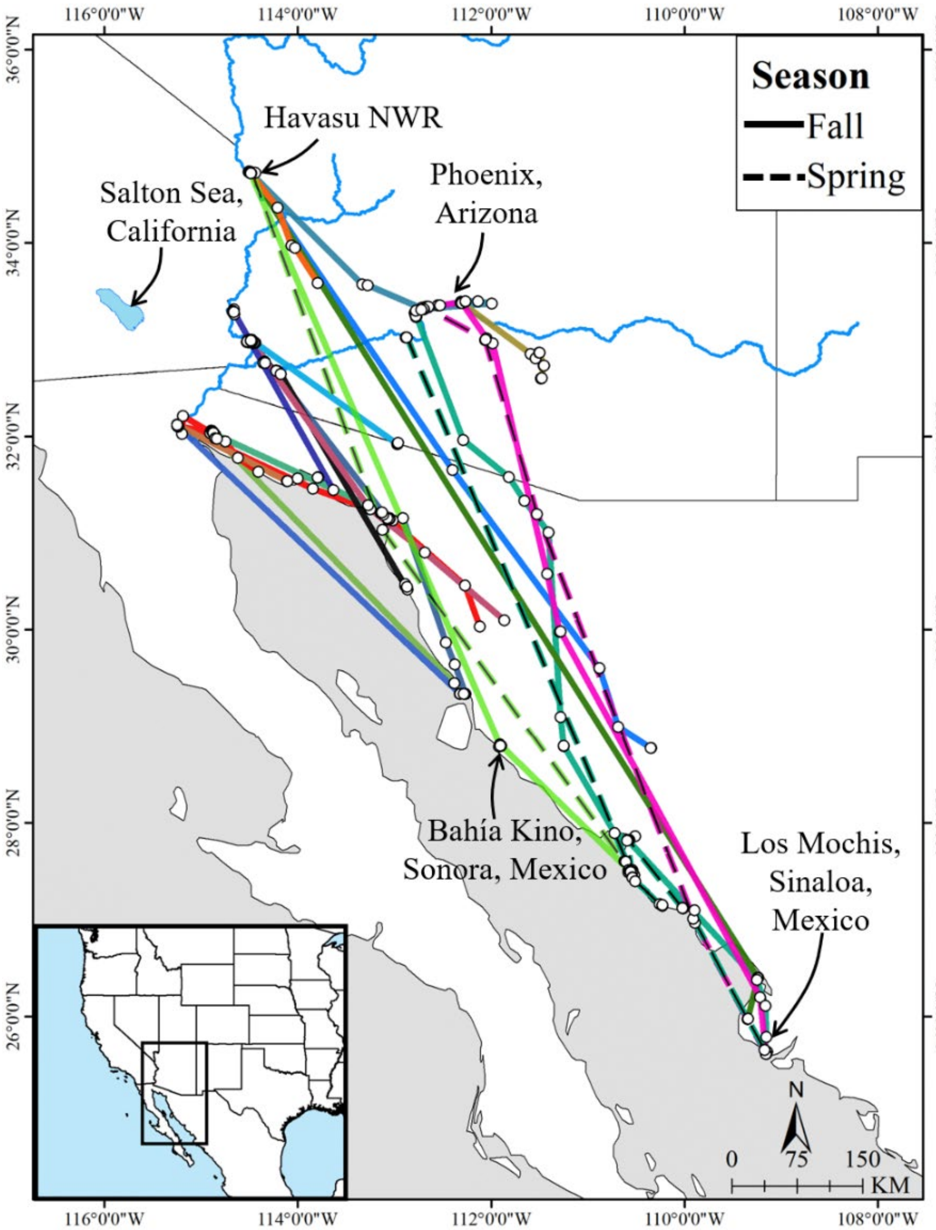

Figure 7. Dispersal and migratory movements of 18 Yuma Ridgway's rails from 2017-2020 (movements of 5 additional rails were too short to show at this scale). Line colors represent different rails, and line types represent fall and spring movements (Harrity and Conway 2020 p. 305).

The Yuma Ridgway's rail, when flying short distances within or between patches of habitat is an awkward flier with a slow, weak, and fluttering flight, legs dangling with the head held high (Todd 1986 p. 67). However, as evidenced by their migration, the Yuma Ridgway's rails are successful strong fliers over longer distances. This type of flight is more duck-like, with the head, tail, and legs held in a straight line and steady, rapid wing beats (Meanley 1985 p. 78, Eddleman and Conway 1998 p. 12).

Outside of migration, the activity of Yuma Ridgway's rails depends on the time of year. For instance, daily movement was lowest during the late breeding period (May-July) and highest during the late winter (January-February) (Conway et al. 1993 p. 287). Juvenile dispersal, movements by unpaired males during the breeding season, and by both sexes post-breeding have also been documented (Figure 8; (Eddleman 1989 p. 44, Harrity and Conway 2018 p. 30). Eddleman (1989 pp. 43–44) suggested that these types of movements would enable Yuma Ridgway's rails to quickly locate areas of new habitat. This was found to be accurate with documentation of Yuma Ridgway's rails moving out of unsuitable areas, including in response to changing water levels or prescribed fire (Smith 1975 p. 18, Conway et al. 2010 p. 2027).

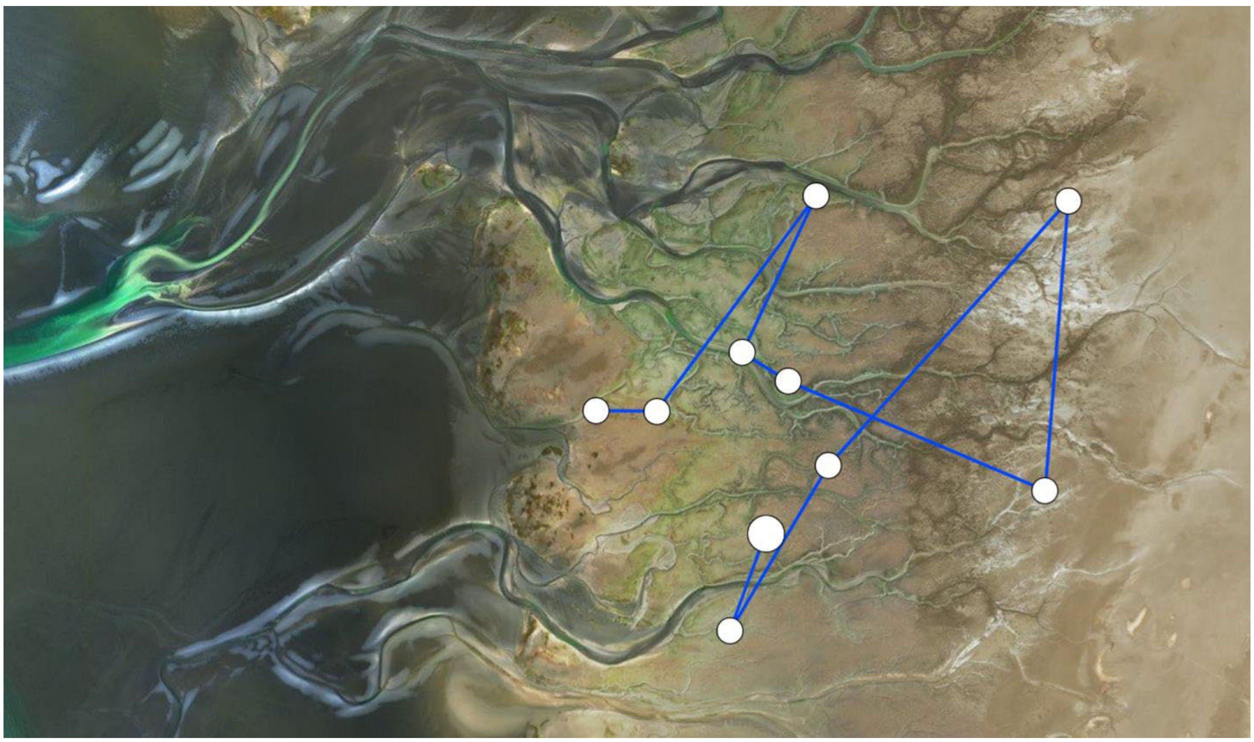

Figure 8. A juvenile Yuma Ridgway's rail moved ~240 km from Imperial NWR to a salt marsh along the Gulf of California, south of Puerto Peñasco, Sonora, Mexico (Harrity and Conway 2018 p. 30).

Population Structure

Information on the population structure, both genetic and demographic, of the Yuma Ridgway's rail is not currently known. Inference from congener species is not applicable because of the endangered status and migratory life history of the species. This data gap could be filled with genetic studies to understand the relationships between populations, and what **genotypes** are present throughout the range.

Chapter 3. Yuma Ridgway's Rail Needs

As a subspecies, the Yuma Ridgway's rail needs multiple, resilient populations to maintain ecological and genetic diversity throughout its range. In turn, resilient populations need individuals that survive and successfully reproduce to maintain viable numbers. Needs for the Yuma Ridgway's rail at the individual, population, and subspecies levels are described below.

Individual Rail Needs

The different life stages of the Yuma Ridgway's rail, and whether that individual migrates, dictate the individual needs of the subspecies (Table 2, Figure 9, Figure 10). Completion of the egg, chick, and juvenile life stages occurs within the established territory within a marsh. This territory can vary in size depending on the quality of habitat and prey availability. Once a juvenile has molted to adult plumage, the life cycle may be completed as a resident bird (non-migratory), migratory, or a combination of the two over several years. For a marsh to be suitable for the first three life stages, it should contain sufficient water quantity to allow for various depths (Anderson and Ohmart 1985 p. 121, Eddleman 1989 pp. 79–87). While we do not know the thresholds of temperature, trace elements, etc. that the rail requires, water should be of sufficient quality to permit egg development or reproduction, cattail and/or emergent vegetation, and presence of prey species (Erwin 2009 p. 72). Chicks, juveniles, and adults use vegetation to move between areas and as shelter from predators or disturbance. As such, a disturbance regime (e.g., prescribed fire, mechanical removal of decadent vegetation) of every 5 to 10 years is recommended to maintain moderate interstitial spacing between vegetation stalks. Disturbances that occur too frequently may lead to marshes with dispersed vegetation that does not provide cover from predators or substrates for nesting. Alternatively, infrequent disturbances may allow decadent vegetation to accumulate, woody vegetation to encroach, and other successional changes that reduce habitat quality for rails. Adults also use vegetation mats, or other stable substrates, to lay eggs (Abbott 1940 p. 264, Bennett and Ohmart 1978 p. 40). For a marsh to be suitable for a resident adult, habitat should contain a mosaic of open water and emergent vegetation to allow for foraging and sheltering while being large enough to move to different areas should disturbance occur. Habitat for migratory adults is more varied, and includes mangroves, saltmarshes, mud flats, cattle tanks, drains, and other areas with emergent vegetation (Harrity and Conway 2020 p. 310). Regardless of habitat type, these areas should include sufficient prey for foraging, and vegetation to shelter in.

Table 2. Life cycle needs of the Yuma Ridgway's rail based on life stage.

	Vegetation	***Water Quality***	***Water Quantity (depth)***	***Prey***	***Area***
Egg	Provides a place above the water (vegetation mat) for the duration of incubation.	Allows for the successful development of eggshell and embryo.	A depth range that allows eggs to remain dry but protected from predators.	NA	NA
Chick	Provides protection from predators and a substrate above the water (vegetation mat) for the duration of downy feathers.	Allows for successful development.	A depth range that allows downy feathers to remain dry while staying protected from predators.	Provided by parents and allows for successful growth.	NA
Juvenile	Provides a source of cover.	Allows for successful development and nutritious prey.	Allows for foraging of prey and protection from predators.	Aquatic invertebrates provide food for growth and successful nesting.	Provides space for foraging.
Adult	Provides a source of cover and nesting materials.	Allows for growth and successful nesting, and nutritious prey.	Allows for foraging of prey and protection from predators.	Aquatic invertebrates provide food for growth and successful nesting.	Provides space for foraging and nest sites.

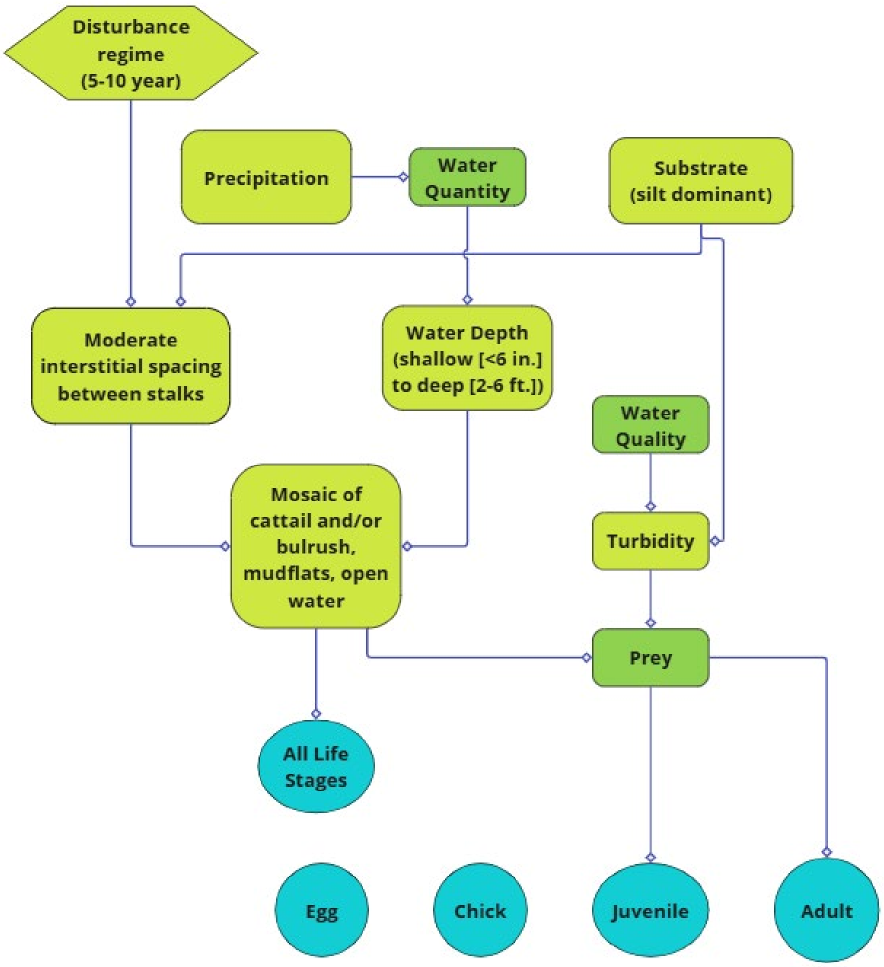

Figure 9. Species Needs for the Yuma Ridgway's Rail.

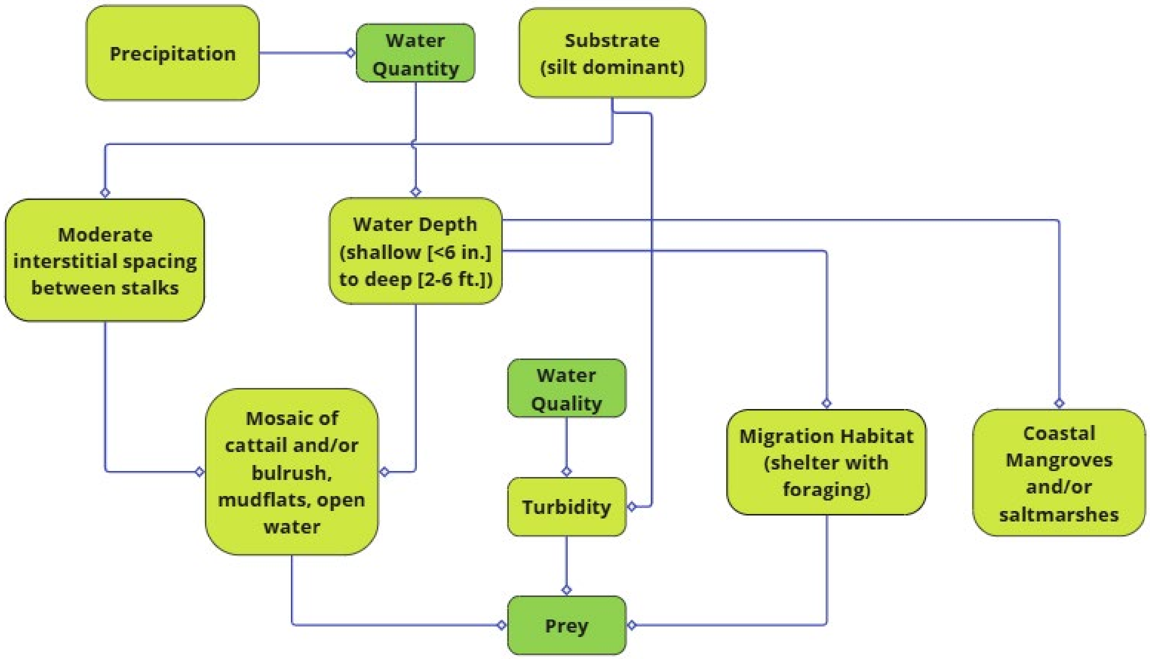

Figure 10. Needs of a migrating Yuma Ridgway's rail.

Local and Regional Needs

For this SSA's purposes, we consider the entire subspecies to be a potential population because of the migratory patterns and potential demographic connectivity. Because of this, we organized the Yuma Ridgway's rail's range into RAUs based on the distinct regions within its range and migratory behaviors. We further subdivided each RAU into LAUs based on land management responsibilities. Both RAUs and LAUs are thus used as analytical tools for assessing the regional and local needs of the species and are not considered unique biological populations.

Both RAUs and LAUs need to have sufficient recruitment to sustain individual persistence over time. To sustain enough Yuma Ridgway's rails, habitat must be managed and maintained to support optimal quality and therefore density of birds. This means managing and maintaining emergent freshwater habitat within the early to mid-successional stages as best as possible.

Species Needs

To adapt to changing environmental conditions, the Yuma Ridgway's rail needs to maintain its ecological and genetic diversity (representation) in resilient populations distributed throughout the subspecies range (redundancy and representation). Within the Yuma Ridgway's rail's range, habitat suitability and connectivity are essential for maintaining populations and allowing for interbreeding and movement. To do this, there are a variety of needs that have been identified as critical for each level (Table 3). The amount of habitat connectivity needed to maintain movement and allow dispersal is a gap in information that needs to be filled.

Table 3. Species needs, based on individual, regional, or species levels.

Level	***Need***	***Function of Need***
Individual	Water quantity	Protection from predators for chicks, and foraging habitat for juveniles and adults.
Individual	Water quality	Provides clean water, which prevents bioaccumulation from direct consumption or consumption of prey.
Individual	Prey base	Food for adults and juveniles to directly eat, and for adults to provide to chicks.
Individual	Appropriate vegetated cover	Shelter, protection from predators, and areas for nesting
Individual	Vegetation quantity	Emergent marsh
Individual	Lack of mammalian invasive species	Prevents direct predation
Regional	High abundance	A high abundance provides greater assurance of successful recruitment and the ability to withstand changes.
Regional	Patchwork of available marshes	Allows for foraging, dispersal, and redundancy to changes of habitat condition.
Regional	Lack of mammalian invasive species	Increases abundance and redundancy.
Species	Multiple, connected, resilient populations	Improves species viability by lessening the risk of extinction from catastrophic events.
Species	Ecological and genetic diversity within the species' range	Maintains diversity and allows for adaptability to changing environmental conditions.

Chapter 4. Stressors

Factors Influencing Viability

Here we consider the historical, current, and anticipated future **anthropogenic** or environmental factors that influence the Yuma Ridgway's rail's population resiliency, contributing to the subspecies' overall viability. These stressors, and their effects, are visualized in Figure 11 for resident birds and Figure 12 for migratory birds.

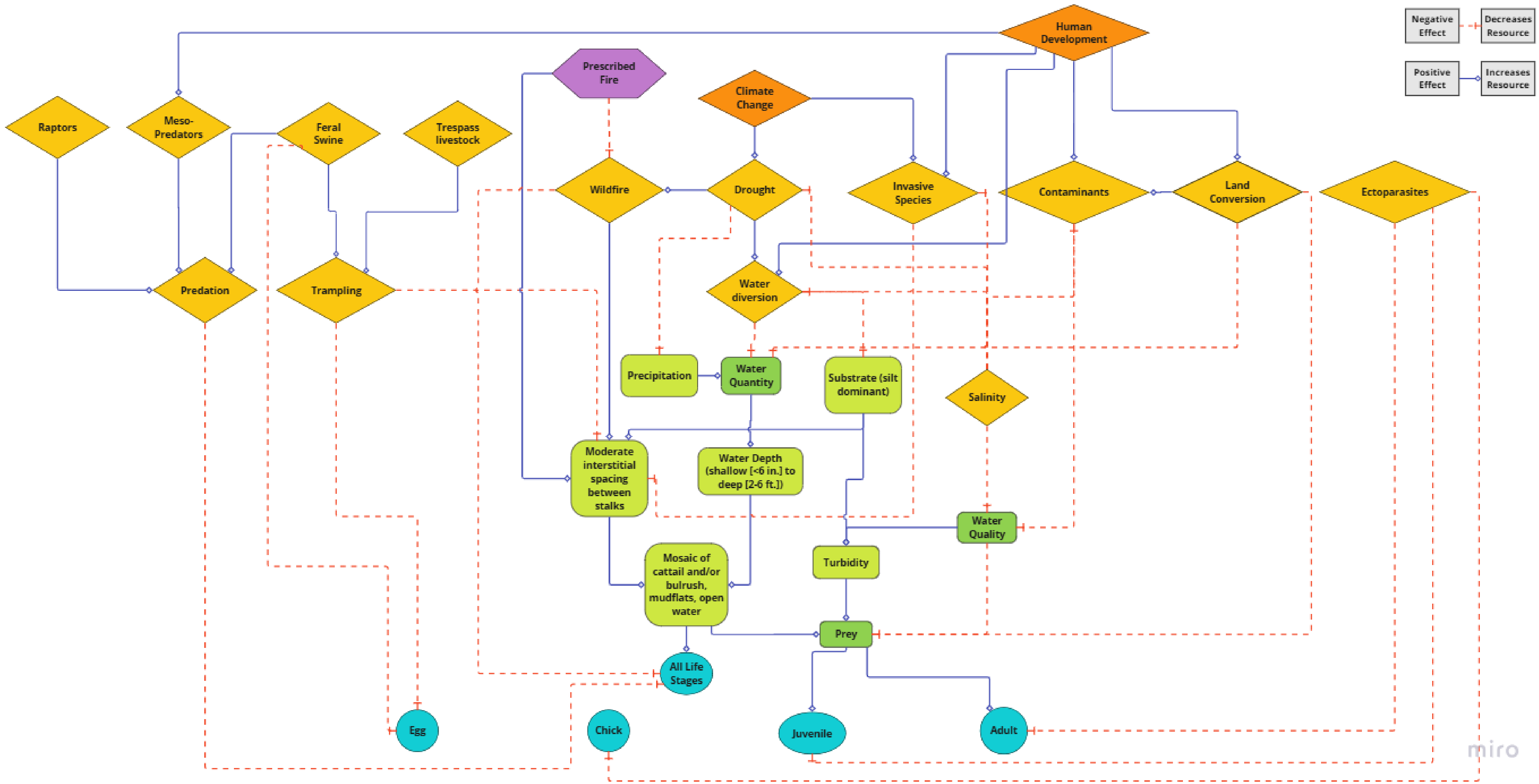

Figure 11. Schematic for the potential stressors that may affect either a life stage directly or a habitat resource for non-migratory birds.

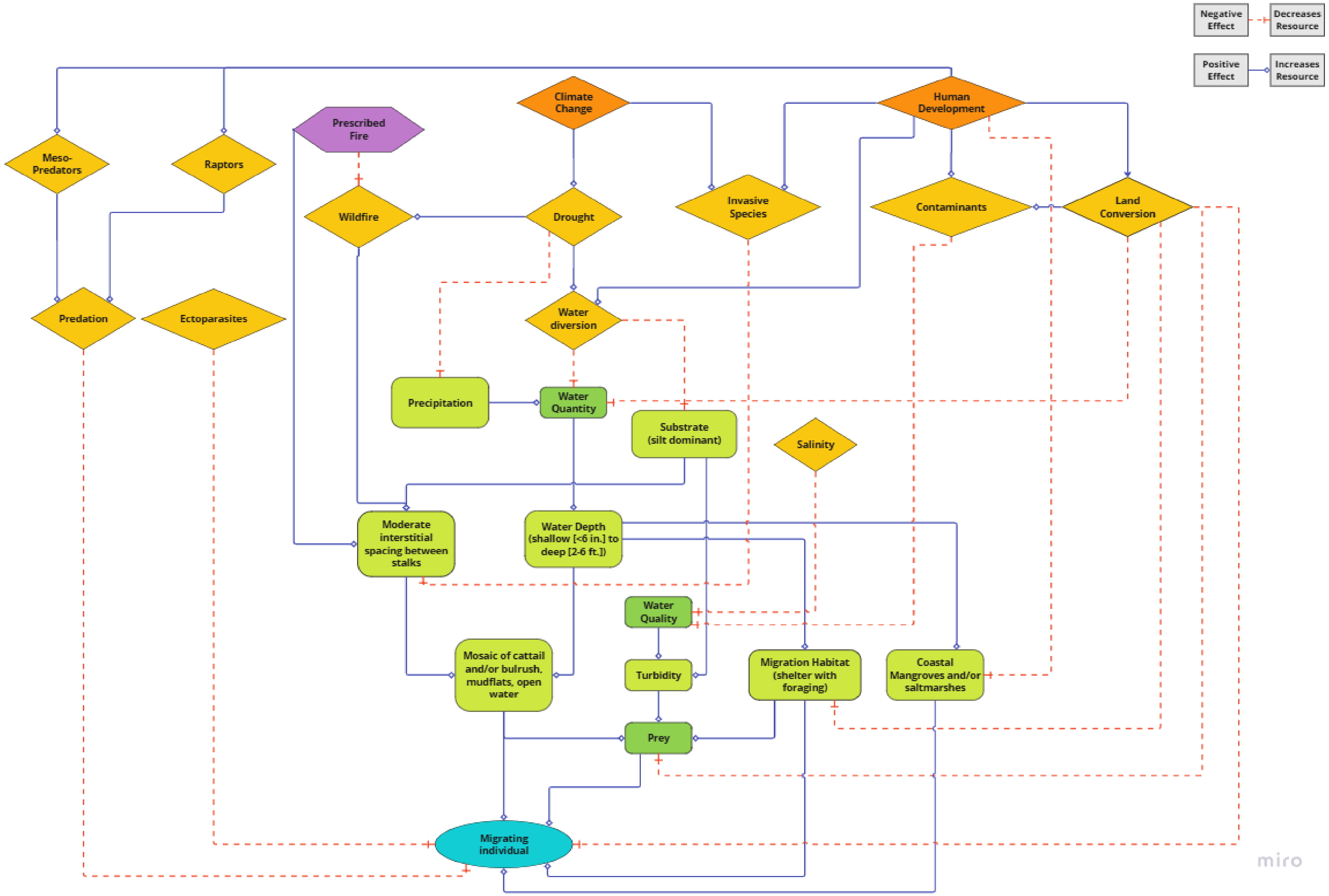

Figure 12. Schematic for the potential stressors that may affect either a life stage directly or a habitat resource for migratory birds.

Environmental Changes

Environmental changes drive numerous stressors that negatively affect wildlife habitat, thus impacting subspecies demography and population viability. Effects of these environmental changes will result in the more direct stressors of drought, wildfire, and invasive species.

Drought

The National Climate Assessment indicates that the southwestern U.S. will continue to get hotter and drier into the future (Garfin et al. 2014 pp. 464–466, Reidmiller et al. 2018 p. 25). From 2000 to 2020, average temperatures for northeastern Arizona have increased 0.8 to 0.9 ℃ (1.4 to 1.6 °F) compared to the long-term average. During this period, the region has also experienced abnormally dry conditions, with increased moderate to severe drought (Environmental Protection Agency (EPA) 2023).

Freshwater ecosystems, such as wetlands, are typically the ecosystems most impacted by drought and are believed to have the highest proportion of species at risk of extinction due to hydrological changes (Desta et al. 2012 p. 585). Droughts can be categorized as either seasonal, which are relatively predictable, or supraseasonal, which are unpredictable in timing and duration but typically extend beyond a season. **Supraseasonal droughts** are often referred to as "creeping disasters" (Lake 2003 p. 1162) because of the slow, gradual progression of their impacts, which can make them difficult to detect and respond to in a timely manner.

Droughts, whether seasonal or supraseasonal, consist of two components: the decline in water availability (the disturbance) and the biotic response to the disturbance (Lake 2003, p. 1162). A supraseasonal drought can lead to a **hydrological drought**, which, while lacking a universally accepted definition, can be defined for our analysis as decreased flows in both surface water and groundwater (Bond et al. 2008 p. 5). This decrease results in lower water levels in marshes, causing cattail and bulrush stands to die unless water is restored to the system, either naturally or through pumping.

It is important to note that the longer and more severe a drought is, the longer the recovery period will be. As the catchment dries out, rainfall is first required to saturate the soils before any recovery can occur (Bond et al. 2008 p. 7, Aldous et al. 2011 p. 227). Moreover, because all freshwater watersheds within the rail's range are associated with modified catchments, droughts have the potential to cause unprecedented and irreversible changes to these already vulnerable ecosystems (Bond et al. 2008 p. 7). While environmental change impacts will already be severe, they are likely to be exacerbated by current land and wetland management practices, resulting in even less water to maintain flows (Erwin 2009 p. 78).

This situation is further complicated by the fact that reservoir levels (e.g., Lake Mead) are currently at critically low levels, resulting in fewer water releases. Because many occupied marshes depend on managed water deliveries from the Colorado River, reduced flow is likely to affect long-term habitat sustainability. Already these low water levels have resulted in substantial reductions in marsh habitat at Havasu NWR (e.g., Topock Marsh). Further downriver at Cibola and Imperial NWRs, their annual water allocations are being exhausted earlier than normal, and reduced flows will exhaust them even sooner. While the Bill Williams River NWR is currently less affected by the Lake Mead releases because its marshes occur within the inundation zone of Lake Havasu, it is reasonable to expect that as regional drought conditions continue, occupied and potentially occupied marshes could experience drying. Regardless, the combination of fewer water releases, exhaustion of annual water allocations, and continuing drought conditions with high temperatures that increase evaporation, leaves no additional water available for marshes that require restoration. Areas outside of the Refuges lack water rights to support existing marshes or develop new ones. Consequently, these marshes rely on agricultural drain flows, water treatment plant releases, or other seepage. It is expected that over time, areas of unmanaged marsh, and even some currently managed marsh areas, will lose their value to the Yuma Ridgway's rail as they dry.

Sea Level Rise

Environmental changes that are global in scale, will also negatively impact the mangrove and estuary habitats in which the Yuma Ridgway's rail overwinters in or uses during migration. Coastal wetlands are among the most altered and threatened natural systems, with many lost to draining and filling (Poff et al. 2002 pp. 23–24). Sea level rise will place additional stress on these systems, leading to habitat diebacks (Poff et al. 2002 p. 25). The combination of sea level rise and coastal development has already caused losses in mangrove ecosystems (Erwin 2009 p. 75). During periods of sea level rise, coastal wetlands can persist if they accumulate soil vertically at the same rate as the water level rises (Poff et al. 2002 p. 25). Historically, the transport of riverine sediments provided this vertical rate of accumulation (Scavia et al. 2002 p. 154). However, with the reduced riverine sediment load in current floodplains, there is an urgent need to preserve existing and intact floodplain rivers and restore hydrologic dynamics, particularly sediment transport (Poff et al. 2002 p. 26, Erwin 2009 p. 74). If, as sea levels rise, coastal margins are armored and prevent the inland migration of wetland and mangrove ecosystems, and if dam operations continue to decrease riverine sediment inflows to the sea, then both coastal wetlands and mangrove ecosystems will be lost (Scavia et al. 2002 p. 153, Erwin 2009 p. 78).

In response to disturbances such as drought drying out habitat or sea level rise inundating habitat, a species can react in two primary ways: first, by "sitting it out" with resistance traits, or second, by recolonizing and recruiting after the disturbance through resilience traits (Bond et al. 2008 p. 7). Refugia habitats are crucial for both responses and are essential for the survival of species that occupy disturbance-prone rivers and wetlands (Lake 2003 p. 1166, Bond et al. 2008 p. 7).

Wetland species, like rails, are habitat specialists and typically cannot survive in different or alternative environments (Poff et al. 2002 p. 18). However, the Yuma Ridgway's rail, along with other marsh bird species, can relocate to areas nearby during disturbances and recolonize areas once suitable habitat is reestablished. They possess well-developed mechanisms for widespread dispersal among suitable habitat patches, making them generally more resilient to habitat disturbances (Bond et al. 2008 p. 7). Regardless, suitable non-degraded habitats must be available for the rail to disperse into.

The Yuma Ridgway's rail already exhibits resilient characteristics that have allowed the species to expand its range as more habitats becomes available and enables it to disperse when habitat becomes unsuitable. However, with environmental change, it is anticipated that the limits of aquatic ecosystem resilience will be exceeded (Poff et al. 2002 p. 2). This could mean that, despite the rail's adaptations for dispersal, suitable wetlands may not be available. If this occurs, the resiliency of the rail's population will be severely compromised, as displaced individuals will concentrate in managed marshes.

Wildfire

In the western U.S., drought driven by environmental change is altering natural fire regimes; wildfires are becoming more frequent, larger, and more severe (Westerling et al. 2006 pp. 940–943, Singleton et al. 2019 p. 712). While severe wildfire within the Yuma Ridgway's rail habitat was historically rare, its occurrence is increasingly possible under drought conditions. When wildfires do occur, and if they occur during nesting season, they pose a threat to flightless adults undergoing simultaneous wing molt as well as eggs or fledglings. These effects were evident in May 2024 when the Refuge Fire burned through marsh vegetation on Imperial NWR. Following the fire, staff found a flightless waterbird chick that died shortly after. Another such wildfire that likely resulted in loss of adults, juveniles, and nests occurred near Bill Williams NWR in June 2021. Conversely, if wildfires occur outside of the primary nesting season and molting period, effects for the rail can be positive because dead cattail are removed, interstitial spacing between new growth is optimal, and greenness improves. These positive effects, however, are dependent on water flows arriving following the fire. When flows are delayed, as they were after the October 2019 fire at the Cienega de Santa Clara due to repairs to the MODE canal, positive effects were delayed because water flows were inhibited because of repairs to the MODE canal (Flessa 2020 p. 5, Villagomez 2025). On the other hand, if water flows arrive normally, effects to rail habitat are positive. This was apparent following a wildfire at the Havasu NWR in January 2026 that burned in Topock Marsh. By end of February new growth of marsh vegetation was observed (J. Barnett pers. comm 2026). Given these observations, it is believed that fires that occur at the end of winter or beginning of the spring, followed by water flows, are the most likely to have positive effects for the rail.

Human Development

Human development can negatively affect Yuma Ridgway's rail habitat through land conversion, hydrologic alteration, water diversion, and contamination from agricultural and urban sources. These changes can reduce marsh extent, degrade vegetation structure, and diminish prey availability. Development-related disturbance and altered water regimes may also promote invasive plant species that further reduce habitat quality and connectivity. In certain parts of the Yuma Ridgway's rail's range, recreation could be a potential stressor to nests by elevating the risk of damage from boat-wake or could be a stressor to nesting birds by increasing noise levels. However, because this potential stressor is localized to small areas within the Yuma Ridgway's rail range, it is not discussed further or included in the analysis of Future Conditions.

Land Conversion

Urbanization refers to the transformation of areas into more urbanized environments, significantly affecting sensitive habitats, particularly for species like the Yuma Ridgway's rail (Lee et al. 2006 p. 150). Habitat conversion due to urbanization has a more profound impact on natural environments than forestry or agriculture. This difference arises from the stark contrast between urban and natural areas, along with the low likelihood that urbanized land will revert to its natural state (Faulkner 2004 p. 93).

The core structural and functional attributes of wetlands are closely tied to their hydrologic regimes, making the impacts of water diversions for urbanization especially detrimental. When urban land use significantly alters the hydrologic regime, these changes are often permanent, even if habitat rehabilitation occurs (Faulkner 2004 p. 94).

Loss of wetlands due to urbanization is primarily driven by activities in upland areas because, upland activities are typically unregulated but still profoundly affect wetland hydrology (Wright et al. 2006 p. 21). Urbanization alters wetland hydrology by changing filtration depth and the duration and frequency of flooding, leading to more severe ecological impacts than other factors (Thom et al. 2001 p. 10). Three main processes contribute to this disruption:

1. Removal of native vegetation that previously intercepted rainfall and prevented soil compaction.

2. Creation of impervious surfaces (roads, rooftops, parking lots) that increase runoff volume and erosion.

3. Installation of efficient storm drainage systems that quickly move water downstream, resulting in more frequent scouring runoff.

These processes diminish infiltration and groundwater recharge rates, which are critical components of wetland hydrology (Thom et al. 2001 p. 7, Wright et al. 2006 p. 22). Within the U.S., urban and rural development accounts for 60 percent of freshwater wetland loss, which is similar to documented losses in other countries (e.g., India) (Wright et al. 2006 p. 16, Sundar et al. 2015 p. 120). Unfortunately, wetlands are particularly vulnerable to urban expansion, often disappearing because their full value, such as groundwater recharge, water filtration, carbon storage, erosion control, and floodwater attenuation, is sometimes overlooked in most planning processes (Li et al. 2010 p. 224).

The hydrology of wetlands can be impacted physically, chemically, and biologically. Urbanization contributes to physical and chemical changes, which subsequently lead to biological impacts. Physical impacts include channelizing surface water inflows or outflows, rerouting natural water supplies (*see Water Diversion below*), and altering soil structure, which affects **permeability** (Thom et al. 2001 p. 6). Chemical impacts arise from concentrated nutrient inflows from agricultural drains, heavy metal runoff from urban areas, and treated sewage containing toxic metals and high nutrient (nitrogen and phosphorus) concentrations. **Bioactive** substances, such as drug residues and **endocrine disruptors**, are also concerns (Lee et al. 2006 p. 154). These chemical changes can disrupt **transpiration** and directly affect the flora and fauna in wetlands (Thom et al. 2001 p. 6). The combined physical and chemical impacts can lead to the establishment of non-native species, which outcompete native wetland biota, resulting in abandonment by native species (Thom et al. 2001 p. 6).

Urbanization is a leading cause of species endangerment in the U.S. (McCauley et al. 2013 p. 1; Czech et al. 2000 p. 595). For marsh birds, land development can negatively impact bird species even at distances of 1,640 to 3,280 feet from marshes. For example, land development covering as little as 14 percent of the area within 1,640 feet of a marsh or wetland can cause wetland specialist species, like the least bittern (*Ixobrychus exilis*) to abandon the area entirely (Wright et al. 2006 p. 55). The push for economic growth with inconsistent environmental standards increases the risk of adversely affecting biodiversity. High human population densities further intensify urban impacts, displacing native species not adapted to human disturbance (Pauchard et al. 2006 p. 279).

This trend of development is prevalent within the range of the Yuma Ridgway's rail, particularly along the lower Gila River in central Arizona and the lower Colorado River as agricultural fields are converted. While the rates of development in Sonora, Mexico, are unknown, coastal areas with tidal flats and mangroves, vital habitats for millions of migratory waterbirds, including the Yuma Ridgway's rail, are disproportionately impacted by fishing, shrimp farms, tourism, and housing developments (Zhang and Ouyang 2019 p. 1). There is uncertainty regarding the degree of human disturbance (i.e., noise) likely to displace individuals. There is more certainty that disturbance which results in habitat loss adversely affects the species' resilience across its range.

Yuma Ridgway's rail, along with other native marsh birds, will have decreased redundancy, representation, and resiliency across its range as habitats become more fragmented or unsuitable due to urbanization. Because of the secretive nature of the Yuma Ridgway's rail, even if rail habitat is maintained the overall suitability of the habitat could be too greatly compromised by human (e.g., noise, contaminants) disturbances during crucial life history stages. There is the potential that if urban expansion fully develops in peripheral areas, such as along the lower Gila River in central Arizona and the Las Vegas Wash in Nevada, it would greatly impact the redundancy of the species across its range, genetic representation, and resiliency of the species.

Water Diversions

Land conversion and water diversions are interdependent because of the characteristics of wetlands being driven by the hydrologic processes within the watershed (Faulkner 2004 p. 94) and because water diversions are often a result of land conversion. For our analysis, we use the State of California's Water Board definition that a water diversion means taking water by gravity or pumping from a surface stream, subterranean stream, or other body of surface water, into a canal, pipeline, or other conduit, and includes impoundment of water in a reservoir (California Water Board 2018). Land conversion often directly affects wetlands with the removal of habitat, whereas water diversions affect wetlands indirectly by affecting hydrologic conditions. For example, water diversions may desiccate a wetland or create new areas of saturated soils where wetland vegetation can establish.

Groundwater extraction is a form of water diversion that may affect wetland quality in regard to water availability, and vegetation growth. Although studies have not directly linked diminished groundwater recharge to wetland quality (Wright et al. 2006 p. 33), reductions in groundwater sources can adversely affect wetlands, especially with limited **recharge**. The water table height, which influences base flows in wetlands, is affected by rainfall, irrigation, infrastructure leakage, evapotranspiration, pumping, and soil compaction (Bhaskar et al. 2016 p. 295). Lowering the water table and shortening hydroperiods could lead to increased invasive species abundance and decreased populations of wetland-obligate species, or even completely desiccate wetlands, although further studies are needed to confirm these effects (Thom et al. 2001 p. 8).

In recent decades the purposeful inclusion of wetland habitat in wastewater treatment facility designs has become more prevalent (Gelt 1997 pp. 2–3). This use of treated wastewater can mitigate reduced base flows, resulting in no net change over time on a watershed scale (Bhaskar et al. 2016 p. 297). Areas experiencing both withdrawals (groundwater or surface water), and direct inputs (wastewater discharge) are referred to as "churned." These **churned systems** exhibit variable water tables, leading to locally reduced or increased base flows, which can impact ecosystem resilience (Bhaskar et al. 2016 p. 297). Las Arenitas Treatment Wetland in Mexico, and the Tres Rios Wetlands in the U.S. are examples of churned systems within the Yuma Ridgway's rail's range that have benefited the species. Because of the water effluent discharged, both have created an estimated 101 ha (250 ac) and 24.42 ha (60.8 ac) of marsh respectively (Zamora 2013, Balluff 2024b p. 4). The proposal to build a second 101 ha (250 ac) wetland near Las Arenitas Treatment Wetland to meet treatment needs has been paused since 2013. Should this initiative move forward, it could allocate an extra 12,000 acre-feet of water to the Rio Hardy. This increase in flow would not only enhance the Rio Hardy but could also reconnect the lower Colorado River to the ocean, creating better estuarine habitats in regions upstream of the river's mouth. The possibility of rediverting water for "toilet to tap" initiatives could greatly reduce these important pockets of habitat by reducing wastewater discharge within the systems.

The creation and maintenance of the Ciénega de Santa Clara from agricultural drain water is an excellent case study on the complexities of water diversions. Water in this case originates in the aquifer under the Wellton-Mohawk Irrigation District in the U.S. Following multi-year negotiations between the U.S. and Mexico, a canal was built to move approximately 1.3 x 10^8 m^3/yr of water from the Wellton-Mohawk valleys to the Ciénega de Santa Clara (Glenn et al. 1992 p. 818). This movement of water began in 1977 and was intended to be temporary. However, due to delays in building the Yuma Desalting Plant (YDP), water movement continued and has resulted in the re-establishment of a wetland in the discharge area with approximately 5,800 ha (11,900 ac) of marsh and approximately 12,2000 ha (301,469 ac) of mud flats and open water (Glenn et al. 1992 p. 818, Carrillo-Guerrero et al. 2013 p. 84). The YDP was completed in 1992, and since drainage water is not a legal, or required, water allocation to the Ciénega, water could be re-diverted to the YDP at any time. Indeed, on three occasions, a portion of this drain water has been redirected to operate the YDP (1992–1993, 2007, 2010–2011) (Carrillo-Guerrero et al. 2013 p. 85). An aerial survey in 1993, following the first reduction, found that this decrease in water resulted in a net loss of 70 percent of vegetation in the upper Ciénega, 67 percent in the mid-central Ciénega, and 38 percent in the lower Ciénega (mean = 58 percent, S.D.= 14.4 percent) (Zengel et al. 1995b p. 18). Similarly, when the MODE canal required repairs that diverted water for 122 days in 2020, Yuma Ridgway's rail detections declined by 76 percent from the average during 1999-2019 (Flessa 2020 p. 60). Since this 2020 MODE outage, additional MODE outages have occurred to conduct further repairs. However, these outages are now carried out in January for shorter time periods (2-4 weeks) on an annual basis with no noticeable declines in Yuma Ridgway's rail detections.

As habitats become either more fragmented or unsuitable due to water diversions that exacerbate conditions from existing droughts, the Yuma Ridgway's rail, along with other native marsh birds, will have decreased redundancy, representation, and resiliency across the Yuma Ridgway's rail's range. As development continues, and as water conservation methods become more efficient, it will become imperative that consideration of water for habitat retention is incorporated into management and design plans. If not, there will be a significant loss of redundancy of the species across its range, which will negatively affect the genetic representation and resiliency of the species.

Contaminants

Land use changes can lead to contaminant runoff entering wetlands, adversely affecting both flora and fauna. Contaminants include heavy metals such as mercury, selenium, cadmium, and lead. The point source for these heavy metals is unknown. Exposure to these metals and non-metals (like arsenic and selenium) generates **superoxide**, which is responsible for toxicity symptoms (Spallholz and Hoffman 2002 p. 30). Currently, selenium is of greatest concern due to its uncertain effects on the Yuma Ridgway's rail. While selenium naturally occurs in wetlands and is widely distributed in nature (Eisler 1985 p. 4), it can be absorbed or ingested by organisms, bind with particulate matter, remain dissolved in water, or volatilize into the atmosphere (Lemly 1997 p. 417). In trace amounts, selenium is an essential nutrient that protects mammals and some birds from the toxic effects of other heavy metals (Eisler 1985 pp. 4, 6). However, at higher concentrations, it can cause acute toxicity in organisms, leading to poor hatching success, deformed embryos, emaciation, and even mortality (Eisler 1985 pp. 7, 27, 29, Heinz and Fitzgerald 1993 p. 93, King et al. 2000 p. 7).

Aquatic birds are primarily exposed to selenium in the form of L-selenomethionine, with lesser amounts of L-selenocysteine from ingested insects and fish (Spallholz and Hoffman 2002 p. 32). The embryonic stage is particularly vulnerable to selenium's effects (Lemly 1996 p. 23, Yost et al. 2023 p. 57), and reproductive failure can occur even if adult birds show no signs of toxicity (Lemly 1996 p. 23). Prior to the studies by Yost et al. (2023, 2025) most research on selenium toxicity focused on waterfowl such as mallards. Yost et al. (2025 pp. 7–8) greatly expanded the dataset on selenium exposure in Yuma Ridgway's rails by analyzing tissue, egg, and prey samples collected across multiple marsh types. However, species-specific toxicity thresholds for rails remain undefined (Yost et al. 2025 p. 15). Consequently, even with improved sampling, definitive conclusions about selenium's reproductive impacts on this species remain elusive (Yost et al. 2025 pp. 14–15).

The most comprehensive study relevant to the Yuma Ridgway's rail is Novak's (2006) research on clapper rails along the Georgia coast, which examined lead exposure. This study highlighted that rails are excellent bioindicators due to their use of both local and landscape-level environments and their position high on the food chain, which reflects their "toxic burden" (Novak et al. 2006 p. 271). Although this study did not focus on selenium, it found that coastal marsh rails exhibited higher DNA breakage than those in river and creek systems, primarily due to lead concentrations (Novak et al. 2006 p. 277). The study was less conclusive regarding the effects of other contaminants on DNA breakage (Novak et al. 2006 p. 278). Importantly, Novak noted that toxicants accumulate in breeding females before nesting, making eggs good indicators of local toxicity (Novak et al. 2006 p. 279, Zhang and Ma 2011 p. 2770). However, for migratory species, toxicants accumulated prior to the nesting season may persist in tissues and be transmitted to eggs, meaning that eggs may not accurately reflect the toxic burden of the local breeding area (Lemly 1996 p. 23, Novak et al. 2006 p. 279, Zhang and Ma 2011 p. 2772). This potential confounding factor is significant for future studies on the Yuma Ridgway's rail.

Selenium is particularly concerning for the Yuma Ridgway's rail because concentrations in potential prey species, specifically crayfish, within its range have been shown to be within or higher than the established toxicity thresholds (Ricca et al. 2022 p. 19). This is likely from irrigation of seleniferous soils leaching selenium into subsurface drainages, thus contaminating potential prey species. This leaching into drainages is believed to be responsible for significant selenium poisoning of fish and wildlife at Kesterson NWR, California (Lemly 1997 pp. 415, 417). Within the Yuma Ridgway's rail's range, the lower Colorado River valley has an unusual distribution of selenium, complicating risk assessments for species (Rusk 1991 p. 12). In areas where flow is restricted, such as backwaters, selenium concentrations can increase due to low rainfall, high evaporation, and limited outflow (García-Hernández et al. 2001 p. 67). Impoundments that restrict drainage and flushing lead to silt accumulation and more concentrated contaminants (Rusk 1991 p. 14). Higher selenium concentrations have been found at sites with greater clay and silt content receiving agricultural drainage (Garcia-Hernandez et al. 2001 pp. 74-75). Some agricultural drain water has also shown higher selenium levels than water from the lower Colorado River (McKernan et al. 2016 p. 3), although no specific areas in the Imperial Valley of California consistently exhibited elevated selenium levels (Roberts 1996 p. 6), indicating an unusual distribution of selenium in drains.

The 2001 study by Garcia-Hernandez found that sites receiving water from irrigation drains and runoff, characterized by strongly reducing conditions (high clay, silt, and organic carbon content), had the lowest selenium concentrations in prey species (García-Hernández et al. 2001 pp. 82–83). Conversely, sites with higher sand and lower organic carbon, receiving water from the Colorado River, exhibited high selenium concentrations due to the river's physio-chemical conditions favoring selenium mobilization from bottom materials (Garcia-Hernandez et al. 2001 p. 83). The highest selenium concentrations in prey species were found in sites receiving agricultural runoff with little to no outflow, large organic carbon substrates, and regularly disturbed bottom materials (García-Hernández et al. 2001 p. 84). In summary, while agricultural drain waters likely carry higher selenium concentrations into wetland sites, the level of organic matter that can immobilize selenium and the frequency of disturbance to re-oxidize selenium determine the risk to species.

Sensitivity to selenium and its compounds varies widely among organisms, and exposure to prey species can also fluctuate seasonally (Eisler 1984 pp. 4, 9). Therefore, it is crucial to address knowledge gaps regarding how selenium impacts the Yuma Ridgway's rail and identify areas within its range that pose the greatest exposure risk. The most stable and extensive wetlands along the Colorado River receive their water from agricultural runoff (Garcia-Hernandez et al. 2001 p. 84). Notably, even if a site has high selenium concentrations, immobilization processes can effectively remove up to 92 percent of total selenium (Lemly 1987 p. 2, García-Hernández et al. 2001 p. 83).

Selenium has been shown to negatively impact reproductive success and potentially cause embryo deformities in eggs from adult waterbirds experiencing selenium toxicity. If the Yuma Ridgway's rail faces similar reproductive challenges, it could significantly affect the species' overall resilience. Thus, addressing the knowledge gap regarding the effects of selenium and other contaminants is essential.

Fire retardants are another potential contaminant to Yuma Ridgway's rail habitat. With the predicted increase of high-intensity fires in the southwest, coupled with Arundo being an invasive plant species that burns hotter than cattail (Giessow 2011 p. 139) within the rail's range, there is a reasonable likelihood that fire retardant could be used over suitable rail habitat while rails are breeding, nesting, or foraging. The effects of retardant to rail-specific prey, and overall rail health is unknown and warrants further study. However, inferring from a 2025 study (Rennert and Kneitel p. 558), fire retardant contamination in vernal pools resulted in increased algae growth which inhibited emergent plant growth. Invertebrate species richness was found to respond positively or negatively depending on the concentration of the retardant (Rennert and Kneitel 2025 p. 559). Although it is reasonable to assume that rails would leave a marsh in response to a fire (assuming they are not within the basic pre-body molt that impacts flight), the effects of the retardant to rail habitat and prey could be negative.

Currently, it is unclear which sites pose the highest risk of selenium, and other contaminant exposure for the Yuma Ridgway's rail. While direct mortality in adult birds would require higher contaminant concentrations than those reported, it is more likely that contaminated sites would primarily affect reproductive success. This could mean that the redundancy of the species across its range might remain unchanged if contaminated sites are maintained in "suitable" conditions, allowing adults to continue occupying them. Consequently, the greatest impact of this stressor may be on the genetic representation and overall resilience of the species because of reduced recruitment, resulting in declining population sizes.

Invasive Wildlife

Feral swine, also known as feral hogs, feral pigs, or in Europe wild boar (*Sus scrofa*), are considered one of the world's worst invasive species due to their significant impact on native vegetation, the spread of weeds and other invasive plants, and predation on both vertebrates and invertebrates (Lowe et al. 2000 p. 8). This designation stems largely from their ability to inhabit a wide range of environments, including forests, woodlands, riparian areas, freshwater and brackish marshes, sand dunes, and coastal beaches and swamps (Dardaillon 1987 p. 389). Feral swine are found on every continent except Antarctica (Wehr et al. 2018 p. 177) and are often referred to as "ecosystem engineers" because their activities affect multiple **trophic levels** across various geographic scales (Wehr et al. 2018 p. 184).

The environmental impacts of feral swine are primarily attributed to two behaviors: wallowing and rooting. Wallowing involves rolling in mud to remove parasites and create a protective layer against pests, resulting in large bare patches of mud across the landscape (Wehr et al. 2018 p. 180). Rooting, on the other hand, occurs when swine use their snouts to turn over soil in search of belowground forage, creating mounds of soil in some areas and depressions in others (Arrington et al. 1999 p. 535). This behavior can disturb soil up to 10 cm (4 in) deep, with an individual swine capable of disturbing up to 200 m^2 (2153 ft^2) of soil in a single day (Wehr 2018 p. 180).

The effects of rooting and wallowing on marsh systems are dependent on local and regional factors. For example, Arrington's 1999 study in a wetland setting found that feral swine do not root in inundated soils, suggesting that hydrology can limit rooting behavior (Arrington 1999 p. 543). The study also revealed that rooted wet prairie areas had taller vegetation, more cover, greater diversity, and more microhabitats than unrooted control areas. When areas were re-flooded, the patches created by rooting supported greater faunal diversity (Arrington 1999 p. 542). Arrington concluded that in floodplains with periodic dry spells, rooting acts as a biotic disturbance that enhances microhabitat diversity and species richness by breaking up dense vegetation and re-oxidizing soils (Arrington et al. 1999 pp. 542, 544). However, it is important to note that this study area experienced regular flooding, which likely facilitated the recovery of rooted areas and influenced feral swine movement (Arrington 1999 p. 543).

In contrast, the loss of habitat due to rooting and wallowing has been linked to the disappearance of the Auckland Islands rail (*Lewinia muelleri*) from Auckland Island (O’Donnell et al. 2015 p. 20). Other studies have indicated that these behaviors can redistribute soil contaminants (Gaines et al. 2005 p. 568) and create habitats in wallowing and rooting depressions that support avian malaria-carrying mosquitoes (LaPointe et al. 2012 p. 215). In cases where feral swine occupy wetland habitats year-round, the impacts on habitat and disease transmission could be exacerbated (Dardaillon 1987 p. 393).

Regarding their diet, feral swine are generally recognized as opportunistic omnivores (Timmons et al. 2011 p. 1, Wehr et al. 2018 p. 180), primarily consuming grasses, forbs, roots, nuts, and tubers (Taylor and Hellgren 1997 p. 33). However, specific dietary information for feral swine in wetlands is limited. A 2008 study of 142 wild boars in a Mediterranean wetland found that 94 percent of their diet consisted of plant matter, while animal matter, though comprising only 5.6 percent by volume, was present in 84.5 percent of samples. Among the animal content, 1.7 percent was crayfish and 2.3 percent was birds, indicating that these two groups made up 30-40 percent of the animal matter in their diet (Giménez-Anaya et al. 2008 p. 199). The study also revealed that Anseriformes (ducks) and Gruiformes (coots, cranes, and rails) accounted for 44 percent of the birds consumed, with predation occurring primarily between March and April and September and October, coinciding with the nesting and molting periods of resident birds (Giménez-Anaya et al. 2008 p. 199). While evidence of egg consumption was lacking, there were indications of chick predation (Giménez-Anaya et al. 2008 p. 200).

Conflicting evidence exists regarding predation on nests by feral swine. A study conducted with dummy northern bobwhite nests in 1993 and 1994 found that feral swine depredated 23.5 percent of the nests, with authors speculating that predation rates could be higher now due to increased swine densities in the area (Timmons et al. 2011 p. 1). Conversely, a 1969 study reported low predation rates, with only 2.6 percent of dummy nests being depredated, even when feral swine populations were high (Henry 1969 p. 170). Similarly, Challies’s 1975 study concluded that there was little evidence of swine affecting the vegetation or populations of nesting seabirds on Auckland Island (Challies 1975 p. 488). He noted that the scarcity of reported instances of swine interfering with nesting seabirds suggested minimal impact on bird populations (Challies 1975 p. 488). Factors such as nest visibility, the secretive nature of birds, and the habitat in which nests are built can contribute to the differences between these studies. O’Donnell’s 2015 study found no confirmed predation on nests by feral swine but noted that all wetland bird species, particularly those that nest on the ground and have females primarily incubating the eggs, are vulnerable to predation by introduced mammals (O’Donnell et al. 2015 p. 23). This study also indicated that lower water levels might increase access for ground predators, although there could be a confounding relationship between water depth and food availability (O’Donnell et al. 2015 p. 27).

Invasive species like feral swine can significantly affect landscapes, influencing multiple trophic levels and geographic scales. Given their numbers and current range, it is unlikely that feral swine will ever be completely eradicated. Their continued presence can impact the resiliency of the Yuma Ridgway’s rail. This influence can be positive, as suggested by Arrington’s 1999 study, which indicated that rooting could break up dense vegetation and promote new growth and microhabitats (Arrington 1999 pp. 542, 543). Conversely, it could also have negative effects, such as habitat destruction, predation on eggs and other life stages (Giménez-Anaya et al. 2008 pp. 199, 200, O'Donnell et al. 2015 p. 20, 23), and the potential redistribution of contaminants (Gaines et al. 2005 p. 568).

If feral swine populations are maintained at lower densities, their impacts could be negligible. However, if swine populations are not kept at lower densities, their trampling, wallowing, and rooting behaviors could hinder nesting and foraging opportunities for the rail, leading to habitat abandonment and negatively affecting population resiliency. Increased predation on Yuma Ridgway's rail nests would further impact reproductive success and survivorship, directly influencing the population's overall resiliency.

Invasive Vegetation

Like invasive swine, invasive vegetation can be detrimental to biodiversity because of the increased likelihood a **monoculture** will develop. Within the Yuma Ridgway's rail's range, four such invasive plant species pose a risk to the species' habitat and therefore persistence within its known and historic range.

Three of the four plant species of greatest concern occur within the water channel. The first is the non-native common reed subspecies (*Phragmites australis australis*). This perennial reed was introduced from Europe and can quickly develop into a monoculture, outcompeting and excluding other native marsh plant species (Sturtevant et al. 2024). When established, this subspecies of *Phragmites* alters marsh ecosystems by increasing surface elevation, aboveground biomass, and organic matter accumulation (Stanton 2004 p. 115). Common reed can also have beneficial impacts, such as removing excess nutrients (like selenium), heavy metals, and carbon, and stabilizing soils in disturbed environments (Azaizeh et al. 2006 p. 192, Kiviat 2013 p. 5). In one instance, a pair of Yuma Ridgway's rails utilized an area of the *P. a. australis* subspecies of common reed. This area, an irrigation ditch, is frequently mowed outside of the nesting season, allowing the common reed to have moderate interstitial spacing between stalks. While nesting was not confirmed, Yuma Ridgway's rail's presence emphasizes the importance of spacing between stalks (A. Lopez pers. comm 2026). In general, though, the *P. a. australis* subspecies of common reed displaces native plants, including sedges, rushes, and cattails and reduces wildlife habitat diversity, resulting in loss of food and shelter for native wildlife (Avers et al. 2014 p. 3). The common reed subspecies native to North America, the American common reed (*Phragmites australis americanus*), is not considered a stressor because if it were to grow within the Yuma Ridgway's rail's range it would likely occur in low densities and would not outcompete native vegetation (Ratz n.d.).

Second is the giant reed (*Arundo donax*). which is the largest member of the *Arundo* genus and is among the largest of the grasses (*Poaceae*), growing to more than 8 m (25 ft) tall (Bell 1993 p. 2). Giant reed is native to Eastern Asia but has been introduced to every continent besides Antarctica because of its perceived uses. For instance, giant reed was first planted in California in the 1820s to provide roofing materials and for erosion control (Hoodle n.d.). Giant reed, like common reed, produces large quantities of aboveground biomass as stalks die but remain within the stands. Not only does this create such small interstitial spacing between stalks that rails cannot move within the stands, but it also creates an increased fuel load that becomes a fire risk (Guthrie 2007 pp. 39–40). This risk of creating higher intensity wildfires within areas is compounded because giant reed, even with green stems, is highly flammable (Bell 1993 p. 2, Scott 1993 p. 17). Once established, giant reed can quickly become dominant, leading to reduced plant diversity and facilitating the establishment of other invasive species.

Finally, the water primrose (*Ludwigia hexapetala*), is a highly adaptable species that significantly impacts wetland ecosystems. Initial invasion of the water primrose into a wetland may lead to the lateral expansion of emergent vegetation. However, after the open aquatic habitat is fully occupied, water primrose will outcompete cattails (Khanna et al. 2018 pp. 12–13). Water primrose is an **allelopathic** plant. Meaning that after it establishes in a waterbody, it releases **allelochemicals** that have been shown to prevent the growth of native plants (Thiébaut et al. 2018 p. 8). Because of this, once a waterbody is occupied by water primrose, its species richness, evenness, and diversity are measurably reduced (Grewell et al. 2019 p. 3). Management of water primrose is intensive because of the plant's extensive creeping stem biomass within a system and need for consistent monitoring and removal following preliminary actions (Enloe et al. 2020 p. 121).

On upland edges, marshes experience woody encroachment as a part of a marsh's natural successional aging. Historically this woody encroachment was controlled by seasonal flooding. Now, in an absence of floods, woody encroachment by both native and non-native woody vegetation can pose a problem. Of primary concern are two tamarisk subspecies, the salt cedar (*Tamarix ramosissima*) and the five-stamen salt cedar (*Tamarix chinensis*). Both can quickly form dense monotypic stands without management. The Athel salt cedar (*Tamarix aphylla*) is also invasive to the southwest but is not as aggressive. It is important to note that tamarisk species have not been found to use more water than native plants as is commonly stated (Graf et al. 1984 pp. 14, 22, 26, 29, Graf 1992 p. 14). It is also important to mention here that an overstory of woody vegetation (native or non-native), may serve as a benefit to the rail by keeping the water and vegetation cooler while also providing shelter from certain predators. Nevertheless, a solid stand of woody vegetation can inhibit water flow that promotes cattail growth and increases the risk of severe wildfires.

The management challenges of woody encroachment are compounded by misinformation about the effects of removing invasive plant species. For example, it is commonly stated that removing common reed, giant reed, and tamarisk will restore the groundwater table, when in reality it does not (Graf et al. 1984 pp. 14, 22, 26, 29, Graf 1992 p. 14). However, removing invasive plant species is beneficial because it allows surface water to flow more easily and thus encourage the growth of native emergent vegetation. Invasive plant removal, especially removal of giant reed and tamarisk, will also decrease the risk of high-severity wildfires. Education on both the benefits of invasive plants, and their removal, may remedy this situation.

Ectoparasites

Every avian taxon can potentially carry parasites, including lice, mites, and ticks (Proctor and Owens 2000 p. 358). The prevalence of **ectoparasites** has led to the evolution of various coping mechanisms in birds, encompassing behavioral, physiological, immunological, life history, and demographic adjustments (Møller and Erritzøe 1998 p. 954). However, introduced parasites have been linked to population declines in several species of Darwin's finches in the Galapagos Islands. These finches did not coevolve with the parasites and, consequently, lacked the necessary coping mechanisms (Koop et al. 2013 p. 2515).

The recent discovery of an unknown species of red mite, or chigger, has raised concerns about the potential decline of the Yuma Ridgway's rail population. This parasite belongs to the Trombiculidae (Acarina) family and the *Blankaarita* genus. Trombiculidae mites are globally distributed, and their larval stage is known to parasitize hosts by feeding on living tissues (Ewing

1944 p. 348, Philips 2000 p. 212). This feeding behavior can lead to localized dermatitis (Philips 2000, p. 212). Some ectoparasites, including certain mite species, are known to kill nestlings or fledglings (Clayton et al. 2010 p. 64). These detrimental effects may be partly due to ectoparasites suppressing the host's immune defenses, forcing the host to expend more energy on an effective immune response, such as antibody production, along with associated behavioral responses like itching (Koop et al. 2013 p. 2515).

Much remains unknown about the impact of the mites on the Yuma Ridgway's rail. The mite is suspected to be a novel species, as no previous studies have reported mite infections in rails or other Rallidae species within the rail's range (Harrity and Conway 2019c p. 143). Notably, none of the 99 rails captured at Imperial NWR in 2016, from the same marshes sampled in 2017, were found to host the mites. In 2017, however, mites were localized to Imperial and Cibola NWR, with 48 of the 52 captured rails at Imperial NWR infected (92 percent), and 2 of the 18 rails at Cibola NWR infected (11 percent) (Harrity and Conway 2019b p. 144). By 2018, the situation worsened, with 93 percent (56 of 60) of the Yuma Ridgway's rails captured at Imperial NWR infected, and 44.4 percent (4 of 9) at Cibola NWR. Additionally, mite infections were found in all captured rails at Mittry Lake and Overton WMA, as well as all rails captured at Ash Meadows NWR. Furthermore, 33.3 percent (5 of 15) of rails captured by the Sonny Bono Salton Sea NWR were infected. Notably, no incidental species (such as Virginia rails or least bitterns) captured in 2018 showed mite infections, despite being in heavily infected areas like Imperial NWR. This trend indicates an increase in infections at Imperial and Cibola and raises two possibilities: (1) the mites may be expanding their range and specifically targeting the Yuma Ridgway's rail, or (2) the Yuma Ridgway's rail may be using a different micro-habitat that increases their exposure to the mites.

If these mites are indeed a novel parasite, they may have originated from Central or South America and been transported north by migrating rails or other migratory marsh birds. This hypothesis is supported by Møller and Erritzøe's findings, which indicate that migratory birds can be exposed to and acquire new types of parasites not found within their native ranges (1998 p. 946). Their study, which compared the sizes of immune defense organs, showed that migratory birds allocate proportionally more resources to anti-parasite defense than resident birds (Møller and Erritzøe 1998 p. 946, 948). Additionally, a telemetry study revealed a migrating rail traveling nearly 450 kilometers within 48 hours (Harrity and Conway 2019a p. 2) and returning close to its original capture site. Since resident birds allocate less energy to anti-parasite defenses, this could explain the increased infection rates observed in Harrity and Conway's study, as well as the localized nature of the infections. The effects to populations are unknown but it is possible that birds with lower immune defenses are more susceptible to infection (Møller and Erritzøe 1998 p. 951).

The overall effects on the population remain uncertain, but abundance could decline due to decreased survival. However, this may result in a population that is more resilient to infections. If migrating individuals are responsible for transporting the parasite, eradication in both the breeding and wintering range would be needed for it to be effective. Since range-wide eradication is unlikely, the ability of individuals to adapt, and the speed at which a population can respond, are crucial for the species' persistence and resilience.

Chapter 5. Current Conditions and Viability Factors

VIABILITY ANALYSIS

This chapter discusses the factors influencing the viability of the Yuma Ridgway's rail. Viability is a result of the factors influencing resiliency of populations, and the subspecies' redundancy and representation. We discuss these viability factors in this way and include past and current factors that influence viability. Please note that the term "factors" can refer to both threats and conservation measures, or in other words, may have either detrimental or beneficial effects to the subspecies. Estimates for the demographic factors like population size, adult and juvenile survival rates, and population growth are not currently available for the Yuma Ridgway's rail. We nevertheless recognize that the species relies on these key features. Because of the limited available information, we base the demographic factor status on the average trend of abundance and occupancy for each LAU within each RAU. We also base the viability of the species on the trend of habitat availability, and what we know of the water security for that area because the habitat relies on sufficient surface water. To note, both resiliency and redundancy use abundance trends in their evaluation. However, these trends are considered through different lenses. For instance, resiliency evaluates for local environmental stochasticity and the ability for those populations to withstand stochastic events, and redundancy considers the number of resilient populations within a region and across the species range to evaluate the species ability to withstand catastrophic events. Therefore, the use of abundance trends for both is not considered confounding. To conclude this chapter, we consider the current conditions of Yuma Ridgway's rail populations.

Redundancy Factors

Redundancy describes a species' ability to withstand catastrophic events. The number, distribution, and resiliency of populations drive this ability. Within an LAU population, resiliency can be determined by the population size, adult survival, juvenile survival, and population growth. The information on survival rates, however, is not known and only estimates on abundance are available. Therefore, maintaining all existing populations, and reestablishing populations within the historical range, will help safeguard against catastrophic events such as high-intensity wildfires. However, with changing environmental conditions increasing the potential of altered precipitation patterns and high-intensity wildfires, increasing species redundancy may not ensure the species' persistence. There are no specific criteria to determine the redundancy of the species across the number of known populations. However, redundancy for this species is based on the trend of estimated abundance or occupancy, and the number of known populations within the 6 RAUs. Based on these estimated trends, positive or stable trends indicate increased redundancy, and declining trends indicate reduced redundancy.

Representation Factors

Representation describes a species' ability to adapt to changing environmental conditions through a breadth of genetic and ecological diversity within and among populations. Information is lacking about the current and historic genetic structure of this species, the extent of genetic flow between populations, and how the biological and physical features of a population relate to the genetics of the species. We do know that the Yuma Ridgway's rail is a unique subspecies of the Ridgway's rail rather than a subspecies of the clapper rail (Chesser et al. 2014 p. CSV). Nevertheless, because of the migratory behavior of the species, we assume that genetic exchange occurs, and therefore some representation of genotypes within and among the populations probably exists though research is needed.

Resiliency Factors

Resiliency describes how well a population can withstand and recover from random events like droughts, fires, storms, or disease. More resilient populations have stronger demographics including enough individuals, good survival rates, and enough reproduction to replace losses. Since survival rates, birth rates, **fecundity**, abundance, and population growth rates respond to habitat quality, habitat quality indicates resiliency. A population is resilient if it has sufficient size coupled with good reproduction so that when something bad happens, the population can rebound. This is dependent upon how well the habitat supports survival and reproduction. Importantly, we recognize that those LAUs and RAUs categorized as stable may represent two different resiliencies. The first is that a stable population may lack the ability to recolonize an area following a catastrophic event. The second is that a stable population may represent that available habitat is nearing its carrying capacity and would therefore be demographically robust and more likely to persist despite limited growth. Determining which of these applies to that LAU or RAU is not currently possible.

We determined that the factors most important for the continued persistence of the Yuma Ridgway's rail were the trend in estimated abundance or occupancy, trend in available habitat, and water security. These factors were determined to be the most influential because of their interconnectedness with key life stages and needs. For instance, the availability of water not only determines the presence of prey, but also habitat health. If sufficient water is present, then it is reasonable that more high-quality breeding habitat will be available. This allows for a higher abundance of birds. With higher abundance comes an increase of redundancy, representation, and resiliency of the species. Further, since little is known about wintering habitat needs, wintering behavior and site fidelity, these factors consider the need for habitat regardless of migratory behavior.

For each of these three factors we assessed if they were in high, stable, low, very low, or **extirpated** condition. Each of these conditions had an associated number so that we could determine the overall condition of that LAU and RAU (Table 4).

Table 4. Condition category table for the resiliency factors considered for each LAU and RAU. Each factor (trend abundance, habitat available, water security) receives an associated score. The scores of each factor are averaged to estimate the overall condition of the LAU and RAU.

Condition Category	***Trend abundance***	***Trend of habitat available***	***Water Security***	***Color Coding***
High	Increasing	Increasing. Where there is marsh, active management is planned or occurring.	Yes. Water delivery and water management plan.	5
Stable	Stable	Stable. Where marsh ages out, new opportunistic/incidental marsh develops elsewhere.	Water available but limited infrastructure to deliver water, and/or no water management plan.	4
Low	Declining	Declining. Inconsistent active management and/or limited growth areas.	Unsecure and/or decrease in water availability that may become permanent.	3
Very Low	No detection within 1-5 surveyed years	No active management and/or no new growth areas.	Intermittent loss of water.	2
Extirpated	No detection for 5 surveyed years	Permanent loss of suitable habitat.	Permanent loss of available water.	1

OVERALL CONDITION

We consider the overall condition to be captured in the resiliency scores of the LAUs and RAUs, because the resiliency score accounts for redundancy, which we assume correlates with representation, and habitat conditions. For this resiliency, we developed brackets to determine the status of LAUs and RAUs (Table 5). A low condition ranking is assigned if the average was less than 3.5, a stable condition would occur if the average was between 3.5 and 4.5, and a high condition would occur if the average was greater than 4.5.

Table 5. Condition score brackets to inform the overall condition of LAUs and RAUs.

Condition Score Brackets	***Expected Condition***
Greater than 4.5	High
3.5-4.49	Stable
2.5-3.49	Low
1.5-2.49	Very Low
1-1.49	Extirpated

CURRENT CONDITIONS

This chapter discusses the demographic and habitat conditions of the Yuma Ridgway's rail as we currently understand them. We continue to define viability as the ability of the species to sustain respective populations over time and characterize the status of the populations in terms of resiliency, redundancy, and representation as defined above.

Current Population Trends

Yuma Ridgway's rails are extant to various degrees across their hypothesized historical range. Because of the scope of the species' range, available data are variable. In evaluating current population trends, we considered information from three different sources.

These sources varied in extent. The first used end-of-year marsh bird survey results submitted to the U.S. Fish and Wildlife Service by agencies and collaborators throughout the U.S. range of the Yuma Ridgway's rail. This source is the most inclusive source and simply used the sum of the highest counts, meaning that if three surveys were completed on a route, the highest single count of those surveys was considered. These high counts were then summed for every route annually to serve as an index of relative abundance and estimate trends through time. This methodology used only the routes within RAUs in the U.S. and is dependent on consistent surveys. Because of this, this method is affected by detection probability and changes in survey effort (e.g., 2020 had fewer surveys done, resulting in reduced total count). The second source of information was a hierarchical Bayesian models that used marsh bird survey data submitted to the Avian Knowledge Network (AKN) to estimate Yuma Ridgway's rail abundance. For this method, some survey routes and RAUs, like the Colorado River Delta RAU, were excluded either because they did not meet certain criteria, or data were not available in AKN (U.S. Fish and Wildlife Service unpublished). Both the end-of-year data score, and the Bayesian model score were averaged since both represent possible abundance. This average of the abundance trend was then used in calculating the overall average score for the individual LAUs. The final source of information was from occupancy models. This methodology also used marsh bird survey data from AKN but did not apply the same filtering criteria as the Bayesian abundance model. This method also did not have access to the data from the Colorado River Delta RAU or the Southern Nevada RAU (U.S. Fish and Wildlife Service 2025, unpublished data). This method estimated occupancy only at the RAU level and not for individual LAUSs.

Of the 19 LAUs:

- 16 have a trend of highest counts. Based on the high counts, 3 LAUs are in good condition, 6 are stable, and 7 are in low condition. The remaining 3 LAUs did not have data to estimate this trend.
- 13 have abundance estimates from the hierarchical Bayesian models. Based on these abundance estimates, 7 LAUs are in good condition, 2 are in stable condition, and 4 are in low condition. The remaining 6 LAUs either did not have data, or did not have sufficient data, to include in the model.
- 1 LAU has no information regarding abundance trends, habitat, or water security.

Of the 6 RAUs, 4 have occupancy estimates. Based on occupancy estimates, 2 RAUs are in good condition, 1 is in stable, and 1 is in low condition.

Current Representation

There is no current information regarding the genetic structure of this species, the amount of genetic flow between populations, or how the biological and physical features of a population tie into the genetics of the species. However, the variation in migratory behavior may suggest that unique genotypes exist within the species' range (e.g., largely non-migratory populations in Southern Nevada RAU versus the more migratory population in Central Arizona RAU). There is also currently an assumption that, historically, the Ciénega de Santa Clara and Rio Hardy Wetlands LAUs were population sources for the rest of the species' range. To determine if the Ciénega de Santa Clara and Rio Hardy Wetlands are still a source population, if migratory genotypes exist, and to determine how the Yuma Ridgway's rail is or is not related to the Sonora and San Blas Ridgway's rail, genetic studies are needed.

Current Redundancy

Despite having a wide distribution, the Yuma Ridgway's rail maintains stable redundancy, with populations remaining sufficiently numerous and well-distributed to support the species' ability to withstand catastrophic events. We evaluated the redundancy of the species by considering the trends of estimated abundance and occupancy, and the number of known populations within the 6 RAUs (Table 6). This method does not account for unknown populations that may occur within incidental habitat within that RAU (e.g., Citrus Valley). Using the average score of the trends of abundance:

- 6 of the 18 (33 percent) LAUs have an increasing trend.
- 7 of the 18 (34 percent) LAUs have a stable trend.
- 5 of the 18 (28 percent) LAUs have a declining trend.

When considering the occupancy modeling of the 4 RAUs, 2 of the 4 (50 percent) are in high condition, 1 (25 percent) to be in stable condition, and 1 (25 percent) is in low condition. Because 13 LAUs (72 percent) are in an increasing or stable redundancy trend, the species can likely withstand catastrophic events.

Current Resiliency

To assess the current resiliency of the Yuma Ridgway's rail, we considered the estimated condition for water security, the trend in habitat available, and the trends of populations based on the three sources of information described above. To determine the overall resiliency of an LAU, we averaged each condition score for water security, habitat availability, and rail population trend. We then averaged the overall score of each LAU to estimate a single resiliency score for each RAU. Below, we provide the condition score brackets and the expected condition of the LAUs and RAUs (Table 5).

Following this method, 4 of the 19 LAUs (21 percent) are in high condition, 11 of the 19 (58 percent) are in stable condition, and 3 of the 19 (16 percent) are in low condition. One LAU is in unknown condition (5 percent). For the overall condition and resiliency of the 6 RAUs, 2 are in high condition, 3 are in stable condition, and 1 is in low condition (Table 6). Based on the average score of the RAUs, the resiliency of the Yuma Ridgway's rail is currently in stable condition with a score of 4.09.

Summary of Current Conditions

Currently, the majority of LAUs have an increasing (6 of 18; 33 percent) or stable redundancy (7 of 18; 39 percent) across the species' range. Because we assume the trends in redundancy equates to trends in representation, we expect representation will increase in 6 LAUs (33 percent), remain stable in 7 LAUs (39 percent), and decrease in the remaining 5 LAUs (28 percent). When taking into consideration habitat suitability, the majority of LAUs have either high or stable resiliency. However, there are noticeably more LAUs that have stable resiliency (11 of 18; 61 percent), instead of high resiliency (4 of 18; 22 percent). When averaging the resiliency scores of the LAUs within each RAU, 2 of the 6 RAUs (33 percent) have high resiliency, 3 of the 6 RAUs (50 percent) have stable resiliency, and 1 RAU (17 percent) has low resilience. When averaging these RAU averages, the overall condition of the Yuma Ridgway's rail is stable with an estimated average score of 4.09 providing redundancy through most of the species' range should a catastrophic event occur but leaving the species at risk of smaller stochastic events.

Table 6. Overall current condition table. Acronyms: National Wildlife Refuge (NWR), Arizona Game and Fish Department (AZGFD), Multi-Species Conservation Plan (MSCP), Wildlife Management Area (WMA).

Current Conditions	Trend Abundance (End-of-Year Data)	Trend Abundance (AKN Data Modeling)	Trend Abundance Average	Trend Occupancy	Trend of habitat available	Water Security	Overall Resiliency LAU	Overall Resiliency RAU
Colorado River Delta RAU				Not modeled				4
Ciénega de Santa Clara	Unknown	3	3		5	3	3.67	
Rio Hardy Wetlands	Unknown	5	5		4	4	4.33	
Salton Sea RAU				5				4.61
Sonny Bono Salton Sea NWR	3	3	3		4	3	3.33	
Wister	4	Not modeled	4		4	5	4.33	
Dos Palmas Preserve	5	Unknown	5		5	5	5	
Yuma RAU				5				4.63
AZGFD Southwest	3	4	3.5		3	3	3.17	
Lower Colorado River MSCP Conservation Areas	4	5	4.5		4	5	4.5	
Cibola NWR	5	5	5		5	4	4.67	
Imperial NWR	5	5	5		5	4	4.67	
Mid-Lower Colorado River RAU				4				4.06
Bill Williams River NWR	4	4	4		5	4	4.33	
Havasu NWR	3	5	4		4	4	4	
Lower Colorado River MSCP Conservation Areas	3	5	4		4	4	4	
Central Arizona RAU				3				3.33
Tres Rios and Rio Salado	3	3	3		5	5	4.33	
AZGFD Owned	3	3	3		4	4	3.67	
Lower Gila River Valley	3	Not modeled	3		3	3	3	
Citrus Valley	Unknown	Unknown			Unknown	Unknown	Unknown	
Southern Nevada RAU				Not modeled				3.94
Ash Meadows NWR	4	5	4.5		3	4	3.83	
Pahranagat NWR	4	Not modeled	4		3	4	3.67	
Las Vegas Wash, WMAs	4	Not modeled	4		5	4	4.33	

Chapter 6. Future Condition

Previous chapters include information on Yuma Ridgway's rail ecology; past and current distribution, stressors on viability, and current conditions. Here, the viability of Yuma Ridgway's rail is assessed by applying future trends to the species' resiliency and redundancy through 2050. Because we do not have information regarding the genetic structure of this species, the amount of genetic flow between populations, or how the biological and physical features of a population tie into the genetics of the species we assume that any loss of redundancy could result in a reduction in representation. Conversely, an increase in redundancy is assumed to increase possible representation. For all scenarios we assume adequate staffing and resources to carry out current, and potentially new, surveys and conservation measures.

DESCRIPTIONS OF FUTURE SCENARIOS

Assumptions

Stressor Assumptions

Based on the best available information, we have made assumptions, summarized below, regarding the likelihood of occurrence and degree of threat for stressors that apply to four future scenarios.

First, environmental change is a currently occurring stressor that has a high likelihood of impacting the species in the future. The IPCC has provided a variety of Shared Socio-economic Pathway (SSP) greenhouse gas emission scenarios through the year 2100 (SSP1-2.6 or SSP3-7.0) (Pörtner et al. 2022 p. 16). Emission levels in the short term will determine which climate model is most likely to occur. In the interim, we have provided scenarios to encompass a range of IPCC models. For this SSA we consider environmental change impacts from SSP1-2.6 in Scenario 1 and Scenario 2 because of currently occurring, and potentially increasing, environmental change adaptation to meet global goals. Scenarios 3 and 4 include SSP3-7.0 should environmental change adaptation measures cease and not meet global goals.

Based on data from the Environmental Protection Agency (EPA), western Arizona has been abnormally dry and continues to have moderate to severe drought conditions (Environmental Protection Agency (EPA) 2023). We assume there will continue to be a high degree of threat from drought to the Yuma Ridgway's rail because of their dependence on water. Water, and its continued availability and security, will drive habitat availability and suitability which will directly impact abundance. Therefore, water and habitat, and their associated stressors, will continue to have a high degree of threat to the continued persistence and survival of the species.

Associated with both environmental change and drought conditions, is the stressor of wildfires occurring within the breeding or nesting season. This stressor is anticipated to have a high degree of threat to the continued persistence of the species because of the predicted increase in high-intensity fires within the southwest. Unlike prescribed fire, which is used as a method to revitalize habitat, these higher intensity wildfires could occur during breeding or nesting season and possibly result in the mortality of eggs, juveniles, and adults. Also, high-intensity fires can result in root damage to valuable cover plants during drought or while marshes are not flooded. As mentioned above, increased drought intensity coupled with higher temperatures may result in more frequent wildfires that can destroy habitat, as well as direct mortality that will likely contribute to declines in the number of birds.

Although some literature shows feral swine to be a stressor to ground-nesting birds, we do not believe that this is happening within the Yuma Ridgway's rail's range to a degree to be a threat to the species resiliency. Further, the National Wildlife Refuges located along the Lower Colorado River successfully carried out intensive management of feral swine in the area. Should feral swine become a higher threat to the Yuma Ridgway's rail habitat in the future, similar management actions would be taken again.

Finally, ectoparasites (including the potentially novel species described above) may be a threat to the Yuma Ridgway's rail, but not enough information is available at this time to fully assess the threat (see Ectoparasites section above). Further research is needed to determine the impact this could have on overall species viability.

Conservation Measure Assumptions

For the four scenarios discussed below, we assume future conservation measures fall into one of two categories. The first category is that current conservation measures, including population surveys and management of habitat within Refuges and Conservation Areas, will continue into the future. Under this category, we assume that additional infrastructure (e.g., pumps) or coordinated prioritization for habitat management will occur. The Yuma Ridgway's rail is federally listed as endangered throughout its range (including Mexico), is a Tier 1-Species of Greatest Conservation Need in Arizona and is listed as a threatened species with full protections in California. Given its status and strong partnerships, conservation measures for the Yuma Ridgway's rail are likely to continue. Therefore, none of the future scenarios assume there will be a discontinuation of the current conservation measures.

The second category is the assumption of additional conservation measures being implemented. These measures would include land protection agreements that would protect and maintain habitat; water allocation agreements; and improvement of infrastructure for more efficient water delivery. Conservation measures would also include the prioritization of areas of habitat within each RAU. These prioritized areas would likely receive more water from the water allocations as well as physical modifications to ensure that areas of habitat are optimally suitable for the rail. The conservation measures noted above are not exhaustive and will be developed based on adaptive management. For the four scenarios we discuss below, we assume that additional conservation measures will be fully successful. All four scenarios are summarized in Table 7 below.

Table 7. Scenario table with analysis metrics.

Scenario	*Trend abundance*	*Trend of habitat available*	*Water Security*
1: Low Environmental Change, No Additional Conservation Measures	If current condition declining (3), this becomes a 2. All other scores stay the same.	If current condition for water security is low (score 3), habitat score is -1. All other scores stay the same.	All water security scores stay the same.
2: Low Environmental Change, Additional Conservation Measures	All trend scores that are less than high (5) are +1.	All habitat scores that are less than high (5) are +1.	All water security scores that are less than than high (5) are +1.
3: High Environmental Change, No Additional Conservation Measures	If habitat is 1, abundance = -2. If habitat is 2, abundance = -1.5. If habitat is 3, abundance = -1. If habitat is 4, abundance = -0.5	If water is a 1, habitat = -3. If water is a 2, habitat = -2. If water is a 3, habitat = -1.	All water security scores decrease by -2.
4: High Environmental Change, Additional Conservation Measures	If habitat is 1.5, abundance = -2. If habitat is 2, abundance = -1.5. If habitat is 2.5, abundance = -1. If habitat 3, abundance = -.5. If habitat is 3.5, abundance = +0. If habitat is 4, abundance = +.5. If habitat is 5, abundance = +1.	If water is a 1, habitat = -3. If water is a 2, habitat = -1.5. If water is a 3, habitat = -1. If water is a 4, habitat = -0.	All water security scores decrease by -1.

Scenario 1

In Scenario 1, we assume future climatic conditions align with the IPCC's SSP1 – 2.6 model which approximates an increase between 1.5 and 2° C in global temperature by 2100. Because of this, we assume that water allocations to Refuges, Conservation Areas, and agricultural areas will remain the same as they are currently. Under this scenario, monitoring of currently occupied sites continues, but no additional conservation measures are implemented, and current conservation structures are minimally maintained. Based on this, if water security in the current condition for an LAU was low (a score of 3), habitat availability would then decrease by a score (-1). We also considered the current trend of abundance, and if the trend was low (a score of 3), this became a score of 2 for this scenario due to no additional conservation measures being undertaken.

Scenario 2

In Scenario 2, we assume future climatic conditions align with the IPCC's SSP1 – 2.6 model which approximates an increase between 1.5 and 2° C in global temperature by 2100. Because of this, we assume that water allocations to Refuges, Conservation Areas, and agricultural areas will remain the same as they are currently. Also, under this scenario, monitoring of currently occupied sites continues. However, under this scenario we assume that additional conservation measures, as described above, would be implemented. Based on the presence and assumed success of conservation measures like water agreements, all water security scores that were less than high (a score of 5) increased by a score (+1). Since water dictates the quality and quantity of habitat, all habitat scores that were less than high (a score of 5) also increased by a score of (+1).

For abundance, because we assume that habitat quality will improve, abundance scores also increased by a score (+1).

Scenario 3

In Scenario 3, we assume future climatic conditions align with the IPCC's SSP3 –7.0 model which approximates an increase between 2.7 and 3.1° C in global temperature by 2100. Under this model, drought effects are anticipated to be substantial. Therefore, for this scenario we anticipate that water allocations will decrease to Refuges, Conservation Areas, and agricultural areas. For all LAUs, the water security score decreases by two (-2). As a result of this, if water is low (3) habitat will decrease by one (-1); if water is very low (2), habitat decreases by 2 (-2); and if water is no longer available to the system (1) then habitat is similarly expected to be lost (-3). Carrying through the cause and effect, if habitat is stable (4), trend of abundance is likely to change slightly (-0.5); if habitat is low (3), trend of abundance decreases by one (-1); if habitat is very low (2), trend of abundance decreases by one and a half (-1.5); and if habitat is lost (1), then abundance is also lost (-2).

Scenario 4

In Scenario 4, we assume future climatic conditions align with the IPCC's SSP3 –7.0 model which approximates an increase between 2.7 and 3.1° C in global temperature by 2100. Under this model, drought effects are anticipated to be substantial. And while we anticipate that water allocations will decrease to Refuges, Conservation Areas, and agricultural areas, under this scenario we assume that additional conservation measures such as agreements and water pump installation will be implemented. As a result, for all LAUs, the water security score decreases by one condition (-1). From this, if water is stable (4), habitat remains the same; if water is low (3) habitat will decrease by one (-1); if water is very low (2), habitat decreases by one and a half (-1.5); and if water is no longer available to the system (1) then habitat is similarly expected to be lost (-3). Carrying through the cause and effect, if habitat is in high condition (5), abundance is expected to increase (+1); if habitat is stable (4), abundance is likely to slightly increase (+0.5); if habitat is stable-declining (3.5), there is no anticipated change in abundance; if habitat is low (3), abundance is likely to decrease slightly (-0.5), if habitat is low-very low (2.5), abundance is likely to decrease by one (-1); if habitat is very low (2), trend of abundance decreases by one and a half (-1.5); and if habitat is lost (1-1.5), then abundance is also lost (-2).

Future Redundancy, Representation, and Resiliency

To determine the overall redundancy, representation, and resiliency within each LAU, and then the expected resiliency of each RAU, we used the same methodology of averaging each LAU score and then averaging those for the RAU score as described under Current Conditions (Table 5). The average RAU scores were then also averaged to inform the expected overall condition of the Yuma Ridgway's rail in that Scenario.

Scenario 1: Low Environmental Change, No Additional Conservation Measures

Colorado River Delta Regional Analysis Unit

Under Scenario 1, the Colorado River Delta RAU is likely to remain in stable condition although we expect some loss of representation because of the declining abundance trend of the Ciénega, and expectation that this trend will continue. Overall, this RAU's average score decreased from 4 to 3.5, which is just above low condition. This reduction is because the Ciénega de Santa Clara is reliant on outflows of the Welton Mohawk Irrigation District, and there is no conservation agreement in place to ensure water allocations would continue should the Yuma Desalting Plant be used. The water security, trend in available habitat, and trends in abundance are all expected to remain in high or stable condition for the Rio Hardy Wetlands LAU. Because this RAU is the lowest RAU in the Lower Colorado System, we assume that this RAU will be most affected by drought and water diversions.

Salton Sea Regional Analysis Unit

Under Scenario 1, the Salton Sea RAU is expected to have a measurable loss of representation and redundancy within the RAU with a change from a high condition score of 4.61, to a stable condition score of 4.25. This reduction is because of the reliance of the Salton Sea on agricultural drain outflows, and these outflows are currently not sufficient to replenish the Salton Sea, which is shrinking. Further, it is expected that while water allocations to agricultural areas will remain the same, application of this water will become more conservative resulting in less outflow. The water security, trend in available habitat, and trends in abundance are all expected to remain in high or stable condition for the Wister and Dos Palmas Preserve LAUs. Occupancy is expected to remain in high condition. Thus, the expectation of a reduction in representation is because of the declining abundance trend of the Salton Sea, and the expectation that this trend will continue.

Yuma Regional Analysis Unit

Under Scenario 1, the Yuma RAU is likely to remain in stable condition although we expect some loss of representation because of the declining abundance trend within the routes surveyed by the Arizona Game and Fish Department, and the expectation that this trend will continue. Occupancy is expected to remain in high condition. Overall, this RAU's average score decreased from 4.63 to 4.31. This reduction is because of the reliance on water from irrigation and upstream flows for areas like Quigley-Achee WMA, which have already lost all available marshes. Further, there is no conservation agreement in place to ensure water allocations to have confidence that revitalized areas will be able to sustain habitat. The water security, trend in available habitat, and trends in abundance are all expected to remain in high or stable condition for the Cibola NWR and Imperial NWR LAUs.

Mid-Lower Colorado River Regional Analysis Unit

Under Scenario 1, the Mid-Lower Colorado River RAU is likely to remain in moderate condition although we expect there to be some loss of representation because of the possible declining abundance trends on the Havasu NWR and within the Lower Colorado River MSCP Conservation Areas LAUs. On average, the trend of abundance will be in stable condition for all three LAUs. Occupancy is also expected to remain in stable condition. Overall, this RAU's average score decreased from 4.00 to 3.75. Because this RAU is predominantly NWRs and Lower Colorado River MSCP Conservation Areas that were established as a part of mitigation, water security and habitat both remained either in high or stable condition in this Scenario.

Central Arizona Regional Analysis Unit

Under Scenario 1, the Central Arizona RAU is expected to have a measurable loss of representation and redundancy within the RAU with a change from a low condition score of 3.33, to a very low condition of 2.61. The expectation of a reduction in representation is due to the declining abundance trends in all known LAUs, and the expectation that this trend will continue. As such, occupancy is expected to decline from low to very low condition. This reduction is also because of the reliance on agricultural drain outflows throughout the system, and there not being a conservation agreement to ensure that water is allocated to the WMAs, and to areas of habitat. This lack of a conservation agreement could result in the loss of habitat should water be wholly diverted for "toilet to tap" efforts. Further, it is expected that where agriculture remains (and is not converted) water allocations will remain the same, application of this water will become more conservative, resulting in less outflow.

Southern Nevada Regional Analysis Unit

Under Scenario 1, the Southern Nevada RAU is the only RAU that is expected to have no changes in the stable condition score of 3.94 and thus maintain its representation. This lack of change could be because no occupancy data was available for occupancy modeling. However, this RAU has a consistent source of water from the outflows of the wastewater treatment plant into the Las Vegas Wash, and the NWRs within this RAU also have water sources available to them. The trend in available habitat remains low both currently and under this future scenario. The density of Yuma Ridgway's rails in this RAU, while low, is either in stable condition based on end-of-year averages or increasing at the Ash Meadows NWR based on the AKN modeling. We expect this stable condition to continue.

Scenario 1 Summary

In Scenario 1 the number of LAUs with increasing or stable redundancy is the same (6 of 18; 33 percent). There is 1 LAU in low condition for redundancy (6 percent), and 5 LAUs with very low condition for redundancy (28 percent). Because we assume the trends in redundancy equate to trends in representation, we expect representation will increase in 6 LAUs (33 percent), remain stable in 6 LAUs (33 percent), and decrease in the remaining 6 LAUs (33 percent). When taking into consideration habitat suitability, the majority of LAUs have either high or stable resiliency. However, there are noticeably more LAUs that have stable resiliency (10 of 18; 56 percent), instead of high resiliency (4 of 18; 22 percent). When averaging the resiliency scores of the LAUs within each RAU, 5 of the 6 RAUs have stable resiliency, and 1 RAU has low resilience (Table 8). When averaging these RAU averages, the overall condition of the Yuma Ridgway's rail is in stable condition with an estimated average score of 3.73 providing resiliency through most of the species' range but leaving the species at risk should a catastrophic event occur.

Table 8. Overall conditions under Future Conditions Scenario 1. Acronyms: National Wildlife Refuge (NWR), Arizona Game and Fish Department (AZGFD), Multi-Species Conservation Plan (MSCP), Wildlife Management Area (WMA).

Scenario 1: ***Low Environmental Change, No Additional Conservation Measures***	**Trend Abundance (End-of-Year Data)**	**Trend Abundance (AKN Data Modeling)**	**Trend Abundance Average**	**Trend Occupancy**	**Trend of habitat available**	**Water Security**	**Overall Resiliency LAU**	**Overall Resiliency RAU**
Colorado River Delta RAU				Not modeled				3.5
Ciénega de Santa Clara	Unknown	2	2	4	4	3	3.00	
Rio Hardy Wetlands	Unknown	5	5		4	4	4.33	
Salton Sea RAU				4.5				4.25
Sonny Bono Salton Sea NWR	2	2	2		3	3	2.67	
Wister	4	Not modeled	4		4	5	4.33	
Dos Palmas Preserve	5	Not modeled	5		5	5	5	
Yuma RAU				4.5				4.31
AZGFD Southwest	2	4	3		2	3	2.67	
Lower Colorado River MSCP Conservation Areas	4	5	4.5		4	5	4.5	
Cibola NWR	5	5	5		5	4	4.67	
Imperial NWR	5	5	5		5	4	4.67	
Mid-Lower Colorado River RAU				3.5				3.75
Bill Williams River NWR	4	4	4		5	4	4.33	
Havasu NWR	2	5	3.5		4	4	3.83	
Lower Colorado River MSCP Conservation Areas	2	5	3.5		4	4	3.83	
Central Arizona RAU				2				2.61
Tres Rios and Rio Salado	2	2	2		5	5	3.83	
AZGFD Owned	2	2	2		4	4	3.33	
Lower Gila River Valley	2	Not modeled	2		2	3	2.33	
Citrus Valley	Unknown	Not modeled			Unknown	Unknown	Unknown	
Southern Nevada RAU				Not Modeled				3.94
Ash Meadows NWR	4	5	4.5		3	4	3.83	
Pahranagat NWR	4	Not modeled	4		3	4	3.67	
Las Vegas Wash, WMAs	4	Not modeled	4		5	4	4.33	

Scenario 2: Low Environmental Change, Additional Conservation Measures

Colorado River Delta Regional Analysis Unit

Because the U.S. Fish and Wildlife Service does not have the authority to implement conservation actions in Mexico, we modeled the Colorado River Delta RAU under Scenario 2 as being the same stable condition as current conditions. If conservation agreements are implemented to secure water allocations into the Rio Hardy from the wastewater treatment plant should "toilet to tap" efforts be realized, and from the Welton Mohawk Irrigation District into the Ciénega, should the Yuma Desalting Plant become operational, there may be an increase in representation and redundancy within this RAU. Because this RAU is the lowest RAU in the Lower Colorado System, we assume that this RAU will be most affected by drought and water diversions.

Salton Sea Regional Analysis Unit

Under Scenario 2, the Salton Sea RAU is expected to have an increase in representation and redundancy with a change from a high condition score of 4.61 to a higher score of 4.89. This increase is because of the assumed development of conservation agreements that will secure water allocations to habitat areas, and an increase in habitat management actions like prescribed fire to reset habitat when needed. As a result, we expect that the trend of available habitat will be in high condition within the Wister Unit LAU and the Salton Sea NWR. This will likely correspond with a high condition of abundance trends within the Salton Sea NWR and Wister Unit LAU, thereby increasing the representation and redundancy within this RAU. The Dos Palmas Preserve LAU is expected to stay in high condition under this scenario. Occupancy is expected to remain in high condition.

Yuma Regional Analysis Unit

Under Scenario 2, the Yuma RAU is expected to have an increase in representation and redundancy with a change from a high condition score of 4.63 to 4.90. This increase is because of the assumed development of conservation agreements that will secure water allocations to habitat areas, and an increase in habitat management actions like prescribed fire to reset habitat when needed. As a result, we expect that there will be an increasing trend of abundance within the locations managed and surveyed by the Arizona Game and Fish Department LAU, Lower Colorado River MSCP Conservation Areas LAU, Cibola NWR LAU and Imperial NWR LAU, thereby increasing the representation and redundancy within this RAU. Occupancy is expected to remain in high condition.

Mid-Lower Colorado River Regional Analysis Unit

Under Scenario 2, the Mid-Lower Colorado River RAU is expected to have a measurable increase in representation and redundancy with a change from a stable condition, score of 4.00 to a high condition score of 4.89. This increase is based on the assumption of increased infrastructure to move water from the Lower Colorado River into the habitat areas, thereby increasing the water security to high condition for all LAUs, and an increase in habitat management actions like prescribed fire to reset habitat when needed such that habitat availability is in high condition for all three LAUs. As a result, we expect that the average trend of abundance for the Bill Williams River NWR LAU will be stable, while Havasu NWR and the Lower Colorado River MSCP Conservation Area LAUs will be in high condition. Occupancy is expected to increase from stable to high condition.

Central Arizona Regional Analysis Unit

Under Scenario 2, the Central Arizona RAU is expected to have a measurable increase in representation and redundancy with a change from a low condition score of 3.33, to a stable condition score of 4.22. This increase is because of the assumed development of conservation agreements that will secure water allocations to habitat areas, even if "toilet to tap" efforts are realized within the Tres Rios and Rio Salado LAU, and adjacent Arizona Game and Fish Department WMAs, and areas along the lower Gila River Valley. This increase is also assumed to occur because of an increase in habitat management actions like prescribed fire to reset habitat when needed. As a result, we expect that there will be an increasing trend of abundance within the locations managed and surveyed under the Tres Rios and Rio Salado Safe Harbor Agreements, WMAs managed by the Arizona Game and Fish Department, and areas in the Lower Gila River Valley, thereby increasing the representation and redundancy within this RAU. Occupancy is expected to increase from low condition to stable condition.

Southern Nevada Regional Analysis Unit

Under Scenario 2, the Southern Nevada RAU is expected to have a measurable increase in representation and redundancy with a change from a stable condition score of 3.94, to a high condition, score of 4.78. This increase assumes the development of conservation agreements to secure water allocations to habitat areas, even if "toilet to tap" efforts are realized to ensure water is available for areas managed by the Nevada Department of Wildlife, County, and Southern Nevada Water Authority. The increase is also assumed to occur because of increased infrastructure to move water from the Lower Colorado River into the habitat areas, thereby increasing the water security, and an increase in habitat management actions like prescribed fire to reset habitat when needed. As a result, we expect that the trend of abundance from the end-of-year count data in all LAUs to be increasing.

Scenario 2 Summary

In Scenario 2 the majority of LAUs have an increasing (12 of 18; 67 percent) or stable redundancy (5 of 18; 28 percent) across the species' range. Only 1 LAU (6 percent) is in low condition for redundancy. Because we assume the trends in redundancy equates to trends in representation, we expect representation will increase in 12 LAUs (67 percent), remain stable in 5 LAUs (28 percent), and decrease in the remaining 1 LAU (6 percent). When taking into consideration habitat suitability all LAUs are in either high or stable resiliency. However, there are noticeably more LAUs that have high resiliency (13 of 18; 72 percent), instead of stable resiliency (5 of 18; 28 percent). When averaging the resiliency scores of the LAUs within each RAU, 4 of the 6 RAUs have high resilience (67 percent), and 2 of the 6 RAUs have stable resilience (33 percent) (Table 9). When averaging these RAU averages, the overall condition of the Yuma Ridgway's rail is in high condition with an estimated average score of 4.61 providing resiliency through most of the species' range and likely allowing the species to recover should a catastrophic event occur.

Table 9. Overall conditions under Future Conditions Scenario 2. Acronyms: National Wildlife Refuge (NWR), Arizona Game and Fish Department (AZGFD), Multi-Species Conservation Plan (MSCP), Wildlife Management Area (WMA).

Scenario 2: *Low Environmental Change, Additional Conservation Measures*	**Trend Abundance (End-of-year Data)**	**Trend Abundance (AKN Data Modeling)**	**Trend Abundance Average**	**Trend Occupancy**	**Trend of habitat available**	**Water Security**	**Overall Resiliency LAU**	**Overall Resiliency RAU**
Colorado River Delta RAU				Not modeled				4
Ciénega de Santa Clara	Unknown	3	3		5	3	3.67	
Rio Hardy Wetlands	Unknown	5	5		4	4	4.33	
Salton Sea RAU				5				4.89
Sonny Bono Salton Sea NWR	4	4	4		5	4	4.33	
Wister	5	Not modeled	5		5	5	5	
Dos Palmas Preserve	5	Not modeled	5		5	5	5	
Yuma RAU				5				4.9
AZGFD Southwest	4	5	4.5		4	4	4.17	
Lower Colorado River MSCP Conservation Areas	5	5	5		5	5	5	
Cibola NWR	5	5	5		5	5	5	
Imperial NWR	5	5	5		5	5	5	
Mid-Lower Colorado River RAU				5				4.89
Bill Williams River NWR	4	4	4		5	5	4.67	
Havasu NWR	4	5	4.5		5	5	4.83	
Lower Colorado River MSCP Conservation Areas	4	5	4.5		5	5	4.83	
Central Arizona RAU				4				4.22
Tres Rios and Rio Salado	4	4	4		5	5	4.67	
AZGFD Owned	4	4	4		5	5	4.67	
Lower Gila River Valley	4	Not modeled	4		4	4	4	
Citrus Valley	Unknown	Not modeled			Unknown	Unknown	Unknown	
Southern Nevada RAU				Not Modeled				4.78
Ash Meadows NWR	5	5	5		4	5	4.67	
Pahranagat NWR	5	Not modeled	5		4	5	4.67	
Las Vegas Wash, WMAs	5	Not modeled	5		5	5	5	

Scenario 3: High Environmental Change, No Additional Conservation Measures

Colorado River Delta Regional Analysis Unit

Under Scenario 3, the Colorado River Delta RAU is expected to have a measurable loss of representation and redundancy within the RAU with a change from a stable condition score of 4 to a very low condition score of 2. Because this RAU is the lowest RAU in the Lower Colorado System, we assume that this RAU will be most affected by drought and water diversions. For instance, under this scenario, we assume that the Yuma Desalting Plant will be operational, and therefore no water will be allocated to the Ciénega de Santa Clara. This will result in the trend of habitat becoming very low, and abundance also being very low with likely extirpation. Within this RAU, the Rio Hardy Wetlands will be in low condition because it is assumed that some water will still be in the system from any agricultural or wastewater outflows not captured by "toilet to tap" efforts. This water will allow habitat to persist in very low condition. The possible trend of abundance will be relatively stable but unable to support sufficient emigration into areas following a catastrophic event.

Salton Sea Regional Analysis Unit

Under Scenario 3, the Salton Sea RAU is expected to have a measurable loss of representation and redundancy within the RAU with a change from a high condition score of 4.61, to a low score of 2.97. Because of the increased effects of drought and excessive heat, we assume that this RAU will be heavily affected by drought and water diversions and the uncertainty around water allocation assurances in land agreements. For the Salton Sea NWR LAU, because the agricultural drain outflows are already insufficient to replenish areas around the Salton Sea, coupled with increased water conservation efforts for human use, the result will be insignificant water to the Salton Sea to support habitat. As a result, we expect that the Salton Sea NWR LAU will become unsuitable for breeding Yuma Ridgway's rails. For the Wister and Dos Palmas Preserve LAUs, water security becomes low condition due to the uncertainty around water allocation assurances in existing land agreements. As a result, habitat is likely to become very low within the Wister Unit and remain stable at the Dos Palmas Preserve. For both of these LAUs, it is expected that the trends in abundance from end-of-year data will remain in stable condition. Occupancy is expected to decline from high condition to stable condition.

Yuma Regional Analysis Unit

Under Scenario 3, the Yuma RAU is expected to have a measurable loss of representation and redundancy within the RAU with a change from a high condition score of 4.63 to a low condition score of 2.96. Because of increased effects of drought and excessive heat, we assume that this RAU will be heavily affected by drought, water diversions, the uncertainty around water allocation assurances in land agreements, and lack of infrastructure to move the decreased allocated water to habitat areas. For the areas like Quigley-Achee WMA and other locations reliant on irrigation outflows and upstream flows, we anticipate insufficient water to support habitat, and therefore no available habitat for the Yuma Ridgway's rail. For the Cibola and Imperial NWR LAUs, which have water allocations from the lower Colorado River, we nevertheless anticipate a drop in water security to "very low" condition because of the lack of suitable infrastructure improvements to move the reduced water allocations into these management areas. However, because of the expectation that habitat management will continue, we anticipate that habitat will remain in low condition, and the tends in abundance from end-of-year data will remain in stable condition. For the Lower Colorado River MSCP Conservation Areas, water security is anticipated to be in low condition, and because of the uncertainty of any continuation of the "habitat maintenance fund" under the Lower Colorado River Habitat Conservation Plan we project that the trend in available habitat will be very low. This is expected to result in either a low condition based on the trend from end-of-year data, or stable condition based on the trend data from AKN. Occupancy is expected to decline from high condition to stable condition.

Mid-Lower Colorado River Regional Analysis Unit

Under Scenario 3, the Mid-Lower Colorado River RAU is expected to have a measurable loss of representation and redundancy within the RAU with a change from a stable condition score of 4.00 to a very-low condition score of 2.42. Because of the increased effects of drought and excessive heat, we assume that this RAU will be heavily affected by drought, water diversions, and lack of infrastructure to move the decreased allocated water to habitat areas. For the Bill Williams River and Havasu NWR LAUs, which have water allocations from the lower Colorado River, we nevertheless anticipate a drop in water security to "very low" condition because of the lack of suitable infrastructure improvements to move the reduced water allocations into these management areas. However, because of the expectation that habitat management will continue, we anticipate that habitat will remain in low condition for Bill Williams River NWR, while dropping to very low for Havasu NWR. For the Lower Colorado River MSCP Conservation Areas, water security is anticipated to be in very low condition, and because of the uncertainty of any continuation of the "habitat maintenance fund" under the Lower Colorado River Habitat Conservation Plan we project that the trend in available habitat will also be very low. As a result, we expect that the average trends of abundance for the Bill Williams River NWR LAU and the Lower Colorado River MSCP Conservation Areas will be low, while Havasu NWR will be in very low condition. Occupancy is expected to go from stable to low condition.

Central Arizona Regional Analysis Unit

Under Scenario 3, the Central Arizona RAU is expected to have a measurable loss of representation and redundancy within the RAU with a change from a low condition score of 3.33, to a very low condition of 1.75. The expectation of a reduction in representation is because of the increased effects of drought and excessive heat, and assumption that this RAU will be heavily affected by drought, water diversions, and the uncertainty around water allocation assurances in the Safe Harbor Agreements should "toilet to tap" efforts be realized. The Tres Rios and Rio Salado LAU, which are managed under Safe Harbor Agreements, are likely to have a low condition of water security because we assume some water will still be in the system from any agricultural or wastewater outflows not captured by "toilet to tap" efforts. However, because water is still expected within the Tres Rios wastewater treatment plant, we project that habitat will be in stable condition. Because of this, the trend of abundance is expected to be in low, or declining condition for this LAU. For the Arizona Game and Fish Department WMAs, we project very low water security because of the decrease in water available to the system. This results in a very low, nearly extirpated, condition for the expected trends of abundance. For the Lower Gila River Valley LAU, which is entirely dependent on agricultural drain outflows, we expect that water will no longer be available in the system. Therefore, we anticipate no habitat, and extirpated condition for trends of abundance. We expect occupancy to change from low to very low condition.

Southern Nevada Regional Analysis Unit

Under Scenario 3, the Southern Nevada RAU is expected to have a measurable loss of representation and redundancy with a change from a stable condition score of 3.94, to a very low condition of 1.61. We expect this change because of the increased effects of drought, excessive heat, and assumption that this RAU will be heavily affected by water diversions, and the uncertainty around water allocation assurances should “toilet to tap” efforts be realized. For both the Ash Meadows and Pahranagat NWR LAUs, despite having access to water, we assume that water security will be in very low condition because of the effects of drought and decreased availability of surface water. This will result in a likely loss of habitat, and therefore extirpated condition for trends of abundance. For the areas managed by the Nevada Department of Wildlife, County, and Southern Nevada Water Authority, we anticipate that water security will also be very low because of the expectation of “toilet to tap” efforts. However, because some water is still expected in the overall system, we project that habitat will be in very low condition. Assuming that there is habitat available, we project that the trend of abundance will be in low to almost very low condition.

Scenario 3 Summary

In Scenario 3 the majority of LAUs have a likely extirpated (5 of 18; 28 percent) or low (7 of 18; 39 percent) redundancy across the species’ range. Only 1 LAU (6 percent) is considered in high condition for redundancy, while the remaining 5 LAUs are in either stable (3 of 18; 17 percent) or very low (2 of 18; 11 percent) redundancy. Because we assume the trends in redundancy equates to trends in representation, we expect representation to significantly decrease across all LAUs. When taking into consideration habitat suitability, a minority of LAUs have stable resiliency (2 of 18; 11 percent). The remaining LAUs are in either low resiliency (6 of 18; 33 percent), very low resiliency (5 of 18; 28 percent), or likely extirpated with no resiliency (5 of 18; 28 percent). When averaging the resiliency scores of the LAUs within each RAU, 2 of the 6 RAUs (33 percent) have low resilience, and 4 of the 6 RAUs (67 percent) have very low resilience (Table 10). When averaging these RAU averages, the overall condition of the Yuma Ridgway’s rail is in very low condition with an estimated average score of 2.28 providing little to no redundancy through most of the species’ range and leaving the species at risk of extinction should a catastrophic event occur.

Table 10. Overall conditions under Future Conditions Scenario 3. Acronyms: National Wildlife Refuge (NWR), Arizona Game and Fish Department (AZGFD), Multi-Species Conservation Plan (MSCP), Wildlife Management Area (WMA).

Scenario 3: ***High Environmental Change, No Additional Conservation Measures***	**Trend Abundance (End-of-year Data)**	**Trend Abundance (AKN Data Modeling)**	**Trend Abundance Average**	**Trend Occupancy**	**Trend of habitat available**	**Water Security**	**Overall Resiliency LAU**	**Overall Resiliency RAU**
Colorado River Delta RAU				Not Modeled				2.00
Ciénega de Santa Clara	Unknown	1.5	1.5		2	1	1.50	
Rio Hardy Wetlands	Unknown	3.5	3.5		2	2	2.50	
Salton Sea RAU				3.5				2.97
Sonny Bono Salton Sea NWR	1	1	1		1	1	1.00	
Wister	2.5	Not modeled	2.5		2	3	2.50	
Dos Palmas Preserve	4.5	Not modeled	4.5		4	3	3.83	
Yuma RAU				3.5				2.96
AZGFD Southwest	1	1	1		1	1	1.00	
Lower Colorado River MSCP Conservation Areas	2.5	3.5	3		2	3	2.67	
Cibola NWR	4	4	4		3	2	3	
Imperial NWR	4	4	4		3	2	3	
Mid-Lower Colorado River RAU				2.5				2.42
Bill Williams River NWR	3	3	3		3	2	2.67	
Havasu NWR	1.5	3.5	2.5		2	2	2.17	
Lower Colorado River MSCP Conservation Areas	1.5	3.5	2.5		2	2	2.17	
Central Arizona RAU				1.5				1.75
Tres Rios and Rio Salado	2.5	2.5	2.5		4	3	3.17	
AZGFD Owned	1.5	1.5	1.5		2	2	1.83	
Lower Gila River Valley	1	Not modeled	1		1	1	1.00	
Citrus Valley	Unknown	Unknown			Unknown	Unknown	Unknown	
Southern Nevada RAU				Not Modeled				1.61
Ash Meadows NWR	1	1	1		1	2	1.33	
Pahranagat NWR	1	Not modeled	1		1	2	1.33	
Las Vegas Wash, WMAs	2.5	Not modeled	2.5		2	2	2.17	

Scenario 4: High Environmental Change, Additional Conservation Measures

Colorado River Delta Regional Analysis Unit

Under Scenario 4, the Colorado Rive Delta RAU is expected to have a measurable loss of representation and redundancy with a change from a stable condition score of 4.0 to a low score of 3.17. Because this RAU is the lowest RAU in the Lower Colorado System, we assume that this RAU will be most affected by drought and water diversions, including from operations of the Yuma Desalting Plant and/or "toilet to tap" efforts. However, under this scenario we expect that a binational conservation agreement will be reached to allocate water from the Welton Mohawk Irrigation District into the Ciénega if, or when, the Yuma Desalting Plant is in full operation. It would be a hope, but not an expectation, that similar conservation agreements would be developed to ensure some water is provided to the Rio Hardy should "toilet to tap" efforts occur. Under this scenario we anticipate that the Ciénega de Santa Clara will have a low, or declining, condition for abundance trend because of the very low water security. However, because of the expected conservation agreement, the trend of available habitat is expected to be in stable condition. For the Rio Hardy Wetlands, we expect that water security will be low, with a low or declining trend for available habitat. However, we expect that the trend of abundance will be in high or improving condition.

Salton Sea Regional Analysis Unit

Under Scenario 4, the Salton Sea RAU is expected to have a measurable loss of representation and redundancy within the RAU with a change from a high condition score of 4.61, to a stable score of 4.39. Because of the increased effects of drought and excessive heat, we assume that this RAU will be heavily affected by drought and water diversions and the uncertainty around water allocation assurances in land agreements. Occupancy for this RAU is expected to remain in high condition. For the Salton Sea NWR LAU, because the agricultural drain outflows are already insufficient to replenish areas around the Salton Sea, coupled with increased water conservation efforts for human use, the result will be very low water security. However, under this scenario we anticipate that the water that is available through conservation agreements will be used for priority areas such that the trend of available habitat will be in low condition instead of lost entirely. For the Wister and Dos Palmas Preserve LAUs, we expect that water security will be in stable condition because of strengthened conservation agreements. Because of this, the Wister LAU habitat will be in stable condition and there is an expected high condition for the trend of abundance. For the Dos Palmas Preserve, we expect that habitat will be in high condition, with a corresponding high condition for the trend of abundance.

Yuma Regional Analysis Unit

Under Scenario 4, the Yuma RAU is expected to have a measurable loss of representation and redundancy within the RAU with a change from a high condition score of 4.63 to a stable condition score of 3.99. Because of the increased effects of drought and excessive heat, we assume that this RAU will be heavily affected by drought, water diversions, the uncertainty around water allocation assurances in existing land agreements, and lack of infrastructure to move the decreased allocated water to habitat areas. Nevertheless, occupancy for this RAU is expected to remain in high condition. For the Arizona Game and Fish Department WMAs, like

Quigley-Achee, and other locations reliant on irrigation outflows and upstream flows, we anticipate that even with improved water delivery infrastructure, water security will be very low, resulting in very low habitat available and either very low or expected extirpation of rails. The Bureau of Reclamation Conservation Area LAU, water security is anticipated to be in low condition because of existing agreements on water allocations continuing, and because of the expectation that there will be a continuation of the "habitat maintenance fund" under the Lower Colorado River Habitat Conservation Plan we project that the trend in available habitat will be in stable condition. For the trend of abundance this is expected to result in high condition. For the Cibola and Imperial NWR LAUs, which have water allocations from the lower Colorado River, we nevertheless anticipate a drop in water security to "low" condition. Because we anticipate water delivery infrastructure improvements to move the reduced water allocations to these management areas, we anticipate that habitat will be in stable condition. Further, because we expect that habitat management will continue and that certain areas of habitat will be prioritized to maximize suitability, it's projected that the trend of abundance will be in high condition.

Mid-Lower Colorado River Regional Analysis Unit

Under Scenario 4, the Mid-Lower Colorado River RAU is expected to have a decrease of representation and redundancy within the RAU with a change from a stable condition score of 4.00 to a low condition score of 3.44. Because of the increased effects of drought and excessive heat, we assume that this RAU will be heavily affected by drought and water diversions. For the Bill Williams River, Havasu NWR LAUs, which have water allocations from the lower Colorado River, we nevertheless anticipate a drop in water security to low condition. For Havasu NWR, despite water delivery infrastructure improvements to move this reduced water to management areas, we expect habitat to be in low condition. For the Bill Williams River NWR, which is also anticipated to have improved water delivery infrastructure habitat is anticipated to be in stable condition. Because we expect that habitat management will continue and that certain areas of habitat will be prioritized to maximize suitability, it's projected that the average trends of abundance will be in high condition for the Bill Williams River NWR, and stable condition for Havasu NWR. For the Lower Colorado River MSCP Conservation Areas, water security is anticipated to be in low condition because of existing agreements on water allocations continuing, and because of the expectation that there will be a continuation of the "habitat maintenance fund" under the Lower Colorado River Habitat Conservation Plan we project that the trend in available habitat will be in stable condition. Based on the average trend of abundance, the Lower Colorado River MSCP Conservation Areas are expected to be in stable condition. Across the RAU, we expect that occupancy will remain in stable condition.

Central Arizona Regional Analysis Unit

Under Scenario 4, the Central Arizona RAU is expected to have a slight loss of representation and redundancy within the RAU with a change from a low condition score of 3.33, to a low condition score of 2.72. The expectation of a reduction in representation is because of the increased effects of drought and excessive heat, and assumption that this RAU will be heavily affected by drought, and water diversions. The Tres Rios and Rio Salado LAU, which are managed under Safe Harbor Agreements, are expected to have a stable condition of water security because we assume that there will be conservation agreements to ensure adequate water is released into the system should "toilet to tap" efforts be realized to maintain habitat. Because of this, we expect the trend in habitat available to be in high condition, and the trends of abundance to be stable. For the Arizona Game and Fish Department WMAs, we project low water security because of the decrease in water available to the system. This results in a low condition trend of habitat available and corresponding low condition for trends in abundance. For the Lower Gila River Valley LAU, which is entirely dependent on agricultural drain outflows, we expect that very little water will be available in the system. Therefore, we anticipate extirpated condition for trends of abundance. Occupancy is expected to remain in low condition.

Southern Nevada Regional Analysis Unit

Under Scenario 4, the Southern Nevada RAU is expected to have a measurable loss of representation and redundancy with a change from a stable condition score of 3.94, to a low condition score of 3. We expect this change because of the increased effects of drought, excessive heat, and assumption that this RAU will be heavily affected by water diversions. However, we do assume that conservation measures, especially for areas reliant on outflows from the wastewater treatment plant, will be in place to ensure that adequate water is released into the system should "toilet to tap" efforts be realized to maintain habitat. This would have the expected result of having a low condition for water security for the areas managed by the Nevada Department of Wildlife, County, and Southern Nevada Water Authority. Habitat would be expected to be in stable condition, and the trend in abundance is anticipated to be in high condition. For both the Ash Meadows and Pahranagat NWR LAUs, we assume that water security will remain in low condition because of drought and decreased availability of surface water. This is despite having access to water and the assumption that infrastructure improvements will deliver available water to priority habitat areas. It is likely that the trend of available habitat will be in very low condition for both NWRs, and low trends of abundance based on the end-of-year data. Ash Meadows NWR could have a stable condition for abundance based on the AKN data.

Scenario 4 Summary

In Scenario 4 the majority of LAUs have a high condition (8 of 18; 44 percent) or stable redundancy (3 of 18; 17 percent) across the species' range. Only 1 LAU (6 percent) is considered in very low condition for redundancy, while the remaining 6 LAUs are in either low redundancy (4 of 18; 22 percent) or likely extirpated (2 of 18; 11 percent). Because we assume the trends in redundancy equates to trends in representation, we expect representation will increase in 8 LAUs (44 percent), remain stable in 3 LAUs (17 percent), and decrease in the remaining 7 LAUs (39 percent). When taking into consideration habitat suitability, the majority of LAUs have stable resiliency (10 of 18; 56 percent). The remaining 8 LAUs have either low resiliency (6 of 18; 33 percent) or very low resiliency (2 of 18; 11 percent). When averaging the resiliency scores of the LAUs within each RAU, 2 of the 6 RAUs have stable resiliency (33 percent), and 4 of the 6 RAUs have low resiliency (67 percent) (Table 11). When averaging these RAU averages, the overall condition of the Yuma Ridgway's rail is in low condition with an estimated average score of 3.45 providing limited redundancy through most of the species' range and leaving the species at risk of extinction should a catastrophic event occur.

Table 11. Overall conditions under Future Conditions Scenario 4. Acronyms: National Wildlife Refuge (NWR), Arizona Game and Fish Department (AZGFD), Multi-Species Conservation Plan (MSCP), Wildlife Management Area (WMA).

Scenario 4: ***High Environmental Change, Additional Conservation Measures***	**Trend Abundance (End-of-year Data)**	**Trend Abundance (AKN Data Modeling)**	**Trend Abundance Average**	**Trend Occupancy**	**Trend of habitat available**	**Water Security**	**Overall Resiliency LAU**	**Overall Resiliency RAU**
Colorado River Delta RAU				Not Modeled				3.17
Ciénega de Santa Clara	Unknown	3	3		3.5	2	2.83	
Rio Hardy Wetlands	Unknown	4.5	4.5		3	3	3.50	
Salton Sea RAU				5				4.39
Sonny Bono Salton Sea NWR	3	3	3		2.5	2	2.50	
Wister	4.5	Not modeled	4.5		4	4	4.17	
Dos Palmas Preserve	5	Not modeled	5		5	4	4.67	
Yuma RAU				4.5				3.99
AZGFD Southwest	1	2	1.5		1.5	2	1.67	
Lower Colorado River MSCP Conservation Areas	4.5	5	4.75		4	4	4.25	
Cibola NWR	5	5	5		4	3	4	
Imperial NWR	5	5	5		4	3	4	
Mid-Lower Colorado River RAU				3.5				3.44
Bill Williams River NWR	4.5	4.5	4.5		4	3	3.83	
Havasu NWR	2.5	4.5	3.5		3	3	3.17	
Lower Colorado River MSCP Conservation Areas	2.5	4.5	3.5		3	3	3.17	
Central Arizona RAU				2.5				2.72
Tres Rios and Rio Salado	4	4	4		5	4	4.33	
AZGFD Owned	3	3	3		3	3	3	
Lower Gila River Valley	1	Not modeled	1		1.5	2	1.50	
Citrus Valley	Unknown	Unknown			Unknown	Unknown	Unknown	
Southern Nevada RAU				Not Modeled				3
Ash Meadows NWR	2.5	3.5	3		2	3	2.67	
Pahranagat NWR	2.5	Not modeled	2.5		2	3	2.50	
Las Vegas Wash, WMAs	4.5	Not modeled	4.5		4	3	3.83	

Future Conditions Summary

We assessed the potential future redundancy, representation, and resilience of Yuma Ridgway's rail populations through four scenarios. For each scenario, we varied the levels of stressors and conservation efforts going forward based on the current stressors affecting each population, assumptions of future stressors and effects of those stressors, and management efforts going forward. Our assessments of these future scenarios, described in detail above, are summarized and compared to the current condition of each population in Table 12 below.

Future Redundancy, Representation, and Resiliency Summary

Redundancy reduces the risk that a large portion of the species' range will be negatively affected by a catastrophic natural or anthropogenic event. Species that occur as multiple populations distributed across larger ranges are likely less susceptible to extinction than are species that occur as a single population within a smaller range. Because of the large range of the Yuma Ridgway's rail, the species is less susceptible to being affected by natural or anthropogenic events. Representation in the form of genetic or ecological diversity is important in maintaining the ability of the Yuma Ridgway's rail to adapt to future environmental change. More information on the genetic structure, genetic flow, and if certain LAUs have unique genotypes is needed to better inform these representation projections. Because of this uncertainty, we expect that the trends in redundancy equate to trends in likely representation. In all scenarios there remains an unknown of how Citrus Valley will, or will not, affect the future redundancy and representation of the species.

Under future Scenario 1, in which current stressor trends continue, water allocations stay the same, and there are no additional conservation measures, there is an expected slight loss of redundancy and representation across the species' range. In terms of resiliency, this loss is projected to occur with one LAU going into very low condition where extirpation is likely. The other LAUs are expected to be in high (4), stable (10), or low (3) condition.

Under future Scenario 2, in which current stressor trends continue, but there are additional and assumed successful conservation measures, redundancy and representation are expected to increase in all LAUs. In terms of resiliency all LAUs are expected to be in either high (13), or stable (5) condition.

Under future Scenario 3, in which current stressors, primarily environmental change effects increase, water allocations decrease, and there are no additional conservation measures, redundancy and representation are expected to measurably decrease. In terms of resiliency, this loss is such that only 2 LAUs are expected to be in stable condition. The remainder are either in low (6), very low (5), or extirpated (5) condition.

Under future Scenario 4, in which current stressors, primarily environmental change effects increase, water allocations decrease, but where there are additional conservation measures, there is an expected slight loss of redundancy and representation across the species' range compared to current conditions. In terms of resiliency this loss is projected with 2 LAUs going into very low condition where extirpation is likely. The other LAUs are expected to be in stable (11), or low (6) condition.

Table 12. Comparison of current resiliency conditions and the potential resiliency conditions for each population and population-site under each Scenario.

Resiliency Summary	**Current Condition**	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**
Colorado River Delta RAU					
Ciénega de Santa Clara	Stable	Stable	Stable	Very Low	Low
Rio Hardy Wetlands	Stable	Stable	Stable	Low	Stable
Salton Sea RAU					
Sonny Bono Salton Sea NWR	Low	Low	Stable	Extirpated	Low
Wister	Stable	Stable	High	Low	Stable
Dos Palmas Preserve	High	High	High	Low	Stable
Yuma RAU					
AZGFD Southwest	Low	Low	Stable	Extirpated	Very Low
Lower Colorado River MSCP Conservation Areas	High	High	High	Low	Stable
Cibola NWR	High	High	High	Stable	Stable
Imperial NWR	High	High	High	Stable	Stable
Mid-Lower Colorado River RAU					
Bill Williams River NWR	Stable	Stable	High	Low	Stable
Havasu NWR	Stable	Stable	High	Very Low	Low
Lower Colorado River MSCP Conservation Areas	Stable	Stable	High	Very Low	Low
Central Arizona RAU					
Tres Rios and Rio Salado	Stable	Stable	High	Low	Stable
AZGFD Owned	Stable	Low	High	Very Low	Low
Lower Gila River Valley	Low	Very Low	Stable	Extirpated	Very Low
Citrus Valley	Unknown	Unknown	Unknown	Unknown	Unknown
Southern Nevada RAU					
Ash Meadows NWR	Stable	Stable	High	Extirpated	Stable
Pahranagat NWR	Stable	Stable	High	Extirpated	Low
Las Vegas Wash, WMAs	Stable	Stable	High	Very Low	Stable
Range-wide	**Stable**	**Stable**	**High**	**Very Low**	**Low**

Glossary

Allelochemicals: Chemicals produced by plants that influence the growth, survival, and reproduction of other organisms.

Allelopathy: The chemical inhibition of one plant by another due to the release of toxic substances.

Anteriorly: Towards the front of the body.

Anthropogenic: Caused or influenced by humans.

Autecological: Relating to the study of individual species in relation to the environment.

Bioactive: Having an effect on living organisms, tissues, or cells.

Brackish: Water that has more salinity than freshwater but less than seawater, often found where rivers meet the sea.

Churned systems: Ecosystems experiencing both withdrawals and direct inputs of water, leading to variable water tables.

Congener: A species within the same genus.

Decurved: Curved gently downward, typically referring to a bill or other anatomical structure whose tip bends below the straight line of its base.

Ectoparasites: Parasites that live on the external surface of a host.

Endocrine disruptor: A chemical substance that interferes with the endocrine (hormone) system, potentially causing developmental, reproductive, neurological, or immune effects.

Extant: Still in existence; not extinct. Refers to species or populations that are currently living.

Extirpated: A species no longer exists in a specific geographic area but exists elsewhere. Locally extinct.

Fecundity: The quantitative ability to produce offspring.

Genotypes: An organism's complete set of genes or the specific genetic information (alleles) for a particular trait, inherited from parents, determining potential characteristics.

Hydrological drought: A phenomenon over a period of time where there is below-average water content in streams, reservoirs, and groundwater.

Interstitial spacing: The space between plant stems or other structures.

Invasive species: Non-native organisms that spread rapidly in a new environment, often outcompeting native species and disrupting local ecosystems.

Local Analysis Unit (LAU): A smaller, more specific area within a Regional Analysis Unit used for detailed analysis and management of species populations and habitats.

Marsh: A tract of soft wet land usually characterized by monocotyledons (such as grasses or cattails).

Molt: The process of shedding and regrowing feathers, hair, or skin in animals.

Monoculture: When a habitat is dominated by a single species of plant or organism. Often leads to reduced biodiversity.

Morphological: Relating to the form and structure of organisms.

Neossoptiles: The first down feathers of a newly hatched bird.

Occiput: The back part of the skull that meets the top of the neck.

Panmictic: A biological population where all individuals have an equal potential to mate with any other member of the opposite sex, resulting in tentirely random mating.

Permeability: The ability of a material (such as soil or rock) to allow fluids to pass through it.

Pied: Having two or more contrasting colors, typically arranged in patches or irregular patterns.

Population: A group of individuals of the same species that live in the same area and can interbreed.

Recharge (hydrological): The process by which water is added to an aquifer, typically from rainfall or surface water infiltrating the ground.

Redundancy: The ability of a species to withstand catastrophic events through population distribution and abundance of populations.

Regional Analysis Unit (RAU): A defined geographic area used for analyzing and managing species populations and their habitats.

Remiges: The flight feathers of a bird's wing.

Representation: The genetic and ecological diversity within and among populations of a species.

Resiliency: The ability of a species to withstand environmental changes and disturbances.

Rectrices: The larger feathers in a bird's tail, used for steering in flight.

Sex ratio: The proportion of males to females in a population.

Species Status Assessment (SSA): A comprehensive analysis used to evaluate the status of a species.

Stochastic disturbance: Randomly occurring events that disrupt ecosystems.

Subspecies: A taxonomic category that ranks below species, representing populations of a species that are distinct in some way but can still interbreed with other populations subspecies of the same species.

Successional stage: A phase in the natural progression of plant and animal communities in an ecosystem over time.

Superoxide: A reactive oxygen species ($O2^-$) that can cause damage to cells and tissues.

Supraseasonal drought: A prolonged and unpredictable drought that extends beyond a single season, often lasting for multiple seasons or years, causing significant and lasting impacts on ecosystems and water availability.

Surface gleaning: A feeding behavior where an animal picks food items from the surface of the water, ground, or vegetation.

Taxonomic history: The historical development and changes in the classification of a species or group of organisms.

Taxonomy: The science of classifying organisms into groups based on similarities and differences of genetic relationships.

Telemetry: The remote monitoring and recording of physiological, behavioral, or environmental data from living organisms. It involves attaching or implanting transmitters that send real-time data, such as heart rate, temperature, movement, or location, to a distant receiver.

Telemetry study: Research involving the use of telemetry to track animal movements and possibly behavior.

Transpiration: The process which results in plants releasing water vapor into the air through their leaves.

Trophic levels: The hierarchical levels in an ecosystem, comprising producers, consumers, and decomposers.

Viability: The ability of a species or population to survive, reproduce, and maintain its numbers over time.

Wetland: An area where water covers the soil or is present near the surface for varying periods of time.

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