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CHAPTER 2: AVIAN SPECIES

Introduction

Marsh communities along the lower Colorado River are generally classified into seven types, which are described by Anderson and Ohmart (1976). Each marsh type is based primarily on the percent cover of cattail (*Typha* spp.), bulrush (*Scirpus* spp.), common reed (*Phragmites australis*), and open water. Historically, marshes along the lower Colorado River were commonly found around oxbow lakes and backwater areas. Today, however, marshes are more frequently found in association with dams, reservoirs, and backwater areas. Marshes of the lower Colorado River frequently consist of cattail, bulrush, giant reed (*Arundo donax*), common reed, saltcedar (*Tamarix* spp.), and willow (*Salix* spp.).

Frequently, marsh communities will interface with woody riparian areas consisting of cottonwood (*Populus* spp.), willow, saltcedar, and mesquite (*Prosopis* spp.). Riparian community structure, as defined by Anderson and Ohmart (1976), is divided into six types (types I through VI) that are based on the density of foliage present in each of three vertical layers. A structural type of I has well developed foliage in all three layers, with the upper canopy dominating.

Marshes and riparian communities are frequently found in association with backwater areas along the lower Colorado River. Backwaters, to some degree, represent the open water elements of the pre-dam Colorado River channel and associated floodplain. Under existing conditions, backwaters include oxbow lakes, abandoned river channel pools, floodplain ponds and lakes, secondary river channel pools, and hydrologically isolated coves on reservoirs. Backwaters may be permanent features or temporary in nature, drying completely during some seasons or years. Some backwaters may be connected or partially connected to the river, while others may be completely disconnected. Generally, backwaters can vary in size, ranging from less than one acre to more than 100 acres. Typically, the interface between backwater areas and marsh communities consists of cattails, bulrush, and common reed. Cattails usually occur in shallow water up to 3 feet deep and are found on stable, sloping substrates. Bulrush is frequently found in association with cattails but in deeper water. Bulrushes can be found in water as deep as 5 feet and can extend as high as 10 feet above the water surface. Thick stands of bulrush usually occur on unmodified banks. Common reed can also grow in dense stands along the backwater/marsh interface.

As required by the MSCP, Reclamation must restore more than 8,000 acres of marsh, riparian, and backwater habitat for 26 covered species. As such, clear and thorough knowledge of habitat requirements must be gained to successfully implement any restoration plan. Of the 26 MSCP covered species, habitat requirements for the California black rail, least bittern, Yuma clapper rail, southwestern willow flycatcher, western yellow-billed cuckoo, and Colorado River cotton rat are discussed in the following species profiles.

Although limited in distribution, the California black rail (*Laterallus jamaicensis coturniculus*) was historically not uncommon (Conway et al. 2002). Most populations, however, are now threatened with extinction, and local populations are thought to be declining because of loss or degradation of suitable habitat (Evens et al. 1991, Eddleman et al. 1994). Currently, the lower Colorado River population of California black rail is thought to be the only stable inland population in the western

1985, Conway et al. 1993); marsh vegetation that averages greater than 2 m heigh (Anderson and Ohmart 1985, Eddleman 1989); the presence of dry ground or isolated islands between water and banks to allow for foraging and walking (Gould 1975, Anderson and Ohmart 1985, Conway et al. 1993); the presence of flowing water through many small channels that measure from 0.5-3 m in width or small bodies of open water measuring 0.02-0.2 ha in size (Tomlinson and Todd 1973, Gould 1975); extensive areas of water where overall depth does not exceed 0.3 m with little or no fluctuation in daily water levels (Tomlinson and Todd 1973, Gould 1975).

Ideally, good Yuma clapper rail habitat should consist of a mosaic of emergent vegetation in stands of differing ages interspersed with shallow pools of open water (Eddleman and Conway 1998). Habitat quality is greatly improved when dry ground is present and appears unaffected when dry ground is present as very narrow strips (Anderson and Ohmart 1985). High or dry ground in relation to rail habitat use typically refers to sites only slightly higher than the water level or prevailing substrate depth (Eddleman 1989).

Generally, Yuma clapper rail along the lower Colorado River encounter frequent fluctuations in water levels. Yuma clapper rail are capable of tolerating frequent water-level fluctuations if marsh vegetation remains undisturbed, water is consistently present, changes in substrate depth occur gradually, and slightly higher sites or upland edge are nearby. The primary issues of concern may likely be related to the timing and speed at which water levels rise (Eddleman 1989). If water rises quickly during the breeding season, nests may be lost, and young, newly hatched Yuma clapper rail with downy plumage may drown (Smith 1975). During other seasons, rapid increases in water level may force Yuma clapper rail into upland areas that make them more susceptible to predation. If implemented early in the breeding season, a rapid drop in water level will expose additional habitat and may provide additional nesting or foraging sites (Eddleman 1989). Bennett and Ohmart (1978) suggest, however, that prolonged periods of low water may be detrimental to wetlands and could result in nest abandonment by Yuma clapper rail.

Although marsh size has been cited as a critical component of Yuma clapper rail habitat (Smith 1975, Gould 1975), Anderson and Ohmart (1985) found that marsh size is independent of Yuma clapper rail density per unit area. Yuma clapper rail are known to exhibit changes in seasonal use of available habitat (Anderson and Ohmart 1985, Eddleman 1989, Conway et al. 1993). Eddleman (1989) found that male Yuma clapper rail differed from females in the size of home ranges used in all seasons. Females had smaller home ranges than males during late breeding, incubation, and early winter, and larger home ranges than males during post breeding. Although movement by Yuma clapper rail varied by season, movement occurred most commonly from late June through October after nesting. At Mittry Lake observed Yuma clapper rail shifted their home ranges or moved more than 500 m from June to October. Eddleman (1989) also found that Yuma clapper rail have a tendency to shift habitats used in response to increases in water level, and have been found along mesquite-marsh edges during periods of high water across all seasons. It is possible that seasonal changes may also serve to reduce predation and improve foraging efficiency (Smith 1975, Todd 1986, Eddleman 1989).

Smith (1975) found that both Yuma clapper rail and crayfish were most abundant in moderately dense cattail and bulrush communities at Topock Marsh. However, Bennett and Ohmart (1978) found that crayfish and Yuma clapper rail were most commonly found in the densest stands of cattails at the Salton Sea and that bulrush communities were not significantly used. Differences in Yuma clapper rail habitat use between the Salton Sea and Topock Marsh may be a reflection of differences in habitats where crayfish are most abundant (Anderson and Ohmart 1985). Along the lower Colorado River, an annual peak in crayfish populations has been shown to correspond with Yuma clapper rail hatching and brood-rearing stages, and crayfish abundance is lowest during the winter, which corresponds with seasonal shifts in use of available habitats by Yuma clapper rail (Bennett and Ohmart 1978, Eddleman 1989, Conway et al. 1993).

Seasonal shifts in use of available habitat include the following characteristics (Eddleman 1989, Conway et al. 1993): in early winter (November-December) Yuma clapper rail have shown a preference for lower emergent stem density and ground coverage, shorter distances to water, dense overhead coverage by vegetation, greater distances to adjacent uplands and vegetative edges, increased water depth and water coverage, and taller emergent plants. Late winter (January-February) preferences included low overhead coverage by vegetation, shorter distances to adjacent uplands, and low stem densities. Yuma clapper rail exhibit narrower habitat breadth during all winter months than at any other time of year (Anderson and Ohmart 1985, Conway et al. 1993). High rail densities during the winter are more strongly correlated with dense cattail-bulrush communities than during other seasons (Anderson and Ohmart 1985). Habitat discrimination by Yuma clapper rail appears greatest during the early winter months when features of occupied habitat showed more differences as compared to available habitat than other seasons (Conway et al. 1993).

During the early breeding season (March-April) Yuma clapper rail exhibited a preference for habitat that was close to open water, and characteristics of preferred habitat during the late breeding season (May-July) included short distances to vegetative edges, greater distances to adjacent uplands, shorter distances to vegetative edge, and short distances to dry ground. During the post-breeding season (August-October), Yuma clapper rail were found to prefer areas with low overhead coverage by vegetation, short distances to vegetative edges, greater distances to adjacent uplands, decreased water depth, and decreased basal coverage by emergent vegetation (Conway et al. 1993).

During the spring Yuma clapper rail are usually associated with dense stands of cattails and bulrush; however, unexpectedly high Yuma clapper rail densities have been documented in dense stands of reed and in moderately dense cattail stands interspersed with open water.

High Yuma clapper rail populations during the summer are less highly correlated with dense cattail-bulrush marshes than at other times of the year and positively correlated with sparse cattail-bulrush marshes that measure less than 1 m tall. Rail densities are highly correlated with dense cattail-bulrush communities during the late summer and fall; however, Yuma clapper rail densities are negatively correlated with those marshes being invaded by trees and grasses. Breadth of habitat use during late summer and fall declines when compared with summer but is broader than habitat found during winter and spring (Anderson and Ohmart 1985).

Although Eddleman (1989) found that seasonal variation in the selection of emergent cover types by Yuma clapper rail was consistent with previous studies (Smith 1975, Bennett and Ohmart 1978, Anderson and Ohmart 1985, Todd 1986), several exceptions were reported. Yuma clapper rail utilized willow and willow-salt cedar communities in response to rising water levels during the late-breeding and post-breeding seasons. Yuma clapper rail were also reported to have utilized upland edges and arroweed communities during the late breeding season, which was also in response to rising water levels.

Generally, the species or density of emergent vegetation does not appear very important to Yuma clapper rail so long as vegetation provides cover and nest sites, and proper water levels are maintained (Anderson and Ohmart 1985, Eddleman 1989). While the presence of residual vegetation as a component of habitat is important for feeding and movement during periods when water levels are high, it probably impedes movement in shallow areas (Eddleman 1989). Water depth and the amount of mud flats present may be the most significant criterion used in the selection of nesting sites in the Imperial Valley (Bennett and Ohmart 1978). Other factors thought to influence nest site selection include: water level consistency throughout the nesting period, the presence of high ground in the form of dikes or high ground for loafing and rearing young, and water depths of 1-15 cm.

Nesting

In the Imperial Valley of California, nests were found in cattail stands where they were typically constructed of dry, interwoven cattail with interspersed grasses and twigs. Located between 35-54 cm above the water surface, nests usually included a ramp composed of fallen cattail leading from the water surface, unless the nests were constructed above relatively dry ground. Ramps were known as a means by which to enter and exit the nest. When located above relatively dry ground, nests were constructed on fallen cattails between 5-16 cm above the ground surface (Bennett and Ohmart 1978). Eddleman (1989) reports that 50 % of nests studied along the lower Colorado River lacked ramps, which may be more common in areas where water levels are high or frequently fluctuate.

Brooding platforms or loafing nests constructed using mats of dead emergent vegetation are frequently found at the base of cattails on mud flats and are thought to serve as a place on which to loaf and cast pellets after feeding. These non-breeding nests differ from other nests in that they are capable of floating when water levels are high (Eddleman and Conway 1998).

Food Habits

Based on the analysis of stomach contents from 10 Yuma clapper rail collected along the lower Colorado River, Topock Marsh south to Imperial Reservoir, they were found to consume mostly introduced exotic crayfish; however; clams (*Corbicula* sp.), isopods, water beetles, and small fish were also found (Ohmart and Tomlinson 1977).

Along the lower Colorado River, Yuma clapper rail are generally found foraging in sites represented by high water coverage, relatively low stem densities (compared with other marsh areas) and water depth of approximately 7.5 cm (Eddleman 1989, Conway et al. 1993). Increases in daily movements, within-day movements, and home ranges during winter months may be a reflection of decreased crayfish abundance where such movements may improve foraging opportunities (Conway et al. 1993).

Conservation and Management

Effects of Human Activity

Historically the Colorado River was known for its extreme variability in flow regimes and associated hydrogeographical components (Reclamation 1999). The construction of dams and subsequent control of river flows promoted the development of suitable Yuma clapper rail habitat (Ohmart and Smith 1973), which resulted from the deposition of sediments and permitted Yuma clapper rail to expand their range northward from the Colorado River Delta in Mexico (Ohmart and Smith 1973, Anderson and Ohmart 1985, Eddleman 1989). Despite increases in the amount of available habitat in the United States, the loss of marshes caused by dredging, riprapping of stream banks, and high water flows remain the primary threats to the species (Todd 1986).

The effects of most pesticides and contaminants on rail are poorly understood, although clapper rail have shown a high tolerance to DDT and DDD (Eddleman et al. 1988). The presence of selenium in Yuma clapper rail, their eggs, and their food (crayfish) has been documented. Selenium occurred in concentrations that are known to have effects on the reproduction of mallards (*Anas platyrhynchos*). The presence of selenium in the lower Colorado River has been linked to areas above Davis Dam and may have resulted from natural processes, burning coal for generation of electricity, uranium and coal mining, or agricultural practices that include irrigation. The effects of selenium on Yuma clapper rail are largely unknown and may potentially impact reproduction (Eddleman 1989).

Predation by raptors is thought to be the primary factor contributing to mortality of Yuma clapper rail on the lower Colorado River. Eddleman (1989) suggests that Yuma clapper rail are most susceptible to predation during the late summer through early fall when they begin to move over larger home ranges. Increased Yuma clapper rail movements coincide with the arrival of wintering raptors during December and January, and predation by raptors is thought to be related to releases of water and subsequent increase in water levels. It is possible that by decreasing the rate at which water levels rise and changing the timing of releases to coincide with the departure of wintering raptors, predation may be minimized.

Ohmart and Smith (1973) suggest that availability of suitable habitat and food are the two primary factors responsible for controlling Yuma clapper rail populations along the lower Colorado River. As long as marsh or backwater habitat for both the rail and crayfish is maintained, the Yuma clapper rail is likely to persist along the lower Colorado River (USFWS 1983).

Degradation of Backwater Habitat

Water regimes along the lower Colorado River range from nominally stable at sites disconnected from the river to seasonally unstable and unpredictable on wetlands connected to the channel. Rapidly rising water levels during the nesting season may flood connected wetlands or backwater habitat and result in the loss of nests and young. Decreased flows may temporarily increase the amount of available foraging habitat, but if low flows persist over extended periods of time, wetlands would likely desiccate, resulting in Yuma clapper rail nest abandonment (Eddleman 1989). Additionally, flow-control structures, such as dams, have greatly altered connected streamside communities (Patten 1998). Reductions in sediment loads, narrowing of channels, reduction in the recruitment of vegetation, and increase of flow velocities are known to contribute to the loss of riparian-wetland, marsh, and backwater communities (Brown and Johnson 1985, Collier et al. 1996, Friedman et al. 1998, Auble and Scott 1998).

Habitat Criterion and Research Needs for Assessing the Value of Habitat

As indicated in Table 2, Yuma clapper rails generally require patch sizes of more than 8 hectares in size, moderately high to high stem density, high foliage density, low water depth, gradual shoreline slopes, and slow water velocities. Nest sites usually include the presence of either moist soils or shallow water. Habitat structure appears to differ seasonally where Yuma clapper rails are known to occupy marsh communities and other areas that are in closer proximity to upland areas. Although Yuma clapper rails are thought to tolerate fluctuations in water levels, fluctuations should occur slowly and gradually. Nest sites are generally located on substrate that is either equal to or slightly higher in elevation than surrounding habitat.

Table 2. Wetland/marsh generalized habitat requirements for Yuma clapper rail.

YUMA CLAPPER RAIL GENERALIZED HABITAT REQUIREMENTS	
Marsh structural type[a]	1, 3, 5, 7
Patch size	> 8 hectare
Stem density	High/Moderately high
Foliage density	High
Water depth[b]	Low
Shoreline slope	Gradual
High/dry ground	Yes
Water velocity	Slow
Substrate beneath nest	Moist soil or water
Proximity to uplands	Marsh, transition zone
Daily water level fluctuation	Low - gradual change
Nest site elevation	Higher or equal to surroundings
Nesting period[c]	Early, mid-season, late

[a] Marsh structural type as defined by Anderson and Ohmart (1976).
[b] Low = < 3.0 centimeters, medium = 3.0-6.0 centimeters, high = > 6.0 centimeters.
[c] Early = February - April, mid-season = May - June, late = July - September.

A variety of studies of clapper rail habitat, such as those conducted by Tomlinson and Todd (1973), and surveys of *yumanensis* habitat (Gould 1975, Eddleman 1989) have led to differing opinions of which criterion actually define suitable Yuma clapper rail habitat (Conway et al. 1993). Until relatively recently, *yumanensis* was thought to be migratory due to a lack of responses to taped calls during winter surveys (Tomlinson and Todd 1973, Smith 1975, Bennett and Ohmart 1978, Todd 1986). However, more recent studies (Eddleman 1989, Conway et al. 1993) revealed, through the use of radio telemetry, that more than 70 % of the Yuma clapper rail population remains along the lower Colorado River during the winter. As such, our understanding of seasonal habitat requirements and Yuma clapper rail responses to seasonal variation in water levels is somewhat limited.

Specific characteristics described as critical components of year-round Yuma clapper rail habitat include: low emergent stem densities and low presence of residual vegetation (Anderson and Ohmart 1985, Conway et al. 1993); marsh vegetation that averages greater than 2 m in height (Anderson and Ohmart 1985, Eddleman 1989), the presence of dry ground or isolated islands between water and banks to allow for foraging and walking (Gould 1975, Anderson and Ohmart 1985, Conway et al. 1993), the presence of flowing water through many small channels that measure from 0.5-3 m in width or small bodies of open water measuring 0.02-0.2 ha in size (Tomlinson and Todd 1973, Gould 1975), and extensive areas of water where overall depth does not exceed 0.3 m with little or no fluctuation in daily water levels (Tomlinson and Todd 1973, Gould 1975). Optimal year-round habitat appears as a mosaic of emergent vegetation in stands of differing ages interspersed with shallow pools of open water (Eddleman and Conway 1998), and consists of cattail and bulrush (Tomlinson and Todd 1973, Gould 1975, Bennett and Ohmart 1978, Todd 1986). Generally, Yuma clapper rail select marshes consisting of emergent cover types (Todd 1986), although cover types have frequently been described as insignificant so long as occupied communities are either partially flooded or covered in shallow water (Ohmart and Smith 1973, Anderson and Ohmart 1985, Eddleman 1989).

During the breeding season, preferred Yuma clapper rail microhabitat consists of shallow water measuring less than 30 cm in depth (Gould 1975, Bennett and Ohmart 1978, Todd 1986) and vegetation usually measuring more than 40 cm tall (Todd 1986). Marshes will have an interface between upland and marsh communities or will have higher ground as a critical component (Tomlinson and Todd 1973, Gould 1975, Smith 1975, Bennett and Ohmart 1978). Eddleman (1989) defines high ground as sites only slightly higher than the water level or the prevailing substrate. Examples of high ground in marshes include gradually sloping shorelines and areas that have resulted from deposition at the sides of existing and filled channels. Microhabitat during the breeding season should also consist of a mat of residual vegetation that covers at least 5 % of the area (Ohmart and Smith 1973, Bennett and Ohmart 1978, Todd 1986). Stable water levels during the breeding season are also thought to be important (Gould 1975, Bennett and Ohmart 1978). During the early breeding season (March-April) Yuma clapper rail prefer habitat that is close to open water. During the late breeding season (May-July) Yuma clapper rail prefer areas in close proximity to vegetative edges, greater distances to adjacent uplands, shorter distances to vegetative edge, and short distances to dry ground. During the post-breeding season (August-October), rail will occupy areas with low overhead coverage by vegetation, short distances to vegetative edges, greater distances to adjacent uplands, decreased water depth, and decreased basal coverage by emergent vegetation (Conway et al. 1993). Characteristics of microhabitat during the summer include sparse cattail-bulrush marshes that measure less than 1 m tall. Microhabitat used during the late summer and fall includes dense cattails and bulrush, and trees and grasses are absent from occupied areas (Conway et al. 1993). In early winter (November-December), clapper rail prefer low emergent stem density and ground coverage, shorter distances to water, dense overhead coverage by vegetation, greater distances to adjacent uplands and vegetative edges, increased water depth and water coverage, and taller emergent plants. Late winter (January-February) preferences included low overhead coverage by vegetation, shorter distances to adjacent uplands, and low stem densities.

Eddleman (1989) suggests that management of existing Yuma clapper rail habitat along the lower Colorado River is not necessary, as long as appropriate water flows are not disrupted. Instead, emphasis should be placed on the creation of new marshes and backwater habitat. Since Yuma clapper rail appear to be highly dependent upon crayfish as their primary source of food, studying crayfish to examine seasonal movements, population dynamics, and habitat requirements should be considered. Understanding crayfish biology on the lower Colorado River should help to further refine seasonal habitat requirements and implications of existing management practices for both the Yuma clapper rail and crayfish. Densely vegetated marshes with shallow water appear to be relatively common along the lower Colorado River and provide adequate nesting habitat for Yuma clapper rail. Interior marshlands with low basal cover and deep water, however, are uncommon and provide few wintering and possibly foraging sites (Conway et al. 1993). Therefore, emphasis should be placed on the creation of interior marshlands rather than breeding habitat. Newly created marshes should be as large as possible to allow for increased foraging opportunities across all seasons. These marshes would provide variation in topography to minimize effects of water-level fluctuations. Larger habitat blocks in breeding areas would provide additional nesting sites and escape cover (Eddleman 1989). Although Yuma clapper rail habitat requirements in terms of plant species, water depth, vegetation height, etc. are reasonably well described, our understanding of vegetation measurements in habitat across all seasons is lacking. Variables such as emergent coverage, residual mat coverage, water depth and coverage, and emergent stem density need to be more clearly understood in order to more effectively create suitable habitat.

Current projects being conducted along the lower Colorado River are assessing whether or not fire can be used to restore Yuma Clapper Rail habitat. Study areas are located within the Imperial National Wildlife Refuge (NWR), at Mittry Lake, Havasu NWR, and at the Salton Sea. Although it is generally believed that fire can be successfully used in the restoration of Yuma Clapper Rail habitat by removing old, decadent vegetation, insufficient data has been collected to formulate any conclusions (C. Conway, University of Arizona, Personal Communication).

Least Bittern

Distribution

Within the lower Colorado River Valley, least bittern are considered relatively common breeders from April to September in expansive marsh communities that include Topock Marsh and near Imperial Dam (Andersen and Ohmart 1984, Rosenberg et al. 1991). A maximum density of 41 individuals was recorded at Imperial NWR on 13 July 1978; however, densities are lower in all other portions of the valley (Rosenberg et al. 1991).

Migration

Least bittern migrants typically summer in temperate areas but winter in both temperate and subtropical marsh habitats (Gibbs et al. 1992). Spring migrants usually arrive on their breeding grounds from early to mid March through mid May (Bent 1926). Adult winter migration usually begins in either September or October, while juvenile least bittern may occasionally remain at nesting areas through October after adults have departed (Palmer 1962). Most least bittern populations in the United States are migratory, however, it is currently unclear if individuals found along portions of the lower Colorado River are migratory or year-round residents. Generally, least bitterns that are migratory will arrive in the lower Colorado River Valley in April and remain through September (Anderson and Ohmart 1984, Rosenberg et al. 1991). Typically, least bittern that nest west of the Rocky Mountains migrate through western Mexico to winter in Costa Rica, while individuals nesting east of the Rocky Mountains migrate to northern Columbia (Hancock and Kushlan 1984).

Habitat

Although least bittern are usually found in a variety of habitats throughout their range (Bent 1926), occupied habitat always includes dense emergent vegetation (Hancock and Kushlan 1984). Typically, least bittern habitat is characterized by both fresh and brackish marshes within tall, dense stands of aquatic and/or semiaquatic vegetation including *Typha* spp., *Carex* spp., *Scirpus* spp., *Sagittaria* spp., or *Myriscus* spp. (Palmer 1962, Hancock and Kushlan 1984, Gibbs et al. 1992). They have also been shown to prefer territories that include interspersed woody vegetation with deep open water (Weller 1961, Palmer 1962). Characteristically, least bittern prefer to forage near open deeper water utilizing emergent vegetation as perches to cling from while attempting to forage for prey on the open-water side (Eastwood 1932, Sutton 1936, Weller 1961).

Within the lower Colorado River Valley, the largest concentrations of least bittern are found in cattail or bulrush habitats within Topock Marsh and near Imperial Dam (Andersen and Ohmart 1984, Rosenberg et al. 1991). Scattered and less-numerous concentrations of least bittern can be found in smaller marsh habitats throughout the Colorado River Valley, including ponds and agricultural canals (Rosenberg et al. 1991). For marsh land cover types defined by Anderson and Ohmart (1976), suitable least bittern habitat usually corresponds to marsh structural types 1, 2, 3, and 5 (Sterling 2005).

Nesting

Least bittern typically choose nest sites among tall, dense stands of emergent vegetation usually consisting of *Typha* spp., *Carex* spp., *Scirpus* spp., but they are occasionally found within *Sagittaria* spp., *Phragmites* spp., *Salix* spp., *Cephalanthus* spp., or *Rhizophora* spp. Nest sites are usually located in clumps of emergent or woody vegetation that measure at least 2 m high (Gibbs et al. 1992). Nests are most frequently constructed directly on top of previous years' vegetation, which serves as a foundation for nest construction. Occasionally, old nests built by other avian species may be used as the nest foundation (Weller 1961).

During initial nest construction, adults will first bend down old or new vegetation to the water surface and then begin piling on plant matter to create a nesting platform (Weller 1961). Platform consistency coincides with available vegetation within that specific breeding territory, but usually the platform vegetation will be of the same species as the nest foundation (Weller 1961). However, Bent (1926) noted two instances where nest platforms were constructed with different material. Bent (1926) described a nest within "rushes" with a platform consisting of "sticks," while a second nest was located within *Typha* spp. but the platform was constructed with *Salix* sticks. Nests are typically constructed 15-76 cm above water and are 8-96 cm in depth (Gibbs et al. 1992).

Least bittern are thought to be non-colonial nesters, but data have shown that under specific conditions, least bittern will breed in concentrated areas (Kushlan 1973). Kushlan (1973) found that least bittern might nest colonially when feeding areas are localized, and Hancock and Kushlan (1984) suggested that colonial nesting behavior exhibited by least bittern, especially when population densities are high, may be a response to an over-abundance of food.

Food Habits

Least bittern found along the lower Colorado River will forage primarily for small fish and amphibians but also for rodents, reptiles, and insects (Andersen and Ohmart 1984).

Conservation and Management

Effects of Human Activity
Habitat destruction and degradation are thought to be the principal range-wide threats to the least bittern (Gibbs et al. 1992). Tiner (1984) estimated that less than half of the wetlands present in the United States at the time of European settlement remain today. Many remaining wetlands have been degraded from their original condition by sedimentation, eutrophication, and chemical contamination. Gibbs et al. (1992) suggest that changes in water quality could adversely affect the least bittern's prey base and increase the potential for impacts from parasites such as nematodes (*Eustrongilides* spp.). Alterations to the hydrology of wetlands, such as drainage or channelization, may reduce least bittern breeding success by drying or flooding potential nest sites (Monfils 2003).

Degradation of Backwater Habitat
Marshes and backwaters that historically occurred along the lower Colorado River have been destroyed or severely degraded because of agricultural conversion, construction of reservoirs, river channelization, and shoreline stabilization. Given the regulated nature of the Colorado River, natural formation of new marshes and backwaters resulting from channel movement and periodic flooding is now unlikely. However, flow regulation and shifts in the timing of flows because of water diversion have resulted in the development of large marsh and backwater complexes where riparian vegetation historically occurred. Marsh complexes developed behind Imperial Dam and Parker Dam at the Bill Williams Delta and Topock Marsh. The construction of training structures also created areas of more expansive and permanent backwaters and marshes than had occurred historically on the lower Colorado River (MSCP 2004).

Habitat Criterion and Research Needs for Assessing the Value of Habitat
Although broadly defined habitat requirements are known (Table 3), detailed information on least bittern reproduction, population structure, home-range sizes, etc. is lacking. As such, establishing habitat requirements and other criterion to effectively manage and stabilize least bittern populations would be very difficult at best (Gibbs et al. 1992). Generally, however, least bittern have exhibited preferences for dense wetland communities with deep water where vegetation is characterized by species of the following genre: *Typha* spp., *Carex* spp., *Scirpus* spp., *Sagittaria* spp., or *Myriscus* spp. (Palmer 1962, Hancock and Kushlan 1984, Gibbs et al. 1992). In North America, however, least bittern are most frequently found in cattail- and sedge-dominated marshes (Hancock and Kushlan 1984). Preferred habitat may also consist of woody vegetation interspersed throughout

Table 3. Wetland/marsh generalized habitat requirements for least bittern.

LEAST BITTERN GENERALIZED HABITAT REQUIREMENTS	
Marsh structural type[a]	1, 2, 3, 5
Patch size	Unknown
Stem density	High
Foliage density	Unknown
Water depth[b]	High
Shoreline slope	Unknown
High/dry ground	Unknown
Water velocity	Unknown
Substrate beneath nest	Water
Proximity to uplands	Marsh
Daily water level fluctuation	Unknown
Nest site elevation	Unknown
Nesting period[c]	Early, mid-season, late

[a] Marsh structural type as defined by Anderson and Ohmart (1976).
[b] Low = < 3.0 cm, medium = 3.0-6.0 cm, high = > 6.0 cm.
[c] Early = February - April, mid-season = May - June, late = July - September.

(Weller 1961, Palmer 1962). Typically, emergent vegetation measures at least 2 m high (Gibbs et al. 1992) and is used for cover, movement over deep water for foraging, and nesting (Eastwood 1932, Sutton 1936, Weller 1961, Palmer 1962, Gibbs et al. 1992). Water depth usually ranges from 10 to 50 cm (Gibbs et al. 1992).

Within the lower Colorado River Valley, the largest concentrations of least bittern are found in cattail or bulrush habitats within Topock Marsh and near Imperial Dam (Andersen and Ohmart 1984, Rosenberg et al. 1991). Scattered and less-numerous concentrations of least bittern can be found in smaller marsh habitats throughout the valley, including ponds and agricultural canals (Rosenberg et al. 1991). Sterling (2005) suggests that least bittern habitat along the lower Colorado River is best described by marsh cover types as defined by Anderson and Ohmart (1976). Marsh cover type 1 (MA-1) consists of nearly 100 % cattails and bulrush with small amounts of *Phragmites* spp. and open water. Marsh cover type 2 (MA-2) is defined as consisting of nearly 75 % cattails and bulrush with many trees and grasses interspersed. Approximately 25 to 50 % of marsh cover type 3 (MA-3) consists of cattails and bulrush with some *Phragmites* spp., open water, trees and grasses. Marsh cover type 7 (MA-7) is defined as open marsh, where approximately 75 % of the total area consists of water adjacent to sparse emergent vegetation and includes sandbars and mudflats when water levels are low. Density of emergent vegetation is thought to, at least in part, dictate the number of least bittern nests found in an area. As such, interspersion of water and cover may be an important characteristic of breeding habitat (Gibbs et al. 1992). Weller and Spatcher (1965), for example, found a greater number of least bittern nests at two Iowa marshes during years when ratios of emergent vegetative cover to open water were equal (the “hemi-marsh” condition), which may represent optimal least bittern habitat characteristics. In Wisconsin, Manci and Rusch (1988) found that least bittern were restricted to deep-water marshes dominated by cattails and sedges, and avoided these areas when dry.

Studies designed to target least bittern habitat requirements should seek to determine minimum patch size requirements, determine whether or not high or dry ground should be present, and what the implications of high water velocities are on least bittern habitat suitability. Additionally, studies should investigate how tolerant least bitterns are to daily fluctuations in water levels and how the rate at which water levels fluctuate might influence habitat suitability. Studies should also investigate nesting habitat structure and how water level fluctuations might decrease nesting habitat quality. Seasonal tolerance to fluctuations in water levels should also be determined. As previously mentioned, detailed information on least bittern demography, habitat requirements, home range sizes, and breeding requirements is lacking and should be studied extensively before establishing habitat requirements for the species. Along portions of the lower Colorado River, least bittern are thought to be year-round residents. As such, studies that help define these variables are extremely important in determining population distributions seasonally and assessing trends in and responses to seasonal habitat features.

Southwestern Willow Flycatcher

Distribution

The southwestern willow flycatcher is a widely distributed summer resident of much of the United States and southern Canada (Brown 1988). The current breeding range of the southwestern willow flycatcher (*E. t. extimus*) includes Arizona, southern California, New Mexico, southern Nevada, southern Utah, and southwestern Colorado (Unitt 1987, Koronkiewicz et al. 2004). Breeding records and museum collections suggest that the southwestern willow flycatcher may have historically been found along the extreme southern reaches of the lower Colorado River region. Prior to surveys conducted by McKernan in 1996, no breeding confirmation had been documented in more than 50 years (McKernan 1997), although surveys conducted by Arizona Partners in Flight in 1993 did document four or five territorial southwestern willow flycatcher along the lower Colorado River near Yuma, Arizona (McKernan 1997).

During surveys conducted in 1996, McKernan (1997) documented eight willow flycatcher nests at sites near the Lake Mead Delta and at Topock Marsh. During surveys conducted by McKernan and Braden (2001), nests were documented at the Virgin River study site, Mormon Mesa North and South, Mesquite West, and Topock Marsh. Southwestern willow flycatcher were also documented at Pahranagat NWR and Overton Wildlife Management Area (WMA) along the Muddy River (McKernan and Braden 2001).

In 2003 Koronkiewicz et al. (2004) conducted southwestern willow flycatcher presence/absence surveys at 95 pre-selected sites along the Virgin and lower Colorado Rivers. Flycatcher were detected on at least one occasion at 54 of the study sites. Resident breeding southwestern willow flycatcher were detected at Pahranagat NWR, Mesquite, Mormon Mesa and Topock Marsh.

McLeod (2005) also found resident southwestern willow flycatcher at survey locations identified in 2003, in addition to several other locations (Littlefield, Grand Canyon, Overton WMA, and Bill Williams NWR). Although flycatcher were recorded at Overton WMA and Bill Williams NWR, no breeding activity was documented.

Migration

Phillips et al. (1964) suggested that *E. t. extimus* was the first to arrive and has been documented in southern Arizona from May 3 to September 10. Occasionally, individuals have been found away from their breeding areas during early June and from July 21 to early September. Rosenberg et al. (1991) suggest that low-elevation breeding populations, all thought to be *E. t. extimus*, migrated early, arriving on their breeding grounds in late April and early May, whereas montane breeding populations, such as *E. t. brewsteri* and *E. t. adastus*, arrived in mid May and continued to pass through the lower Colorado River Valley through mid-June.

Koronkiewicz et al. (2004) documented southwestern willow flycatcher along the Virgin and lower Colorado Rivers and tributaries between 15 May and 25 July. Most southwestern willow flycatchers south of the Bill Williams River were detected before 18 June, with a single detection recorded on 2 July. As the result of monitoring subsequent to initial sightings at sites south of the Bill Williams River, all individuals recorded were most likely north-bound migrants (Koronkiewicz et al. 2004).

Arrival and departure times of southwestern willow flycatcher vary in relation to sex and age (Sogge et al. 1997, Yong and Finch 1997). Bent (1942) observed that male southwestern willow flycatcher arrived on breeding grounds ahead of females, which may be due to competition among males for high-quality territories, ability to tolerate harsher weather than females, and differences between males and females in travel distances to breeding and wintering areas (Yong and Finch 1997). Adults can start migrating earlier in the fall than young flycatcher because they delay molting until they reach their wintering grounds in Central and South America. Unitt (1987) suggests that young southwestern willow flycatcher molt into their first winter plumage prior to migration, which adds to the length of stay on their breeding grounds.

Habitat

In general, southwestern willow flycatcher prefer territories with high shrub density, open canopies, and moderate ground vegetation cover (Whitmore 1977). They require dense, low-growing woody vegetation (i.e., tree and/or shrub) (Bent 1942) and occur in both mesic and xeric conditions (Barlow and McGillivray 1983, Sedgwick and Knopf 1992).

The southwestern willow flycatcher is an obligate riparian subspecies that requires dense willow thickets (Sedgwick and Knopf 1992) or other available low-growing woody vegetation (Stoleson and Finch 1999) with greater canopy cover (Sedgwick and Knopf 1992) along rivers, streams, marshes, or open water areas (USFWS 1997). Consequently, habitat selection may be influenced by floodplain morphology. That is, southwestern willow flycatcher may select territories within larger floodplains due to the presence of young, dense riparian vegetation communities influenced by fluvial-geomorphic processes (Hatten and Paradzick 2003).

Historically, southwestern willow flycatcher were likely abundant summer residents along the lower Colorado River due to the prevalence of riparian willow thickets (McKernan 1997, McKernan and Braden 2001). However, habitat reduction and degradation have significantly reduced distribution and numbers of this species (USFWS 1997). The invasion of salt cedar was originally thought to have contributed to habitat degradation (Whitmore 1977). However, recent studies (Brown and Trosset 1989, McKernan 1997, Sogge et al. 1997, McKernan and Braden 2001, Koronkiewicz et al. 2004, McLeod et al. 2005) have found that southwestern willow flycatcher do in fact utilize tamarisk within breeding territories. Optimal structural components found within available habitat likely influence habitat selection rather than the presence or absence of native plant communities (Brown and Trosset 1989). Additionally, such structural components (i.e., patch and canopy morphology) vary widely throughout the range of the southwestern willow flycatcher and, therefore, requirements can be broadly defined (Sogge et al. 1997). Specifically, Sogge et al. (1997) split potential southwestern willow flycatcher habitat into four general habitat communities including: monotypic high-elevation willow, monotypic exotic, native broadleaf dominated, and mixed native/exotic.

Monotypic high-elevation willow: Nearly monotypic, dense stands of willow (often *Salix exigua* or *S. geyeriana*) above 2,300 m in Arizona, 3-7 m in height with no distinct overstory layer; often associated with sedges (*Carex* sp.), rushes (*Juncus* sp.), nettles (*Urtica* sp.), and other herbaceous wetland plants; usually very dense structure in lower 2 m; live foliage is high from the ground to the canopy.

Monotypic exotic: Nearly monotypic, dense stands of exotics such as salt cedar or Russian olive (*Elaeagnus angustifolia*), 4-10 m in height forming a nearly continuous, closed canopy (with no distinct overstory layer); lower 2 m often very difficult to penetrate due to dense branches; however, live foliage density may be relatively low, 1-2 m above ground, but increases higher in the canopy; canopy density is uniformly high**.**

Native broadleaf dominated: Composed of a single willow species, often Goodding's willow (*Salix gooddingii*), or a mixture of native broadleaf trees and shrubs including cottonwood, willows, boxelder (*Acer negundo*), ash (*Fraxinus* spp.), alder (*Acnus* spp.), and buttonbush (*Cephalanthus occidentalis*), height from 3-15 m; characterized by trees of different size classes; often a distinct overstory of cottonwood, willow, or other broadleaf tree with recognizable subcanopy layers and a dense understory of mixed species; exotic or introduced species may be a rare component, particularly in the understory.

Mixed native/exotic: Dense mixtures of native broadleaf trees and shrubs mixed with exotic or introduced species such as salt cedar or Russian olive; exotics are often primarily in the understory but may be a component of the overstory; the native and exotic components may be dispersed throughout the habitat or concentrated as a distinct patch within a larger matrix of habitat; overall, a particular site may be dominated primarily by natives or exotics, or be a more or less equal mixture.

Riparian patches used by breeding southwestern willow flycatcher vary in size and shape, and may be a relatively dense, linear, contiguous stand or an irregularly shaped mosaic of dense vegetation with open areas. Southwestern willow flycatcher have nested in patches as small as 0.8 ha and as large as several hundred hectares. Southwestern willow flycatcher have not, however, been found nesting in narrow, linear riparian habitats measuring less than 10 m wide, although they will use these areas during migration (Sogge et al. 1997, Sogge and Marshall 2000).

Telemetry studies in Arizona suggest that male southwestern willow flycatcher habitat use differed significantly from the amount of available habitat. In total, 53 % of recorded southwestern willow flycatcher locations occurred in mixed mature riparian habitat, which represented only 28 % of the available habitat (Cardinal and Paxton 2005).

Southwestern willow flycatcher breeding habitats usually include or are near open water or saturated soils. As a general rule, southwestern willow flycatcher nests are rarely more than a few dozen meters away from water or saturated soils (Sogge and Marshall 2000).

Results of studies conducted along the lower Colorado River by McKernan and Braden (2001) suggest that vegetation species composition varied equally for both occupied and unoccupied study areas and provided no clear distinction, based on perennial species composition, as to what constitutes suitable southwestern willow flycatcher habitat. Foliage height profiles of occupied study areas provided no clear demarcation of the understory, subcanopy, or canopy structure. Only slight differences in canopy heights between occupied and unoccupied areas were detected, which suggests that canopy height may probably not be a good indicator of suitable habitat. Based on foliage density, patchiness of occupied and unoccupied habitats were for the most part equivalent, suggesting that patchiness may not serve as an indicator of occupancy, although it may represent the quality of occupied habitat.

Koronkiewicz et al. (2004) reported that southwestern willow flycatcher breed in a wide variety of riparian habitat types throughout the Virgin and lower Colorado River regions. Although occupied southwestern willow flycatcher habitat at each of the study areas consisted of relatively homogeneous, contiguous stands of riparian vegetation, the sites differed from each other both in structure and composition. Vegetation and habitat characteristics at four study sites were measured during the 2003 study. On plots at Pahranagat NWR (n=25), average canopy height was 15.3 m (SE=1.6), percent total canopy closure was 90.8 % (SE=2.57), percent woody ground cover was 13.8 % (SE=3.4), percent of plot centers within 30 m of standing water or saturated soil was 24 %, distance to nearest canopy gap was 5.9 m (SE=0.8), percent of plot centers within 30 m of a broadleaf tree was 100 %, the number of shrubs or sapling stems within a 5 m radius of the plot center was 10.6 (SE=5.9), and the number of tree stems within an 11.3 m radius of the plot center was 11.2 (SE=2.3). The one characteristic reported by Koronkiewicz et al. (2004) and common to all habitat types where southwestern willow flycatcher were found, regardless of plant species composition, height, and canopy closure was that foliage density was always greatest from 2-4 m above the ground (at and immediately above mean nest height). (For vegetation and habitat characteristics at the Mesquite, Mormon Mesa, and Topock study sites, refer to Table 6.1 in Koronkiewicz et al. 2004). Generally, McLeod (2005) found that canopy closure was greater and there were more tree stems at nest sites than at non-nest sites.

Along the Gila and San Pedro rivers in Arizona, nesting southwestern willow flycatcher selected dense habitat patches dominated by young tamarisk and willow trees located near moist soils or standing water and within a larger complex of riparian forest. Occupied patches had greater basal area and total foliage volume than unoccupied patches, and foliage density was greater at all height intervals. Canopy cover was greater and less variable in occupied patches. Maximum canopy did not differ between occupied and unoccupied patches, although there was less variation in height in occupied patches. Average canopy cover was 88 %, while minimum canopy cover was 71 % (Paradzick 2005).

In Arizona, Allison et al. (2003) report that areas within southwestern willow flycatcher nesting habitat exhibited greater canopy closure than non-nesting areas, and foliage density was highest at nest height. Greater canopy closure, taller canopy height, and dense foliage at nest height might provide a more favorable microclimate at nests. The presence of water may also be a factor in providing a suitable microclimate (Sogge 2000). Based on microclimate data collected in 2003, Koronkiewicz et al. (2004) suggest that microclimate (in a complex interaction with habitat type, vegetative structure, and possibly other factors) may potentially limit nesting habitat suitability. Because standing water or saturated soils were present at all nesting sites, Koronkiewicz et al. (2004) suggest that measuring the presence of water early in the breeding season may serve as a good indicator of preferred southwestern willow flycatcher breeding habitat.

Microclimate studies were conducted by McLeod et al. (2005) to document temperature, relative humidity, and soil moisture at southwestern willow flycatcher nests. Comparisons were made between nest sites, within territory sites, and with unoccupied riparian habitat outside the southwestern willow flycatcher's territory. Results suggested that southwestern willow flycatcher prefer to establish territories and build their nests at sites with significantly cooler, more humid, and wetter microclimates.

Nesting

In southern California and Arizona, nest building begins in mid to late May. Females usually select the site, collect nesting material, and build the nest while males perch nearby. Nest construction usually lasts between 4 and 7 days (Sedgwick 2000, Sogge 2000).

McKernan and Braden reported that 40.9 % (27 of 66) of the known nests substrates during the 2000 surveys consisted of tamarisk and nest success was significantly greater for nests placed in tamarisk than for nests placed in willow species (McKernan and Braden 2001). It was also reported that the highest southwestern willow flycatcher productivity occurred in monotypic tamarisk habitats while some of the lowest flycatcher productivity occurred at willow dominated sites. Koronkiewicz et al. (2004) reported that 57 % of all nests found were placed in tamarisk, 24 % were found in Goodding's willow, and 18 % in coyote willow (*Salix exigua*). In Arizona, tamarisk and Goodding's willow were the primary nesting substrates, although mesquite, common buttonbush, and Arizona ash (*Fraxinus velutina*) were also used (Munzer et al. 2005).

Along the Virgin, lower Colorado, and Bill Williams Rivers, McKernan (1997) reported that the mean height of nest placement for all nests found was 2.4 m (s.d. ± 0.35) while Koronkiewicz et al. (2004) reported a mean nest height of 2.9 m (SE=0.19) and McLeod (2005) suggested a mean nest height of 3.2 m. In Arizona, mean nest height at two different study areas was 4.73 and 3.58 m (Munzer et al. 2005).

Food Habits

The southwestern willow flycatcher is primarily insectivorous and capable of catching flying insects on the wing, although they may also glean insects from leaves by hovering. Flycatchers forage within and above the canopy, along the patch edge, in openings within their territory, and above surface water (Sogge 2000). In Ontario, flycatchers were reported as having spent 5 % of their time foraging and 63 % sitting. As such, they have been described as “time minimizers” because they are able to simultaneously engage in foraging, territorial advertising, vigilance, and resting (Prescott and Middleton 1988). In southeastern Washington, Frakes and Johnson (1982) reported that willow flycatchers exhibited flexibility in behavior by changing their foraging behavior such that it was optimized for a particular habitat in response to interspecies competition.

Changes in native vegetation are thought to alter available food resources and subsequently influence avian population abundance, distribution, and behavior (Kleintjes and Dahlsten 1994). Salt cedar is thought to negatively impact flycatcher reproduction and spatial distribution by altering insect fauna (Sedgwick 2000). Durst (2004) reported significant differences between arthropod communities found in native, mixed, and exotic riparian habitats as well as differences in flycatcher diets in each of these habitats. Based on the flycatcher’s ability to exploit a diverse array of arthropod taxa, there is little evidence to suggest that changes in potential prey base associated with salt cedar have an impact on southwestern flycatcher habitat quality (Durst 2004).

Based on the analysis of fecal samples collected from southwestern willow flycatcher at Roosevelt Lake in central Arizona, Durst (2004) identified 1,316 individual prey items across eight taxonomic groups, which represent between 94 and 96 % of the southwestern willow flycatcher’s prey. The taxonomic groups identified included *Araneae*, *Coleoptera*, *Diptera*, *Formicidae*, *Hemiptera*, *Homoptera*, flying *Hymenoptera*, and *Lepidoptera*. Significant differences in southwestern willow flycatcher diets were reported by habitat. More *Homoptera* were consumed in exotic habitat than in mixed or native habitats, more *Lepidoptera* were consumed in native habitat than in mixed or exotic habitats, and more *Araneae* were consumed in native habitats than in exotic ones (Durst 2004).

Based on the stomach contents of 135 willow and alder flycatcher that were collected from May through September from 17 states, Beal (1912) reports that 96.05 % of food consumed consisted of animal matter, and 3.95 % consisted of vegetable matter. *Coleoptera* (beetles) of all types made up approximately 17.89 % of the animal matter consumed and represented a large portion of southwestern willow flycatcher diet during all months except September, when vegetable matter was the most frequently consumed. *Hymenoptera* (bees, wasps, and ants) represented the largest item of animal food consumed by southwestern willow flycatcher (41.37 %) in every month and were represented mostly by bees and wasps. *Diptera* (flies) accounted for 14.20 % of the southwestern willow flycatcher’s diet and were consumed regularly every month except for September when it only accounted for 8.05 % of the southwestern willow flycatcher’s diet. The southwestern willow flycatcher’s diet also consisted of *Hemiptera* (true bugs), and *Lepidoptera* (butterflies and moths). Of the vegetable food consumed, primarily during the month of September, raspberries and blackberries (*Rubus* spp.) were among the most common.

In Ontario nestling diets consisted primarily of *Diptera* and *Hemiptera* but also included *Mollusca* (mollusks), *Arachnida* (spiders), *Isopoda* (primitive crustaceans), *Orthoptera* (grasshoppers and crickets), *Coleoptera*, *Lepidoptera*, and *Hymenoptera* (Prescott and Middleton 1988).

Conservation and Management

Effects of Human Activity

The decline of the southwestern willow flycatcher has likely occurred due to the destruction and degradation of riparian woodlands in combination with heavy brood parasitism by the brown-headed cowbird (*Molothrus ater*) (Ehrlich et al. 1992). However, along the lower Colorado River, dramatic changes in flow regime due to human manipulation have facilitated habitat degradation and destruction. That is, the restriction of seasonal natural flood events has enabled aggressive exotic plant species to invade and out-compete native plants restricting regeneration and repopulation, which has subsequently influenced flycatcher habitat. Livestock grazing may also directly influence flycatcher populations. In Arizona, riparian woodlands comprise less than 0.5 % of the landscape (Strong and Bock 1990) where cattle grazing is the major cause of decline (Ehrlich et al. 1992, Sedgwick 2000). Damage by livestock includes soil compaction and gullying, grazing of willows, and changes in willow foliage height and volume (Harris et al. 1987). However, cattle grazing is not a significant concern influencing southwestern willow flycatchers along the lower Colorado River.

Salt cedar have invaded riparian areas throughout the west, particularly the southwest, and have replaced some riparian communities completely. For example, salt cedar replaces the preferred multi-layered shrub community with a monotypic stand that has only one shrub layer, decreases plant and insect diversity, and can increase the frequency and intensity of fire. Dams, flood control, and highly saline irrigation water also give salt cedar a competitive edge over native vegetation (Sogge et al. 1997). More than 40 % of all avian species depend, at least in part, on the presence of riparian communities in the southwestern United States (Hunter et al. 1988). Loss of native riparian habitat and subsequent spread of salt cedar has been shown to negatively influence the population sizes of many riparian bird species (Anderson et al. 1977) and studies along the Colorado River suggest the bird species richness and total density is lower in salt cedar communities than in native riparian habitat (Anderson and Ohmart 1984). However, recent work has shown southwestern willow flycatchers will often nest within salt cedar when specific habitat components are present (Koronkiewicz et al. 2004). Specifically, microclimate, which is influenced by habitat structure, type, and presence of water, may be a limiting factor in nesting suitability (Koronkiewicz et al. 2004) regardless of the presence of a native or an exotic plant community (McKernan and Braden 2001).

The southwestern willow flycatcher is a common host for brood parasitism by the brown-headed cowbird (Bent 1942, King 1955, Walkinshaw 1966, Sedgwick and Knopf 1988). Brood parasitism may pose a significant threat, particularly in its western range where habitat is limited and fragmented, and where livestock are often present in meadows and riparian habitats. There is, however, evidence of adaptive behavior toward brown-headed cowbird parasitism in some populations. Parasitized nests may be abandoned or dismantled, and renesting may occur in some cases (Sedgwick and Knopf 1988), although fewer eggs may be laid (Holcomb 1974). Southwestern willow flycatcher nesting success and productivity are thought to be in some cases reduced as a result of brown-headed cowbird parasitism (Sedgwick and Knopf 1988, Larison et al. 1998, Whitfield and Sogge 1999, Sedgwick and Iko 1999, Finch et al. 2000). McLeod et al. (2005) reports that nest parasitism across all study sites along the lower Colorado River ranged from 0-47 % and averaged 26 %. McKernan and Braden (2001) suggest nest parasitism by brown-headed cowbird along the lower Colorado River has little consequences, if any, on the daily or overall probability of nest survival for the southwestern willow flycatcher.

Degradation of Backwater Habitat

Along the Colorado River, riparian habitats have been modified, reduced, or lost downstream of dams as a result of changes in flood frequency and duration (Marshall and Stoleson 2000). In 1981 24 months of continual high flows from water releases at Alamo Dam resulted in the loss of 120 ha of cottonwood-willows at the confluence of the Bill Williams and Colorado Rivers (Hunter et al. 1987). Flood-control projects generally shorten, straighten, and narrow river channels such that main channels are cutoff from side channels and adjacent floodplains, thereby reducing meander patterns, slowing stream velocity, and dampening the effects of flooding. Channelization alters stream banks by elevating them well above groundwater, which essentially restricts access by phreatophytic vegetation to groundwater and reduces the overall width of wooded riparian habitat (Marshall and Stoleson 2000).

Habitat Criterion and Research Needs for Assessing the Value of Habitat

Along the lower Colorado River, significant differences in vegetation measurements were identified between southwestern willow flycatcher nesting habitat and non-use areas (Table 4). Canopy height in occupied habitat ranged from 5.2-15.8 m, percent canopy closure ranged from 89.6-98.4 %, and nest substrate height ranged from 2-21.8 m. Vertical foliage density in native habitats ranged from 2-4 m, while foliage density in mixed native/exotic and monotypic exotic habitat was confined to the upper strata. Nesting substrate usually consists of salt cedar, Goodding's willow, Fremont cottonwood (*Populus fremontii*), mesquite, coyote willow, and snags (Koronkiewicz et al. 2004, McLeod et al. 2005, Munzer et al. 2005). Linear southwestern willow flycatcher habitat measures at least 10 m wide for nesting purposes. Although habitat less than 10 m wide will not be used for breeding, they will be used as stopover areas during migration (Sogge et al. 1997, Sogge and Marshall 2000).

Microclimate data collected along the Virgin and lower Colorado Rivers by Koronkiewicz et al. (2004) and McLeod et al. (2005) suggest that southwestern willow flycatcher select nesting habitat by proximity to water or saturated soils, diurnal temperature, and relative humidity. In native habitat where at least 90 % of the community is dominated by native vegetation, the average distance to water or saturated soils is 38.7 m. In exotic habitat where 90 % of the community consists of exotic vegetation, the average distance to water or saturated soils is 28.3 m. In mixed habitat where 50 to 90 % of the vegetation is dominated by either native or exotic plants, the average distance to water or saturated soils is 28.4 m. Mean diurnal temperature in native habitat is 28.7 degrees C while diurnal temperature in exotic habitat is 31.3 degrees C. Diurnal temperatures in mixed habitat averages 32.2 degrees C. Diurnal relative humidity averages 42.2 % in native habitat, 55 % in exotic habitat, and 49 % in mixed habitat.

The southwestern willow flycatcher has, as a result of its decline and subsequent listing as an endangered species, been relatively well studied. As such, scientists and land managers throughout the southwestern United States have identified a variety of planned or needed research.

Table 4. Generalized habitat requirements for southwestern willow flycatcher.

SOUTHWESTERN WILLOW FLYCATCHER GENERALIZED HABITAT REQUIREMENTS	
Community type[a]	Mixed, SC
Community structural type[b]	III, IV
Patch size	≥ 0.8 hectares
Linear habitat width / length	Unknown length / ≥ 10 meter width
Understory density	High
Foliage density	High
Foliage density height	2-4 meters
Canopy cover	High
Proximity to water	≤ 24 meters
Nesting period[c]	Mid-season, late
Nesting habitat selection based on microclimate[d]	Yes

[a] Although cottonwood and willow dominate yellow-billed cuckoo habitat, saltcedar is frequently found in the understory; mixed = native/non-native, CW = cottonwood willow; SC = monotypic saltcedar, W = monotypic willow.
[b] Community structural types as defined by Anderson and Ohmart (1976).
[c] Early = February - April, mid-season = May - June, late = July - September.
[d] Although not well understood, southwestern will flycatcher nest site selection is thought to be influenced, at least in part, by microclimate where humidity is high and temperature is cooler (Koronkiewicz et al. 2004, McLeod et al. 2005).

Riparian areas in the southwest are critically important to a variety of vertebrate taxa (Ellis et al. 1997, Auble and Scott 1998) and are possible only where a river or other water source provides a moisture substrate (Patten 1998). Although water management practices have been implicated in reducing the health of riparian communities (Busch and Smith 1995, Friedman et al. 1998), much remains to be learned about how such practices affect riparian vegetation and how water management can be altered to benefit riparian habitat and southwestern willow flycatcher. The effects of groundwater withdrawal or pumping, surface water movement, and dredging and channel bed alterations on riparian communities should be studied further (Stoleson et al. 2000).

Habitat characteristics at southwestern willow flycatcher breeding sites should continue to be quantified in terms of patch area and shape, proximity to water (Stoleson et al. 2000, Paradzick 2005), stand age and successional status, vertical structure, plant species composition, landscape matrix, climate and microclimate, and topography (Stoleson et al. 2000, Munzer et al. 2005). The relative importance of different habitat types to southwestern willow flycatcher may vary both seasonally and annually among sites, affecting observed home ranges and movement patterns. As such, telemetry studies involving fledgling and female southwestern willow flycatcher should be conducted to better understand family movements and fledgling dispersal patterns, and habitat use over time (Cardinal and Paxton 2005).

Features of habitat structure associated with nest parasitism may be related to nest searching behavior of brown-headed cowbird and should be investigated in future research. Community-wide studies should be investigated, since habitat features that decrease parasitism in some species may increase parasitism in others (Larison et al. 1998). Because parasitism rates vary with site, year, patch size, and southwestern willow flycatcher and brown-headed cowbird population sizes, sites should be monitored over multiple seasons (Finch et al. 2000). Although brown-headed cowbird parasitism has been found to negatively impact southwestern willow flycatcher populations, habitat destruction and modification are the primary causes of decline in southwestern willow flycatcher populations; brown-headed cowbird parasitism is merely a symptom. Therefore, habitat acquisition, improvement, and restoration must be given high priority and implemented in conjunction with brown-headed cowbird monitoring and, if necessary, control measures (Whitfield and Sogge 1999).

Although Durst (2004) was able to describe southwestern willow flycatcher diets as they pertain specifically to sites in Arizona, such data have yet to be collected along the lower Colorado River. To further quantify the effects of encroachment by exotic vegetation on southwestern willow flycatcher habitat, invertebrate sampling in occupied and unoccupied areas should be conducted. Furthermore, differences in the abundance and diversity of invertebrates between occupied and unoccupied habitat may help to further define southwestern willow flycatcher-specific habitat requirements.

Western Yellow-billed Cuckoo

Distribution

The summer distribution of the western yellow-billed cuckoo ranges throughout much of the United States, southeastern Canada, Greater Antilles, and Mexico, but range boundaries have been confused by recurrent observations of non-breeding individuals away from their breeding sites. Vagrants are not unusual on the Atlantic coast and Canadian prairies, and they are occasionally found as far away as Alaska and Western Europe (Bent 1940, Ehrlich et al. 1992, Hughes 1999).

Although once thought to be fairly common throughout the lower Colorado River Valley, the largest remaining western yellow-billed cuckoo population occurs in the Bill Williams Delta. Populations are apparently decreasing elsewhere in the valley (Anderson and Ohmart 1984, Rosenberg et al. 1991). Halterman (1998) suggests that the Bill Williams NWR is one of the few remaining places in the western United States were an apparently viable population of western yellow-billed cuckoo exists. Gaines (1974) suggests that the area above Laguna Dam on the Colorado River may be the last stronghold for western yellow-billed cuckoo in California.

In 2003, while conducting southwestern willow flycatcher surveys along the Virgin and lower Colorado rivers, Koronkiewicz et al. (2004) documented western yellow-billed cuckoo at Pahranagat NWR, Mormon Mesa, Topock Marsh, Bill Williams NWR, Imperial NWR and Yuma. In 2004, McLeod et al. (2005) documented cuckoos at Pahranagat NWR, Topock Marsh, Bill Williams NWR, and Yuma.

The western yellow-billed cuckoo’s winter range extends from northern South America to eastern Peru, Bolivia, and northern Argentina (Ehrlich et al. 1992).

Migration

The western yellow-billed cuckoo is one of the few species whose normal spring migration period extends well into mid June (Robbins et al. 1986). Along the lower Colorado River, the western yellow-billed cuckoo was reported as a fairly common breeder from June through August and a rare breeder in late May and early September (Phillips et al. 1964, Anderson and Ohmart 1984, Rosenberg et al. 1991). Halterman (1998) reports that most breeding pairs were not encountered at the Bill Williams NWR until early July, and a few pairs were not encountered until late July.

Habitat

Nesting habitat throughout much of the western yellow-billed cuckoo's range consists of trees or shrubs in open woodlands with dense undergrowth, extensive riparian woodlands, thickets, or parks (Ehrlich et al. 1992).

Mature cottonwood-willow stands provide the primary habitat in the lower Colorado River Valley. Willows or isolated cottonwoods mixed with tall mesquite (*Prosopis glandulosa* and *P. pubescens*) are also used but to a lesser extent. As a mid-summer breeder in the lower Colorado River Valley, the western yellow-billed cuckoo must be a nest-site specialist for cooling eggs. Mature cottonwoods, with willows forming a subcanopy layer, provide the best shading of any riparian habitat. Standing water found in many cottonwood-willow-dominated areas may also help reduce air temperature by evaporative cooling (Rosenberg et al. 1991).

On a 20-ha study plot along the Bill Williams River, Rosenberg et al. (1982) report that western yellow-billed cuckoo were most commonly found in stands of cottonwood and Goodding's willow with a patchy understory of salt cedar (*Tamarix chinensis*), cattails, and bulrush. Another study on the Bill Williams NWR documented that western yellow-billed cuckoo utilize extensive areas of willow, salt cedar, and cattails (Halterman 1998).

Western yellow-billed cuckoo in Arizona are most frequently found in cottonwood-willow and dense mesquite associations throughout the state (Phillips et al. 1964). In California Gaines (1974) only observed western yellow-billed cuckoo in areas where the extent of riparian vegetation exceeded 300 m in length and 100 m in width. No observations were made in narrow riparian strips 20-100 m wide. All observations were made within 100 m of water, and areas in which western yellow-billed cuckoo were found most frequently consisted of extensive riparian vegetation interspersed with lakes, sloughs, and/or marshy areas. Other reported characteristics of western yellow-billed cuckoo habitat included dense understory vegetation and willow thickets. Gaines also suggests that as much as 10 ha of river bottom vegetation per breeding pair may be required for nesting.

The relationship between habitat patch size and the proportion of patches that are occupied by western yellow-billed cuckoo has been found to be of considerable importance in defining nesting habitat in California (Laymon and Halterman 1989). Only 9.5 % of sites measuring between 20 and 40 ha were found occupied, while 100 % of sites measuring more than 80 ha in size were occupied. Along the lower Colorado River, 46.2 % of sites that were between 20 and 40 ha were occupied. One study site more than 80 ha in size was found to be occupied (Laymon and Halterman 1989).

Nesting

Nesting microhabitat is generally described as consisting of broad-leafed deciduous hardwoods with thick bushes, vines, or hedgerows providing dense foliage within 10 m of the ground (Laymon 1980, Hughes 1999). In arid regions nesting sites are usually restricted to river bottoms, ponds, marshes, and damp thickets with relatively high humidity (Gaines and Laymon 1984). Nests in the western United States are usually associated with willow, Fremont cottonwood, mesquite, hackberry (*Celtis* spp.), soapberry (*Sapindus saponaria*), alder, and cultivated fruit trees (Hanna 1937, Laymon 1980, Hughes 1999). At the Bill Williams NWR, 79 % of western yellow-billed cuckoo monitored in 1998 were found in cottonwood-willow-dominated habitat and 94 of 95 nests were found in willows specifically (Halterman 1998).

Based on four nests found in California, Laymon (1980) describes nest site characteristics as: height from ground ranging from 2.5-4.3 m, distance from trunk ranging from 4.0-4.5 m, distance from end of branch ranging from 0.3-1.0 m, percent foliage cover in area ranging from 70-85 %, foliage cover above nest ranging from 80-98 %, and distance of nest to foliage above ranging from 0.15-90 m. Nests were generally well concealed by surrounding foliage, especially from above.

At Bill Williams NWR, vegetation surveys determined that the average nest height was 5.8 m and ranged from 1.8 to 17.0 m. The average nest tree measured 9.2 m tall and 19.0 cm in diameter at breast height (DBH). The average canopy closure in nesting habitat was 78.7 %, and the amount of bare ground ranged from 65.8-18.6 %. Areas with low ground cover consisted primarily of grasses. Willows were the dominant tree species at nest sites (67.3%), followed by cottonwoods (18.5%) and salt cedar (14.3%). The shrub layer surrounding nests consisted mainly of salt cedar, although seep willow (*Baccharis glutinosa; B. salicifolia*) were also present. The percent canopy closure decreased as distance from the nest increased and measured 95 % directly beneath the nest. The maximum average tree foliage (3-5 m) was at nest height, suggesting that western yellow-billed cuckoo prefer to nest in trees where foliage density is highest (Halterman 1998).

Food Habits

The western yellow-billed cuckoo's diet consists mostly of insects, especially caterpillars (*Lepidoptera* spp.). It is also known to consume tree frogs, occasional bird eggs, berries, and other fruit (Ehrlich et al. 1992). Of six birds examined from the lower Colorado River, large insects made up the largest portion of western yellow-billed cuckoo diet. Cicadas (*Diceroprocta apache*) were apparently the western yellow-billed cuckoo's most important food item. Other food items included mantids (*Orthoptera* spp.), grasshoppers (*Orthoptera* spp.), and caterpillars (*Lepidoptera* spp.). Western yellow-billed cuckoo are also known to catch lizards and tree frogs (Rosenberg et al. 1991). On the Bill Williams River, grasshoppers were also considered an important food item. Rosenberg et al. (1982) and Halterman (1998) report that cicadas and katydids were the principal food items at the Bill Williams NWR. Young western yellow-billed cuckoo were fed cicadas, katydids, caterpillars, sphinx moth larvae, and grasshoppers. Adult males showed a preference for green Orthopterans while females preferred cicadas (Halterman 1998).

Rosenberg et al. (1991) report that of 48 observed foraging attempts, two-thirds occurred in willows and the remainder in cottonwoods. Nearly all attempts apparently occurred at more than 6 m above the ground. Based on telemetry studies of two western yellow-billed cuckoos at the Bill Williams NWR, it was determined that, although western yellow-billed cuckoo nest predominantly in willows, they prefer to forage in cottonwoods (Halterman 1998).

The onset of breeding appears to be correlated with an abundance of local food (Hamilton and Orians 1967, Rosenberg et al. 1982, 1991, Ehrlich et al. 1992). Once initiated, the breeding cycle occurs extremely rapidly and requires only 17 days from egg-laying to fledgling of young (Hamilton and Orians 1967, Hughes 1999). Large clutch sizes are thought to be a response by western yellow-billed cuckoo to the presence of excess food sources (Nolan and Thompson 1975, Fleischer et al. 1985).

Conservation and Management

Effects of Human Activity

Habitat studies along the lower Colorado River in Arizona suggested that 31 % (1,068 ha) of cottonwood-willow habitat was lost from 1976 to 1986 and resulted in a 16 % decrease in western yellow-billed cuckoo populations. Water releases from Alamo Dam in the 1970s and 1980s destroyed approximately 99 % of remaining cottonwoods and 64 % of willows. The estimated number of western yellow-billed cuckoo before flooding was approximately 13 birds per 40 ha. Post-flood populations were estimated at three western yellow-billed cuckoo per 40 ha (Groschupf 1987, Hughes 1999). Remnant fragments of riparian habitat are also being threatened by the encroachment of salt cedar. Laymon and Halterman (1987) report that cottonwood-willow communities present in 1977 are now monotypic stands of salt cedar that remain unused by western yellow-billed cuckoo. Historically, riparian communities were destroyed by agricultural conversion, submersion below reservoirs, and channelization for flood control (Halterman 2002). Pesticides are thought to affect western yellow-billed cuckoo behavior or cause death by direct contact. Pesticide spraying in orchards has exposed nests and young to sublethal poisoning (Laymon 1980). Pesticides also contaminate the cuckoo's preferred prey, especially *Lepidopteran* larva. Other prey species, such as frogs, occur in pesticide-contaminated runoff adjoining agricultural land. Shell fragments taken from three nests in California averaged 19 % thinner than shells collected from pre-DDT periods (Laymon and Halterman 1987). In Florida, Grocki and Johnston (1974) found that 15 of 16 individual birds collected during the spring and fall had DDT or its metabolites in interfurcular adipose tissue. Pesticide concentrations ranged from 0.01-3.34 parts per millions lipid weight. Average DDT concentrations were found to be higher in cuckoo collected during the fall than those collected during the spring, suggesting that pesticides may be excreted during migration or when over wintering. Pesticides may also be translocated to brain or muscle cells.

Degradation of Backwater Habitat

Flow-control structures, such as dams, have greatly altered connected streamside communities (Patten 1998) and destroyed much of the riparian communities once present along the lower Colorado River (Halterman 1998). Reductions in sediment loads, narrowing of channels, reduction in the recruitment of vegetation, and increase of flow velocities are known to contribute to the loss of riparian-wetland, marsh, and backwater communities (Brown and Johnson 1985, Collier et al. 1996, Auble and Scott 1998, Friedman et al. 1998). Remaining remnant riparian habitat fragments are being threatened by encroachment of exotic vegetation such as salt cedar. Monotypic stands of salt cedar generally increase the likelihood of catastrophic fire (Bock and Bock 1990, Smith et al. 1998) and may desiccate water courses (Vitousek 1990, DiTomaso 1998). Removal of groundwater, coupled with regulated flows, has contributed significantly to the loss of riparian communities and promoted erosion through the loss of stream bank stabilization by plant roots (Groeneveld and Griepentrog 1985).

Habitat Criterion and Research Needs for Assessing the Value of Habitat

Vegetation measurements taken at nest sites in 1998 determined that the average nest height was 5.8 m and ranged from 1.8-17.0 m (Table 5). The average nest tree measured 9.2 m tall and 19.0 cm DBH. The average canopy closure in nesting habitat was 78.7 %, and the amount of bare ground ranged from 65.8-18.6 %. Areas with low ground cover consisted primarily of grasses. Willows were the dominant tree species at nest sites (67.3 %), followed by cottonwoods (18.5 %) and salt cedar (14.3 %). The shrub layer surrounding nests consisted mainly of salt cedar, although seep willow was present also. The percent canopy closure decreased as distance from the nest increased and measured 95 % directly above the nest. The maximum average tree foliage (3-5 m) was at nest height, suggesting that western yellow-billed cuckoo prefer to nest in trees where foliage density is highest (Halterman 1998). During summer 2001 Halterman (2002) reported measurements that differed considerably from those reported in 1998. Average nest height was 7.3 m, average nest tree height was 10.3 m, and the average tree height was 9.7 m. Total canopy cover at the nest was 89.5 %, and all but one nest were found in Goodding's willow (Halterman 2002). Laymon and Halterman (1989) suggest narrow sites dominated by salt cedar should be considered poor habitat; however, western yellow-billed cuckoo found using these areas have been shown to nest successfully. Habitat use by western yellow-billed cuckoo may be too variable to allow the use of a single set of evaluation criteria. Such variability in habitat use suggests a need for continued long-term studies to evaluate habitat variables under varying conditions. Additionally, habitat preferences and requirements are not fully understood and should be studied further (Halterman 2002).

Based on multi-year surveys throughout California and along the Colorado River, Laymon and Halterman (1989) suggest that western yellow-billed cuckoo habitat requirements be redefined to include characteristics of microhabitat. Rosenberg et al. (1991) also indicate that microclimate may be a significant factor in selection of nesting habitat, since western yellow-billed cuckoo are mid-summer breeders and may be required to cool their eggs. That is, western yellow-billed cuckoos may select cottonwoods and willows for nesting habitat to shade from harmful temperatures and select cottonwood/willow groves with standing water to benefit from the evaporative cooling process (Rosenberg et al. 1991). Although such studies have been conducted since 1989 (Halterman 1998, Halterman 2002, Halterman 2004), much remains to be learned. Determining how and why western yellow-billed cuckoo are selecting habitat will improve the likelihood of successfully creating or restoring suitable habitat.

Even though widespread loss of riparian habitat has been implicated as the primary reason for decline of the western yellow-billed cuckoo (Laymon and Halterman 1987, Ehrlich et al. 1992), recent declines along the lower Colorado River, at the Bill Williams NWR, and in California do not appear highly correlated with large-scale losses of nesting habitat. A secondary factor, or combination of factors, is probably contributing to recent declines (Halterman 2002). Continued research should be conducted to identify secondary causes of declines in western yellow-billed

Table 5. Generalized habitat requirements for western yellow-billed cuckoo.

WESTERN YELLOW-BILLED CUCKOO GENERALIZED HABITAT REQUIREMENTS	
Community type[a]	CW, W
Community structural type[b]	I, III
Patch size	20-40 hectares
Linear habitat length/width	300 meters / 100 meters
Understory density	High
Foliage density	High
Foliage density height	$\leq$ 10 meters
Canopy cover	High
Proximity to water	$\leq$ 100 meters
Nesting period[c]	Mid-season, late
Nesting habitat selection based on microclimate	Unknown

[a] Although cottonwood and willow dominate yellow-billed cuckoo habitat, saltcedar is frequently found in the understory; mixed = native/non-native, CW = cottonwood willow; SC = monotypic saltcedar, W = monotypic willow.
[b] Community structural types as defined by Anderson and Ohmart (1976).
[c] Early = February - April, mid-season = May - June, late = July - September.

cuckoo populations. Laymon and Halterman (1987) suggested that pesticides may be at least partially responsible for these declines. Since western yellow-billed cuckoo are known to consume insects, tree frogs, and occasionally bird eggs (Ehrlich et al. 1992), the prevalence of pesticides in the western yellow-billed cuckoo's prey should be evaluated as well.

Although western yellow-billed cuckoo are known to successfully nest in salt cedar, changes from native vegetation to salt cedar and other exotic species are thought to alter available food resources and subsequently influence avian population abundance, distribution, and behavior (Kleintjes and Dahlsten 1994). In Arizona Durst (2004) reports significant differences between arthropod communities found in native, mixed, and exotic riparian habitats, as well as differences in southwestern willow flycatcher diets in each of these habitats. Implications associated with these types of changes with regards to the western yellow-billed cuckoo should be investigated to determine how to better manage exotic communities in an attempt to create native riparian communities along the lower Colorado River.

Laymon (1980) suggests that the possibility of captive breeding and reintroduction of western yellow-billed cuckoo to naturally regenerated or reforested riparian habitat should be investigated. Western yellow-billed cuckoo may recolonize portions of their former range if suitable habitat has been restored. Western yellow-billed cuckoo were found foraging on 11 ha of replanted sites in southern California in the second year and nesting during the third year following replanting. Western yellow-billed cuckoo recolonized areas only when cottonwood and willows grew to optimum height and foliage volume (Anderson and Laymon 1989).

Yellow-billed cuckoo nests occasionally are parasitized by the brown-headed cowbird. Clotfelter and Brush (1995) report the use of the western yellow-billed cuckoo as hosts by the bronzed cowbird (*Molothrus aeneus*) in south Texas and suggest that bronzed cowbird parasitism and egg puncturing of western yellow-billed cuckoo nests and eggs increases the frequency of nest abandonment, which may have contributed to the decline of the species. However, little information is known of the frequency of parasitism of the western yellow-billed cuckoo along the Bill Williams and lower Colorado Rivers. Therefore, additional research is needed to investigate the frequency and impact of parasitism on the western yellow-billed cuckoo within the lower Colorado River Valley. Community-wide studies should be pursued since habitat features that decrease parasitism in some species may increase parasitism in others (Larison et al. 1998).

It has been suggested that yellow-billed cuckoos, because they are late arrivals to the lower Colorado River Valley, may select nesting habitat based at least in part on nest site microclimate to keep nests and eggs cool. Prior to implementation of yellow-billed cuckoo habitat restoration plan, studies should specifically target microclimate and investigate the significance of nest microclimate on habitat suitability.

Conclusions

As mentioned in the preceding avian profiles, the primary threat to all backwater, marsh, and riparian obligate species described is loss or degradation of habitat. As a highly managed and regulated system, the lower Colorado River is not the dynamic and highly variable system it once was. The decrease of periodic flooding and sediment deposition, coupled with increased flow velocities and other factors, has contributed to the degradation or loss of stream side communities. Furthermore, such conditions have promoted the encroachment of non-native vegetation such as salt cedar and common cane to name a few.

Changes to stream-side communities have wide ranging implications to all bird species. Their responses to such changes can be highly variable, since they tend to utilize habitat and other available resources differently. For example, sediment deposition resulting from the construction of dams has created suitable habitat for the Yuma clapper rail, which is thought to have allowed it to extend its range northward into areas where it historically wasn't found. Additionally, Yuma clapper rail have been shown to change habitat requirements seasonally; however; shallow water and emergent vegetation interspersed with high ground are considered vital components of suitable Yuma clapper rail habitat regardless of season. Although the California black rail is also considered a marsh obligate species, it appears to prefer the transition zone between marsh and upland communities. Also, it is not known to alter habitat requirements seasonally. As such, California black rail appear to be considerably more vulnerable to fluctuations in water levels than Yuma clapper rail and other marsh species. It has been suggested that creation of habitat suitable for Yuma clapper rail may also benefit the California black rail. Indeed, such a possibility may be true during certain seasons and should be investigated further. However, structure of habitat and fluctuation of water levels are thought to be the limiting factors in determining whether or not habitat will be utilized. California black rail have been shown to utilize dense emergent vegetation almost exclusively. Yuma clapper rail, on the other hand, have been shown to utilize both dense and moderately dense communities and alter habitat requirements seasonally. Additionally, Yuma clapper rail have been shown to tolerate high water levels by moving to high ground. However, such responses by California black rail have not been documented. Given these differences, newly created habitat targeted specifically for the Yuma clapper rail may not necessarily benefit the Yuma black rail.

Although different species may require similar habitat, it is clear that structure is important in dictating whether or not these birds will utilize available habitat. Studies designed to quantify such differences may provide information on how to best create suitable habitat for more than a single species. Although marsh size has not been shown to be important to species such as the Yuma clapper rail, creation of larger marshes would likely promote structural diversity, as opposed to small habitat patches where a single structural type would prevail.

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CHAPTER 3: MAMMALS

Currently, the Colorado River cotton rat (*Sigmodon arizonae plenus*) is believed to be disjunct from other populations of *S. arizonae*, which occur in a variety of habitats throughout Arizona and California (Hoffmeister 1986, Blood 1998). As such, the species is limited in distribution to a narrow band of mesic habitat along the lower Colorado River, although the distributional limits of *S. a. plenus* along the Colorado River have yet to be established, and the southern extent of its range are still unknown (Blood 1998). Federally, the Colorado River cotton rat is listed as a Candidate 2 species and a species of special concern in California (Blood 1998).

Generally, *S. a. plenus* is described as a pallid species that most closely resembles *Sigmodon hispidus eremicus*, although much larger in size. Underparts of *S. a. plenus* are pale buff in color, and the rump is rusty. The ears and feet are dull white or gray, and the tail is light brown above and dull gray beneath. *S. a. plenus* measures approximately 294 mm TL, the body measures 164.3 mm long, and the tail is approximately 129.7 mm long (Hoffmeister 1986).

Based on the loss of previously occupied habitat and the lack of trapping success in southern Nevada, isolated cotton rat populations are thought to have gone extinct (Bradley 1966).

Colorado River Cotton Rat

Distribution

The Arizona cotton rat (*Sigmodon arizonae*), as a species, is distributed from northern Yuma County near Ft. Whipple and Camp Verde south and southeast to southern Gila and southwestern Graham counties, and all but the northeastern corner of Cochise County. The Colorado River cotton subspecies, however, is thought to be limited to northwestern Yuma County along the Colorado River from Parker to Ehrenberg (Hoffmeister 1986).

In Nevada, Hall (1946) describes the Colorado River cotton rat's range as restricted to the bottomlands of the Colorado River at the extreme southern tip of the state. Colorado River cotton populations once occurring along the river in Nevada are now thought to be extinct (Hall 1946, Bradley 1966).

Grinnell (1914) reports having collected Colorado River cotton rat from along the California side of the Colorado River. Specimens were collected from an area located a several kilometers south of Palo Verde, 8 km northeast of Yuma, and from an area near Pilot Knob. Although described by Grinnell (1914) as *S. hispidus eremicus*, Hoffmeister (1986) believed that, based on measurements reported by Grinnell, the species was most likely *S. arizonae* and probably *S. a. plenus*. Goldman (1928) reports Colorado River cotton rats from only three locations in California: Needles; Colorado River opposite Parker, Arizona; and 24 km southwest of Ehrenberg, Arizona. The distribution was apparently spotty, rather than continuous.

Currently, the distributional limits of Colorado River cotton rat along the Colorado River have yet to be established, and the southern extent of its range are still unknown (Blood 1998). Generally, Colorado River cotton rat are thought to be restricted in distribution to the mesic habitats of the lower Colorado River Valley and believed to avoid the xeric conditions of the surrounding desert (Grinnell 1914, Goldman 1928, Hoffmeister 1986).

Systematics

Four subspecies of *S. arizonae* have been described and include *arizonae, plenus, cienegae,* and *jacksoni* (Hoffmeister 1986). Although initially described by Goldman (1928) as *S. hispidus plenus*, Zimmerman (1970) showed that *S. hispidus* and *S. arizonae* differed greatly in chromosome number and structure, and were distinguishable in skeletal structure.

Habitat

Arizona cotton rats generally occupy arid desert habitat composed of mesquite tumbleweed (*Salsola* spp.), and sparse grasses (Hoffmeister 1986). The Colorado River cotton rat, however, is generally thought to be restricted to isolated sections of alluvial bottom along the Colorado River (Goldman 1928) and has demonstrated a strong distributional association with patterns of irrigation canals (Hoffmeister 1986).

Grinnell (1914) reports that Colorado River cotton rats were found in a tule (*Scirpus acutus*) patch at the edge of a slough adjacent to a dense stand of seedling willow. Northeast of Yuma, Grinnell found Colorado River cotton rats in wiregrass (*Cynodon dactylon*) bordering a backwater near a stand of young willow. Near Pilot Knob, Colorado River cotton rats were reported in cane (*Phragmites* spp.) surrounded by dense arroweed (*Pluchea sericea*). Generally, Grinnell found that Colorado River cotton rats occupied cottonwood willow communities where the dominant vegetation consisted of willow, Fremont cottonwood, baccharis (*Baccharis glutinos; B. salicifolia*), and common reed. Grinnell also noted that Colorado River cotton rats were common in irrigated agricultural fields.

In Nevada Colorado River cotton rats were found on a tract of less than 0.4 ha in size with flowing water and cattail. The surrounding upland communities consisted of bermudagrass (*Cynodon dactylon*) and mesquite. The Colorado River cotton rats were found living just above water level and created runways that passed through 2.5 cm or more of water. Runways measured approximately 8 cm in width and were made by either cutting grass near its base or by running over grass and pushing it down (Hall 1946).

Blood (1998) suggests that Colorado River cotton rat along the Colorado River may have expanded their range by occupying agricultural fields. He also reports (Blood 1990) capturing Colorado River cotton rat in disturbed and open areas. Trapping efforts in grassy habitats along the Colorado River resulted in no captures. Zimmerman (1970) reports capturing *S. a. plenus* in stands of common reed near Parker, Arizona.

Nesting

Nesting habitat is largely unknown, although Hall (1946) reported that the Colorado River cotton rat were found living just above the water line in Nevada. Similar species, including *S. hispidus eremicus* (Goldman 1928), are thought to be restricted in distribution to the lower Colorado River

Valley and have been taken from areas dominated by *Pluchea, Typha,* and *Phragmites* (Hoffmeister 1986). *S. h. eremics* is known to nest beneath rocks, logs, and in burrows.

Food Habits

Specific details on the feeding habits of the Colorado River cotton rat are unknown; however, similar species, such as *S. hispidus,* are largely herbivorous and diets usually consist of stems, foliage, seeds, insects, and small vertebrates (Martin et al. 1961).

Conservation and Management

Effects of Human Activity

Flow-control structures, such as dams, have greatly altered connected streamside communities (Patten 1998) and destroyed many of the backwater communities once present along the lower Colorado River. Reductions in sediment loads, narrowing of channels, reduction in the recruitment of vegetation, and increase of flow velocities are known to contribute to the loss of riparian-wetland, marsh, and backwater communities (Brown and Johnson 1985, Collier et al. 1996, Auble and Scott 1998, Friedman et al. 1998). Marshlands on the lower Colorado River are threatened by encroachment of salt cedar, *Phragmites*, and other exotics. Salt cedar generally increases the likelihood of catastrophic fire (Bock and Bock 1990, Smith et al. 1998) and may desiccate water courses (Vitousek 1990, DiTomaso 1998). Removal of groundwater, coupled with regulated flows, has contributed significantly to the loss of riparian communities and promoted erosion through the loss of stream bank stabilization by plant roots (Groeneveld and Griepentrog 1985). In contrast, human activity may potentially benefit the Colorado River cotton rat. Along the Colorado River, Blood (1990) captured individuals only in disturbed agricultural fields, while Grinnell (1914) noted that cotton rats were common in irrigated fields.

Degradation of Backwater Habitat

Marsh and backwaters that historically occurred along the lower Colorado River have been destroyed or severely degraded by agricultural conversion, construction of reservoirs, river channelization, and shoreline stabilization. Given the regulated nature of the Colorado River, natural formation of new marshes and backwaters resulting from channel movement and periodic flooding is now unlikely. However, flow regulation and shifts in the timing of flows for water diversion have resulted in the development of large marsh and backwater complexes where riparian vegetation historically occurred. Marsh complexes developed behind Imperial Dam and Parker Dam at the Bill Williams Delta and Topock Marsh. The construction of training structures also created areas of more expansive and permanent backwaters and marshes than had occurred historically on the lower Colorado River (MSCP 2004).

Habitat Criterion and Research Needs for Assessing the Value of Habitat

The Colorado River cotton rat is thought to require habitat dominated by emergent vegetation including common reed, bulrush, and cattails (Table 6). Other species include willow, cottonwood, baccharis, bermudagrass, and arroweed. However, specific habitat requirements (e.g., stem density, vegetation height, water depth) for the Colorado River cotton rat are unclear. Studies are needed to better discern optimal structural components needed by the cotton rat along the Colorado River. In addition, Colorado River cotton rats are known to occupy – and some research indicates they prefer – disturbed agricultural fields and exhibit a strong distributional association with irrigation

Table 6. Generalized habitat requirements for Colorado River cotton rat.

COLORADO RIVER COTTON RAT GENERALIZED HABITAT REQUIREMENTS	
Community type	Agriculture/cottonwood-willow
Structural type	Unknown
Proximity to water	Close
Patch size	Unknown
Water depth	Unknown
Water fluctuation	Unknown
Seasonal requirements	Unknown
Nesting requirements	Unknown

canals. Additional research is needed to discern why such areas are beneficial over native habitat. Specifically, studies should attempt to define Colorado River cotton rat distributions and determine if distribution is seasonally variable. If distribution is seasonal, studies should attempt to identify seasonal differences in habitat type and structure. Studies should also attempt to identify soil types associated with suitable habitat and how soil types might influence nesting and burrowing. Patch or habitat size requirements are largely unknown and should be the target of future studies along with implications of daily fluctuations in water on habitat suitability. Studies should also attempt to address nesting habits and their relationship with water velocity and fluctuation. Finally, studies should seek to determine where suitable habitat is located relative to upland areas, marsh and riparian communities.

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