II. BIOLOGY, ECOLOGY, AND STATUS

A. Taxonomy

The willow flycatcher is one of 11 flycatchers in the genus *Empidonax* (Order Passeriformes, Family Tyrannidae) breeding in North America. Although the *Empidonax* flycatchers are notoriously difficult to distinguish by sight in the wild, each has unique morphological features, vocalizations, habitats, behaviors and/or other traits that allow biologists to distinguish them.

The willow flycatcher was described by J.J. Audubon from a specimen taken along the Arkansas River in the early 1800s (Audubon 1831); he named it *Muscicapa traillii*. Since then, the species has undergone a series of name changes and species/subspecies designations (see Aldrich 1951, Browning 1993). Prior to 1973, the willow flycatcher and alder flycatcher (*E. alnorum*) were treated together as the Traill's flycatcher (*E. traillii*) (AOU 1957). Subsequent work established that they are two separate species (Stein 1958, 1963, Seutin and Simon 1988, Winker 1994), and the American Ornithologists' Union accepted that classification (AOU 1973). Some sources (AOU 1983, McCabe 1991) also treat *E. traillii* and *E. alnorum*, and all their subspecies, as a "superspecies," the "*traillii* complex." However, the two flycatchers are distinguishable by morphology (Aldrich 1951, Unitt 1987), song type, habitat use, structure and placement of nests (Aldrich 1953, Gorski 1969), eggs (Walkinshaw 1966), ecological separation (Barlow and McGillivray 1983), and genetics (Seutin and Simon 1988, Winker 1994, Paxton and Keim unpubl. data). The breeding range of the alder flycatcher generally lies north of the willow flycatcher's range.

The southwestern willow flycatcher is one of four subspecies of the willow flycatcher (Figure 1) currently recognized (Hubbard 1987, Unitt 1987), though Browning (1993) posits a fifth subspecies (*E. t. campestris*) in the central and midwestern U.S. The willow flycatcher subspecies are distinguished primarily by subtle differences in color and morphology, and by habitat use. The southwestern subspecies *E. t. extimus* was described by Phillips (1948), and its taxonomic status has been accepted by most authors (Aldrich 1951, Bailey and Niedrach 1965, Behle and Higgins 1959, Hubbard 1987, Phillips et al. 1964, Oberholser 1974, Monson and Phillips 1981, Unitt 1987, Schlorff 1990, Browning 1993, USFWS 1995). Recent research (Paxton 2000) concluded that *E. t. extimus* is genetically distinct from the other willow flycatcher subspecies.

The southwestern willow flycatcher is generally paler than other willow flycatcher subspecies, and also differs in morphology, e.g., wing formula, bill length, and wing:tail ratio (Unitt 1987 and 1997, Browning 1993). These differences require considerable experience, training, and reference study skins to distinguish, and are not reliable characteristics for field identification. Evidence also suggests song form differences among some willow flycatcher subspecies (Sedgwick 2001); these differences may serve as another parameter to distinguish the subspecies, although variations within subspecies may occur as well (Travis 1996, Sedgwick 1998).

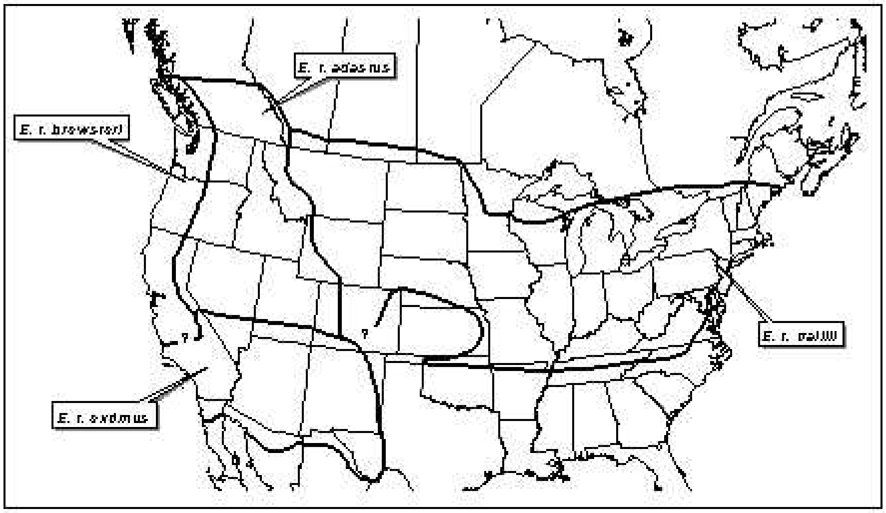

Figure 1. Breeding ranges of the subspecies of the willow flycatcher (*Empidonax traillii*).
From Sogge et al. (1997b), adapted from Unitt (1987), Browning (1993).

B. Range and Distribution

The historical breeding range of the southwestern willow flycatcher included southern California, southern Nevada, southern Utah, Arizona, New Mexico, western Texas, southwestern Colorado, and extreme northwestern Mexico (Figures 1 and 3[Fig. 3 follows page 68]; Hubbard 1987, Unitt 1987, Browning 1993). The flycatcher's current range is similar to the historical range, but the quantity of suitable habitat within that range is much reduced from historical levels. The flycatcher occurs from near sea level to over 2600 m (8500 ft), but is primarily found in lower elevation riparian habitats. Throughout its range, the flycatcher's distribution follows that of its riparian habitat; relatively small, isolated, widely dispersed locales in a vast arid region. Marshall (2000) found that 53% of southwestern willow flycatchers were in just 10 sites (breeding groups) rangewide, while the other 47% were distributed among 99 small sites of ten or fewer territories. In some parts of its northern range, questions of range boundaries between other willow flycatcher subspecies exist, including possible intergradations between subspecies. In California (see Figures 1 and 3), individuals of *E. t. extimus* and *E. t. brewsteri* are morphologically fairly distinct, even where their ranges are near one another (Unitt 1987). However, in southern Utah, southwestern Colorado, and perhaps northern New Mexico, there may be fairly broad clinal gradations between the southwestern willow flycatcher and the Great Basin/Rocky Mountain race *E. t. adastus* (Unitt 1987). Phillips et al. (1964)

suggested that *E. t. extimus* may be typical of lower elevations, noting that willow flycatchers from high elevations in eastern Arizona had some characteristics of *E. t. adastus*. Therefore in northern parts of the southwestern willow flycatcher's range, clinal gradations with *E. t. adastus* may exist with increasing elevation, as well as latitude. Recent genetic work by Paxton (2000) verified *extimus* genetic stock in south-central Colorado (i.e., San Luis Valley) and southwestern Utah (e.g., Virgin River). Overall, Paxton (2000) showed that the northern boundary for extimus was generally consistent with that proposed by Unitt (1987) and Browning (1993). This recovery plan adopts a range boundary that reflects these results. However, because of the absence of flycatchers in the lower to mid elevations of the Colorado Plateau in southern Utah and Southwestern Colorado, Paxton (2000) did not address potential sub-specific differences resulting from elevation or habitat differences and watershed boundaries. The Service recognizes that future data may result in refinements to the northern boundary. Records of probable breeding flycatchers in Mexico are few and are restricted to extreme northern Baja California del Norte and northern Sonora (Unitt 1987, Wilbur 1987). The flycatcher's wintering range includes southern Mexico, Central America, and probably South America (Stiles and Skutch 1989, Howell and Webb 1995, Ridgely and Gwynne 1989, Unitt 1997, Koronkiewicz et al. 1998, Unitt 1999). State-by-State summaries follow:

1. California

Historically, the southwestern willow flycatcher was common in all lower elevation riparian areas of the southern third of California (Wheelock 1912, Willett 1912 and 1933, Grinnell and Miller 1944), including the Los Angeles basin, the San Bernardino/Riverside area, and San Diego County (Unitt 1984, 1987). River systems where the flycatcher persists include the Colorado, Owens, Kern, Mojave, Santa Ana, Pilgrim Creek, Santa Margarita, San Luis Rey, San Diego, San Mateo Creek, San Timoteo Creek, Santa Clara, Santa Ynez, Sweetwater, San Dieguito, and Temecula Creek (Whitfield 1990, Holmgren and Collins 1995, Kus 1996, Kus and Beck 1998, Whitfield et al. 1998, McKernan and Braden 1999, L. Hays unpubl. data, Griffith and Griffith in press, W. Haas pers. comm., B. Kus pers. comm. and unpubl. data, McKernan unpubl. data).

2. Arizona

The historical range of the flycatcher in Arizona included portions of all major watersheds (H. Brown 1902 unpubl. data, Willard 1912, Swarth 1914, Phillips 1948, Unitt 1987). Contemporary investigations (post-1990) show the flycatcher persists, probably in much reduced numbers, along the Big Sandy, Bill Williams, Colorado, Gila, Hassayampa, Little Colorado, Salt, San Francisco, San Pedro, Santa Cruz, Santa Maria, Tonto Creek, and Verde river systems (Sferra et al. 1997, Sogge et al. 1997a, McKernan and Braden 1999, Paradzick et al. 1999, Tibbitts and Johnson 1999, Smith et al. 2002).

3. New Mexico

The historic breeding range of the flycatcher is considered to have been primarily from the Rio Grande Valley westward, including the Rio Grande, Chama, Zuni, San Francisco, and Gila watersheds (Bailey 1928, Ligon 1961, Hubbard 1987); breeding was unconfirmed in the San Juan and Pecos drainages (Hubbard 1987). Contemporary surveys documented that flycatchers persist in the Rio Grande, Chama, Zuni, San Francisco, and Gila watersheds and that small breeding populations also occur in the San Juan drainage and along Coyote Creek in the Canadian River drainage, but breeding remains unconfirmed in the Pecos watershed (Maynard 1995, Cooper 1996, Cooper 1997, Williams and Leal 1998, S. Williams, pers. comm.). The Gila Valley was identified by Hubbard (1987) as a stronghold for the taxon, and recent surveys have confirmed that area contains one of the largest known flycatcher populations (Skaggs 1996, Stoleson and Finch 1999). The subspecific identity (*E. t. extimus*. vs. *E. t. adastus*) of willow flycatchers in northern New Mexico has been problematical (Hubbard 1987, Unitt 1987, Maynard 1995, Travis 1996), but recent genetic research supports affiliation with *E.t. extimus* (Paxton 2000).

4. Texas

The eastern limit of the southwestern willow flycatcher's breeding range is considered to be in the Trans-Pecos region of western Texas (Unitt 1987), where presumably breeding flycatchers were reported from Fort Hancock on the Rio Grande (Phillips 1948), the Davis Mountains, including a reported nest with young in July 1890 (Oberholser 1974), Big Bend National Park (Wauer 1973, 1985), and possibly the Guadalupe Mountains (Phillips, pers. comm., cited in Unitt 1987). Current status in Texas is essentially unknown; no recent survey data are available.

5. Utah

The north-central limit of the flycatcher's breeding range is in southern Utah. Historically, the bird occurred in the following river systems: Colorado, Kanab Creek, San Juan (Behle et al. 1958, Behle and Higgins 1959, Behle 1985, Browning 1993), Virgin (Phillips 1948, Wauer and Carter 1965, Whitmore 1975), and perhaps Paria (BLM, unpubl. data). Behle and Higgins (1959) suggested that extensive habitat likely existed along the Colorado River and its tributaries in Glen Canyon. Contemporary investigations verified probable breeding flycatchers along the upper Virgin River, and Panguitch Creek (Langridge and Sogge 1998, Peterson et al. 1998, USFWS unpubl. data), but failed to locate breeders along the San Juan (Johnson and Sogge 1997, Johnson and O'Brien 1998). The subspecific identity (*E. t. extimus* vs. *E. t. adastus*) of willow flycatchers in high elevation/central Utah remains somewhat unresolved (Behle 1985, Unitt 1987, Browning 1993), and requires additional research.

6. Nevada

The historical status of the flycatcher at its range limit in southern Nevada is unclear; Unitt (1987) reported only three records, all before 1962. Contemporary investigations (post-1990) have verified breeding flycatchers on the Virgin River and Muddy River, the Amargosa River drainage at Ash Meadows NWR, Meadow Valley Wash, and the Pahranagat River drainage (McKernan and Braden 1999, Micone and Tomlinson 2000, USFWS unpubl. data).

7. Colorado

The historic and current breeding status of the southwestern willow flycatcher in Colorado is unclear (USFWS 1995). Hubbard (1987) believed the subspecies ranged into extreme southwestern Colorado, Browning (1993) was noncommittal, and Unitt (1987) tentatively used the New Mexico-Colorado border as the boundary between *E. t. extimus* and *E. t. adastus*. Several specimens taken in late summer have been identified as *E. t. extimus*, but nesting was not confirmed (Bailey and Niedrach 1965). Breeding willow flycatchers with genetic characteristics of the southwestern subspecies occur at Alamosa National Wildlife Refuge and McIntire Springs, but flycatchers from Beaver Creek and Clear Creek (Andrews and Righter 1992, Owen and Sogge 1997) did not have the southwestern subspecies genetic characteristics (Paxton 2000). There is much riparian habitat in southwestern Colorado that has not yet been surveyed for willow flycatchers; additional populations may be found with increased survey effort.

8. Mexico

The breeding status of the flycatcher in Mexico is unclear. Russell and Monson (1998) accepted no evidence that willow flycatchers ever nested in Sonora. However, several specimens from Sonora and Baja California del Norte are accepted as breeding evidence by others (Unitt 1987, Wilbur 1987, Browning 1993). In the more general treatments of field guides, where supporting evidence is not cited, the willow flycatcher is described as breeding in northern portions of Baja California del Norte and Sonora (Blake 1953, Peterson and Chalif 1973, Howell and Webb 1995). Based on the apparent historical abundance on the lower Colorado River near the U.S. - Mexico border before construction of dams, and current presence, it is likely that the flycatcher was present, perhaps abundant, in the Colorado River's delta in Mexico. Given the presence of flycatchers along the Rio Grande in southern New Mexico and the existence of riparian habitat along some drainages in northern Mexico, southwestern willow flycatchers may also breed in northern Chihuahua.

C. Habitat Characteristics

1. Overview and General Habitat Composition

The breeding habitat of the southwestern willow flycatcher is discussed in depth in Appendix D, and in Sogge and Marshall (2000). The flycatcher breeds in different types of dense riparian habitats, across a large elevational and geographic area. Although other willow flycatcher subspecies in cooler, less arid regions may breed more commonly in shrubby habitats away from water (McCabe 1991), the southwestern willow flycatcher usually breeds in patchy to dense riparian habitats along streams or other wetlands, near or adjacent to surface water or underlain by saturated soil. Common tree and shrub species comprising nesting habitat include willows (*Salix* spp.), seepwillow (aka mulefat; *Baccharis* spp.), boxelder (*Acer negundo*), stinging nettle (*Urtica* spp.), blackberry (*Rubus* spp.), cottonwood (*Populus* spp.), arrowweed (*Tessaria sericea*), tamarisk (aka saltcedar; *Tamarix ramosissima*), and Russian olive (*Eleagnus angustifolia*) (Grinnell and Miller 1944, Phillips et al. 1964, Hubbard 1987, Whitfield 1990, Brown and Trosset 1989, Brown 1991, Sogge et al. 1993, Muiznieks et al. 1994, Maynard 1995, Cooper 1996, Skaggs 1996, Cooper 1997, McKernan and Braden 1998, Stoleson and Finch 1999, Paradzick et al. 1999). Habitat characteristics such as plant species composition, size and shape of habitat patch, canopy structure, vegetation height, and vegetation density vary across the subspecies' range. However, general unifying characteristics of flycatcher habitat can be identified. Regardless of the plant species composition or height, occupied sites usually consist of dense vegetation in the patch interior, or an aggregate of dense patches interspersed with openings. In most cases this dense vegetation occurs within the first 3 - 4 m (10-13 ft) above ground. These dense patches are often interspersed with small openings, open water, or shorter/sparser vegetation, creating a mosaic that is not uniformly dense. In almost all cases, slow-moving or still surface water and/or saturated soil is present at or near breeding sites during wet or non-drought years.

Thickets of trees and shrubs used for nesting range in height from 2 to 30 m (6 to 98 ft). Lower-stature thickets (2-4 m or 6-13 ft) tend to be found at higher elevation sites, with tall stature habitats at middle and lower elevation riparian forests. Nest sites typically have dense foliage from the ground level up to approximately 4 m (13 ft) above ground, although dense foliage may exist only at the shrub level, or as a low dense canopy. Nest sites typically have a dense canopy, but nests may be placed in a tree at the edge of a habitat patch, with sparse canopy overhead. The diversity of nest site plant species may be low (e.g., monocultures of willow or tamarisk) or comparatively high. Nest site vegetation may be even- or uneven-aged, but is usually dense (Brown 1988, Whitfield 1990, Muiznieks et al. 1994, McCarthey et al. 1998, Sogge et al. 1997a, Stoleson and Finch 1999).

Historically, the southwestern willow flycatcher nested in native vegetation such as willows, buttonbush, boxelder, and *Baccharis*, sometimes with a scattered overstory of cottonwood (Grinnell and Miller 1944, Phillips 1948, Whitmore 1977, Unitt 1987). Following modern changes in riparian plant communities, the flycatcher still nests in native vegetation where available, but also nests in thickets dominated by the non-native tamarisk and Russian olive and in habitats where native and non-native trees and shrubs are present in essentially even mixtures (Hubbard 1987, Brown 1988, Sogge et al. 1993, Muiznieks et al. 1994, Maynard 1995, Sferra et al. 1997, Sogge et al. 1997a, Paradzick et al. 1999). The number of nests in different broad habitat types (e.g., dominated by native, exotic, and mixed native-exotic plant associations) is presented in Table 1.

Table 1 . Number of known southwestern willow flycatcher territories located within major vegetation/habitat types, by Recovery Unit. Data are from Sogge et al. 2002, based on last reported habitat and survey data for all sites where flycatchers were known to breed, 1993-2001. See Section IV.A. for definition of Recovery Units.

	Recovery Unit						
Vegetation Type	Basin & Mojave	Coastal California	Gila	Lower Colorado	Rio Grande	Upper Colorado	Total
Native (>90%)	63	109	188	37	68	3	468
Mixed native/exotic (>50% native)	3	49	77	56	46		231
Mixed exotic/native (>50% exotic)			108	50	3		161
Exotic (>90%)			77	2	11		90
Not reported	3	28	4	1			36
Total	69	186	454	146	128	3	986

Habitats Dominated by Native Plants

Occupied sites dominated by native plants vary from single-species, single-layer patches to multi-species, multi-layered strata with complex canopy and subcanopy structure. Site characteristics differ substantially with elevation. Low to mid-elevation sites range from single plant species to mixtures of native broadleaf trees and shrubs including willows, cottonwood, boxelder, ash (*Fraxinus* sp.), alder (*Alnus* sp.), blackberry, and nettle. Average canopy height can be as short as 4 m (13 ft) or as high as 30 m (98 ft). High-elevation nest sites dominated by native plants are more similar to each other than low elevation native sites. Most known high elevation (>1,900 m / 6,230 ft) breeding sites are comprised completely of native trees and shrubs, and are dominated by a single species of willow, such as coyote willow (*Salix exigua*) or Geyer's willow (*S. geyeriana*). However, Russian olive is a major habitat component at some high elevation breeding sites in New Mexico. Average canopy height is generally only 3 to 7 m (10-23 ft). Patch structure is characterized by a single vegetative layer with no distinct overstory or understory. There is usually dense branch and twig structure in the lower 2 m (6.5 ft), with high live foliage density from the ground to the canopy. Tree and shrub vegetation is often associated with sedges, rushes, nettles and other herbaceous wetland plants. These willow patches are usually found in mountain meadows, and are often associated with stretches of stream or river that include beaver dams and pooled water.

Habitats of Mixed Native and Exotic Plants

Southwestern willow flycatchers also breed in sites comprised of dense mixtures of native trees and shrubs mixed with exotic/introduced species such as tamarisk or Russian olive. The exotics are often primarily in the understory, but may be a component of overstory. At several sites, tamarisk provides a dense understory below an upper canopy of gallery willows or cottonwoods, forming a habitat that is structurally similar to the cottonwood-willow habitats in which flycatchers historically nested. A particular site may be dominated primarily by natives or exotics, or be a more-or-less equal mixture. The native and exotic components may be dispersed throughout the habitat or concentrated in distinct, separate clumps within a larger matrix. Generally, these habitats are found below 1,200 m (3,940 ft) elevation.

Habitats Dominated by Exotics Plants

Southwestern willow flycatchers also nest in some riparian habitats dominated by exotics, primarily tamarisk and Russian olive. Most such exotic habitats range below 1,200 m (3940 ft) elevation, and are nearly monotypic, dense stands of tamarisk or Russian olive that form a nearly continuous, closed canopy with no distinct overstory layer. Canopy height generally averages 5 to 10 m (16 - 33 ft), with canopy density uniformly high. The lower 2 m (6.5 ft) of vegetation is often comprised of dense, often dead, branches. However, live foliage density may be relatively low from 0 to 2 m (6.5 ft) above ground, but increases higher in the canopy. The flycatcher does not nest in all of the exotic species that can dominate riparian systems. For example, flycatchers rarely use giant reed (*Arundo donax*) and are not known to use tree of heaven (*Ailanthus altissima*).

Forty-seven percent of willow flycatcher territories occur in mixed native/exotic habitat (> 10% exotic) and twenty-five percent are at sites where tamarisk is dominant (Sogge et al. 2000). Flycatchers nest in tamarisk at many river sites, and in many cases, use tamarisk even if native willows are present (Table 2) (Sferra et al. 2000). Southwestern willow flycatchers nest in tamarisk at sites along the Colorado, Verde, Gila, San Pedro, Salt, Bill Williams, Santa Maria, and Big Sandy rivers in Arizona (McCarthey et al. 1998), Tonto Creek in Arizona (McCarthey et al. 1998), the Rio Grande and Gila rivers in New Mexico (Hubbard 1987, Maynard 1995, Cooper 1995, Williams, unpubl. data), and the San Dieguito, lower San Luis Rey, and Sweetwater rivers in California (Kus, unpubl. data), Meadow Valley Wash (Tomlinson, unpubl. data), and Virgin River in Nevada (McKernan and Braden 1999). Rangewide, 86% of nests were in tamarisk in mixed and exotic habitats. In Arizona, 93% of the 758 nests documented from 1993 - 1999 in mixed and exotic habitats were in tamarisk. This distribution is similar on an annual basis in Arizona, where in 1999, 92% of the 303 nests in mixed and exotic habitats were in tamarisk (Paradzick et al. 2000). In addition to the tamarisk, three other exotics have been used as nesting substrates. Two nests were documented in giant reed (Greaves, pers. comm.) in California, 26 nests were documented in Russian olive and one nest was documented in Siberian elm (*Ulmus pumila*) in New Mexico (Stoleson and Finch, unpubl. data).

Table 2. Relative abundance of southwestern willow flycatcher nests, by substrate for rangewide data compiled from 1993 - 1999, including some data from 2000 (Sferra et al. 2000). Percents are expressed in relation to total number of nests for each habitat type. Number of nests is shown in parentheses. Native habitats are those with < 10% cover of exotic plant species. Mixed and exotic habitats have >10% exotic plant species. Coast live oak and boxelder nests are not representative of distribution across the range: coast live oak nests only occur on the upper San Luis Rey in California and boxelder nests only occur in the Cliff-Gila area on the Gila River in New Mexico. Few tamarisk nests were found in native habitat.

	Percent (number of nests)	
Nest substrate	Native	Mixed and exotic
Tamarisk	-	86 (768)
Willow[1]	41 (459)	11 (103)
Coast live oak	10 (116)	0
Boxelder	33 (371)	0
Other[2]	15 (165)	3 (26)

[1] *Salix gooddingii, Salix exigua, Salix geyerana, Salix lasiolepis, Salix laevigata, Salix taxifolia.*

[2] Other nest substrates used in descending order of frequency: buttonbush *(Ceanothus occidentalis*), cottonwood (*Populus fremontii*), Russian olive (*Elaegnus angustifolia*), stinging nettle (*Urtica dioica*), alder (*Alnus rhombifolia, Alnus oblongifolia, Alnus tenuifolia*), velvet ash (*Fraxinus velutina*), poison hemlock (*Conium maculatum*), blackberry (*Rubus ursinus*), seep willow (*Baccharis salicifolia, Baccharis glutinosa*), canyon live oak (*Quercus chrysolepis*), rose *(Rosa californica, Rosa arizonica*, *Rosa multiflora*), sycamore (*Platinus wrightii*), giant reed (*Arundo donax*), false indigo (*Amorpha californica*), Pacific poison ivy (*Toxicodendron diversilobum*), grape (*Vitus arizonica*), Virginia creeper (*Parthenocissus quinquefolia*), Siberian elm (*Ulmus pumila*), walnut (*Juglans hindsii*).

Sferra et al. 2000 compiled the nesting success of 84% of the 2,008 nests documented primarily between 1993 - 1999, and some nests documented in 2000. Nest productivity in tamarisk-dominated sites is 23 -54%, which is similar to native willow-dominated sites (Table 3). Tamarisk nest success averaged 45% in New Mexico and 54% in Arizona, indicating that tamarisk nests are at least as successful as nests in other substrates.

However, because the physical and structural characteristics of tamarisk stands vary widely, not all have the same value as flycatcher breeding habitat. Among sites with tamarisk, suitable flycatcher breeding habitat usually occurs where the tamarisk is tall and dense, with surface water and/or wet soils present, and where it is intermixed with native riparian trees and shrubs. However, flycatchers breed in a few patches comprised of >90 % tamarisk, with dry soils and surface water >200 m away from some of their territories.

Tamarisk eradication can be detrimental to willow flycatchers in mixed and exotic habitats, especially in or near occupied habitat or where restoration is unlikely to be successful. Risks to the flycatcher increase if the tamarisk control projects are implemented in the absence of a plan to restore suitable native riparian plant species or if site conditions preclude the re-establishment of native plant species of equal or higher functional value. Threats also increase if the eradication projects are large-scale in nature, thus possibly setting the stage for large-scale habitat loss.

Table 3. Southwestern willow flycatcher nest success, by substrate, for data compiled from 1993 - 1999 in California, Arizona, and New Mexico, including some data from 2000 (Sferra et al. 2000). Nest success is calculated as the percent of nests fledging at least one flycatcher. Number of nests is in parentheses. Native habitats are those with < 10% cover of exotic plant species. Mixed and exotic habitats have > 10% cover of exotic plant species. Coast live oak and boxelder represent only two areas: the upper San Luis Rey in California and the Cliff-Gila area on the Gila River in New Mexico. Sample size is too small to calculate percent nest success for some categories, indicated by "-" notation. Data in mixed and exotic habitats in California have not yet been compiled.

	Percent nest success (number of nests)					
	California		Arizona		New Mexico	
Plant substrate	Native	Mixed and exotic	Native	Mixed and exotic	Native	Mixed and exotic
Tamarisk	0	N/A	0	54 (585)	-	45 (49)
Willow	47 (240)	N/A	36 (77)	39 (36)	42 (65)	23 (35)
Coast live oak	72 (116)	0	0	0	0	0
Boxelder	0	0	0	0	47 (289)	0
Other	55 (62)	N/A	44 (18)	-	53 (60)	-

2. Suitable, Potential, and Unsuitable Habitat

<u>Definitions.</u> The definition of the two commonly used terms - "currently suitable habitat" and "potentially suitable habitat " – are important for managers to understand for the recovery of the flycatcher. These terms encompass all the habitat components thought to influence reproductive success, including foraging habitat, micro-climate, vegetation density and distribution throughout the home range, presence of water, patch size, presence of other southwestern willow flycatchers, or other factors as they become identified.

Currently suitable habitat (hereafter "suitable habitat") is defined as a riparian area with all the components needed to provide conditions suitable for breeding flycatchers. These conditions are generally dense, mesic riparian shrub and tree communities 0.1 ha or greater in size within floodplains large enough to accommodate riparian patches at least 10 m wide (measured perpendicular to the channel); see Appendix D for more details. Currently, this definition of suitability is based solely on habitat characteristics, not on measures of flycatcher productivity or survival. Suitable habitat may be occupied or unoccupied; any habitat in which flycatchers are found breeding is, by definition, suitable. **Occupied suitable habitat** is that in which flycatchers are currently breeding or have established territories. **Unoccupied suitable habitat** appears to have physical, hydrological, and vegetation characteristics within the range of those found at occupied sites, but does not currently support breeding or territorial flycatchers. Some sites that appear suitable may be unoccupied because they may be missing an important habitat component not yet characterized. Other sites are currently suitable but unoccupied because the southwestern willow flycatcher population is currently small and spatially fragmented, and flycatchers have not yet colonized every patch where suitable habitat has developed.

Potentially suitable habitat (= "potential habitat") is defined as a riparian system that does not currently have all the components needed to provide conditions suitable for nesting flycatchers (as described above), but which could - if managed appropriately – develop these components over time. **Regenerating potential habitats** are those areas that are degraded or in early successional stages, but have the correct hydrological and ecological setting to be become, under appropriate management, suitable flycatcher habitat. **Restorable potential habitats** are those areas that could have the appropriate hydrological and ecological characteristics to develop into suitable habitat if not for one or more major stressors, and which may require active abatement of stressors in order to become suitable. Potential habitat occurs where the flood plain conditions, sediment characteristics, and hydrological setting provide potential for development of dense riparian vegetation. Stressors that may be preventing regenerating and restorable habitats from becoming suitable include, but are not limited to, de-watering from surface diversion or groundwater extraction, channelization, mowing, recreational activities, overgrazing by domestic livestock or native ungulates, exotic vegetation, and fire.

Unsuitable habitats are those riparian and upland areas which do not have the potential for developing into suitable habitat, even with extensive management. Examples of unsuitable habitat are found far outside of flood plain areas, along steep-walled and heavily bouldered canyons, at the bottom of very narrow canyons, and other areas where physical and hydrological conditions could not support the dense riparian shrub and tree vegetation used by breeding flycatchers even with all potential stressors removed.

Knowledge of the habitat components necessary for nesting flycatchers (Appendix D) will improve as additional studies are undertaken, allowing for more quantitative and possibly regionalized habitat descriptions in the future.

Specifying locations where nesting habitat is or could develop for flycatchers should not be confused with the overall management goal of rehabilitating and/or improving entire watersheds for southwestern willow flycatcher recovery. The health of riparian ecosystems and the development, maintenance, and regeneration of flycatcher nesting habitat depends on appropriate management of uplands, headwaters, and tributaries, as well as the main stem river reaches. All of these landscape components are inter-related. As a result, nesting habitat is only a small portion of the larger landscape that needs to be considered when developing management plans, recovery actions, biological assessments for section 7 consultations with the USFWS, or other documents defining management areas or goals for flycatcher recovery.

The Importance of Unoccupied Suitable Habitat and Potentially Suitable Habitat. Because riparian vegetation typically occurs in flood plain areas that are prone to periodic disturbance, suitable habitats will be ephemeral and their distribution dynamic in nature. Suitable habitat patches may become unsuitable through maturation or disturbance (though this may be only temporary, and patches may cycle back into suitability). Therefore, it is not realistic to assume that any given suitable habitat patch (occupied or unoccupied) will remain continually occupied and/or suitable over the long-term. Unoccupied suitable habitat will therefore play a vital role in the recovery of the flycatcher, because it will provide suitable areas for breeding flycatchers to: (a) colonize as the population expands (numerically and geographically), and (b) move to following loss or degradation of existing breeding sites. Indeed, many sites will likely pass through a stage of being suitable but unoccupied before they become occupied. Potential habitats that are not currently suitable will also be essential for flycatcher recovery, because they are the areas from which new suitable habitat develops as existing suitable sites are lost or degraded; in a dynamic riparian system, all suitable habitat starts as potential habitat. Furthermore, potential habitats are the areas where changes in management practices are most likely to create suitable habitat. Not only must suitable habitat always be present for long-term survival of the flycatcher, but additional acreage of suitable habitat must develop to achieve full recovery. Therefore, habitat management for recovery of the flycatcher must include developing and/or maintaining a matrix of riparian patches - some suitable and some potential - within a watershed so that sufficient suitable habitat will be available at any given time.

3. Patch Size and Shape

The riparian patches used by breeding flycatchers vary in size and shape. They may be relatively dense, linear, contiguous stands or irregularly-shaped mosaics of dense vegetation with open areas. Southwestern willow flycatchers nest in patches as small as 0.1 ha (0.25 ac) along the Rio Grande (Cooper 1997), and as large as 70 ha (175 ac) in the upper Gila River in New Mexico (Cooper 1997). Based on patch size values given in publications and agency reports (see Appendix D), mean size of flycatcher breeding patches is 8.5 ha (21.2 ac) (SE = 2.0 ha; range = 0.1 - 72 ha; 95% confidence interval for mean = 4.6 - 12.6; n = 63 patches). The majority of sites are toward the smaller end, as evidenced by a median patch size of 1.8 ha. Mean patch size of breeding sites supporting 10 or more flycatcher territories is 24.9 ha (62.2 ac) (SE = 5.7 ha; range = 1.4 - 72 ha; 95% confidence interval for mean = 12.9 - 37.1; n = 17 patches). Aggregations of occupied patches within a breeding site may create a riparian mosaic as large as 200 ha (494 ac) or more, such as at the Kern River (Whitfield 2002), Roosevelt Lake (Paradzick et al. 1999) and Lake Mead (McKernan 1997).

Flycatchers are generally not found nesting in confined floodplains where only a single narrow strip of riparian vegetation less than approximately 10 m (33 ft) wide develops, although they may use such vegetation if it extends out from larger patches, and during migration (Sogge and Tibbitts 1994, Sogge and Marshall 2000, Stoleson and Finch 2000z).

Flycatchers often cluster their territories into small portions of riparian sites (Whitfield and Enos 1996, Paxton et al. 1997, Sferra et al. 1997, Sogge et al. 1997b), and major portions of the site may be occupied irregularly or not at all. Most flycatcher breeding patches are larger than the sum total of the flycatcher territory sizes at that site. Flycatchers typically do not pack their territories into all available space within a habitat. Instead, territories are bordered by additional habitat that is not defended as a breeding territory, but may be important in attracting flycatchers to the site and/or in providing an environmental buffer (from wind or heat) and in providing post-nesting use and dispersal areas. Recent habitat modeling based on remote sensing and GIS data has found that breeding site occupancy at reservoir sites in Arizona is influenced by vegetation characteristics of habitat adjacent to the actual occupied portion of a breeding site (Arizona Game and Fish Dept, unpubl. data); therefore, unoccupied areas can be an important component of a breeding site. It is currently unknown how size and shape of riparian patches relate to factors such as flycatcher site selection and fidelity, reproductive success, predation, and brood parasitism.

4. Hydrological Conditions

In addition to dense riparian thickets, another characteristic common to most occupied southwestern willow flycatcher sites is that they are near lentic (quiet, slow-moving, swampy, or still) water. In many cases, flycatcher nest plants are rooted in or overhang standing water (Whitfield and Enos 1996, Sferra et al. 1997). Occupied sites are typically located along slow-moving stream reaches; at river backwaters; in swampy abandoned channels and oxbows; marshes; and at the margins of impounded water (e.g., beaver ponds, inflows of streams into reservoirs). Where flycatchers occur along moving streams, those streams tend to be of relatively low gradient, i.e., slow-moving with few (or widely spaced) riffles or other cataracts. The flycatcher's riparian habitats are dependent on hydrological events such as scouring floods, sediment deposition, periodic inundation, and groundwater recharge for them to become established, develop, be maintained, and ultimately to be recycled through disturbance.

5. Other Habitat Components

Other potentially important aspects of southwestern willow flycatcher habitat include landscape features (distribution and isolation of vegetation patches), physical features (micro-climate temperature and humidity) and biotic interactions (prey types and abundance, parasites, predators, interspecific competition). Population dynamics factors such as demography (i.e., birth and death rates, age-specific fecundity), distribution of breeding groups across the landscape, flycatcher dispersal patterns, migration routes, site fidelity, philopatry, and conspecific sociality also influence where flycatchers are found and what habitats they use. Most of these factors are poorly understood at this time, but may be critical to understanding current population dynamics and habitat use. Refer to Wiens (1985, 1989a, 1989b) for additional discussion of habitat selection and influences on bird species and communities.

6. Migration and Wintering Habitat

The migration routes used by southwestern willow flycatcher are not well documented. *Empidonax* flycatchers rarely sing during fall migration; therefore, distinguishing species is difficult. However, willow flycatchers (all subspecies) sing during spring migration. As a result, willow flycatcher use of riparian habitats along major drainages in the southwest has been documented (Sogge et al. 1997b, Yong and Finch 1997, Johnson and O'Brien 1998, McKernan and Braden 1999). Migrant southwestern willow flycatchers may occur in non-riparian habitats and/or be found in riparian habitats unsuitable for breeding. Such migration stopover areas, even though not used for breeding, may be critically important resources affecting productivity and survival.

The flycatcher winters in Mexico, Central America, and northern South America (Phillips 1948, Gorski 1969, McCabe 1991, Ridgely and Tudor 1994, Koronkiewicz et al. 1998, Unitt 1999). Popular literature on the birds of Mexico, Central, and South America describes willow flycatcher wintering habitat as humid to semi-arid, partially open areas such as woodland borders (Ridgely and Gwynne 1989, Stiles and Skutch 1989, Howell and Webb 1995). Second growth forest, brushy savanna edges, and scrubby fields and pastures are also used (Ridgely and Tudor 1994). In Panamá, Gorski (1969) found them in transitional and edge areas, often near a wetland. Similarly, in Costa Rica and Panamá, Koronkiewicz et al. (1998 and pers. comm) found willow flycatchers defending winter territories in areas with standing water, sluggish-moving streams with floating or emergent vegetation and adjacent seasonally inundated savanna, dense woody shrubs, patches or stringers of trees, and open grassy areas. They observed willow flycatchers most often along the edges of wetland areas, in dense woody shrubs bordering and extending into drier portions of the wetland, and in forest edge along open areas of the wetland. The most commonly used vegetation was patches of dense woody shrubs (*Mimosa* sp.) approximately 1-2 m (3-7 ft) tall, bordering and extending into wet areas. See Appendix E for detailed discussion of migration and wintering habitat and ecology.

D. Breeding Biology

The willow flycatcher (all subspecies) breeds across much of the conterminous United States and in portions of northern Mexico and extreme southern Canada (Figure 1). This section discusses the breeding-season ecology of the southwestern willow flycatcher. Relatively few ecological studies have been published on the southwestern subspecies, and much of what is known is presented in unpublished literature (e.g., technical reports). The following discussion uses ecological information from other subspecies where it is appropriate, and qualifies such information where it is extrapolated to the southwestern willow flycatcher.

1. Vocalizations

The willow flycatcher's primary song, "*fitz-bew*," distinguishes it from all other *Empidonax* flycatchers and other bird species (refer to Stein 1963 for a detailed discussion). This is the primary territorial song of male willow flycatchers. Singing bouts are usually comprised of a series of *fitz-bews*, sometimes interspersed with *britt* notes, lasting from less than a minute to over a half-hour. Males sing to advertise their territory to prospective mates and other nearby males. Female willow flycatchers also sing, although not as often as do males, and/or sometimes more quietly (Seutin 1987, Sedgwick and

Knopf 1992, Paxton et al. 1997, Sogge et al. 1997b, SWCA 2000, M. Whitfield unpubl. data). Migrant willow flycatchers often sing from tall song perches during spring migration, in much the way that territorial birds do (Johnson and Sogge 1997, Sogge et al. 1997b).

Male willow flycatchers sing most persistently early in the breeding season and early in each nesting cycle. Song rate declines as the season progresses, particularly once the male finds a mate and nesting efforts begin (Braden and McKernan 1998). Territorial flycatchers often begin singing well before dawn, and song rate is generally highest early in the morning. Short periods of pre-dawn singing often continue as late as July (Sogge et al. 1997b). In breeding groups with many territorial males, morning song rate may remain high throughout most of the breeding season. Unmated males and males with territories near other willow flycatchers tend to vocalize more than males in isolated territories (M. Whitfield, pers. comm.), which may make detection of isolated flycatchers more difficult.

Another common vocalization used by flycatchers is the *"whitt"* call, given by both sexes. *Whitts* are uttered during various activities, including foraging, perching, collecting nesting material, during interactions between flycatchers, as an alarm call, and on wintering grounds. *Whitt*s are often the most common vocalization used during mid- and late breeding season (Braden and McKernan 1998). Many other bird species have similar *whitt* calls, so unlike the *fitz-bew*, the *whitt* is not generally considered unique to willow flycatchers. Willow flycatchers also use an array of varied vocalizations, usually produced by paired adults interacting in close proximity to a nest and/or offspring. These include *wheeo*, *wheep*, *wheek-a-dee*, and *brrrt* phrases. See McCabe (1991) and Sedgwick (2000) for a detailed discussion of willow flycatcher vocalizations.

2. Breeding Chronology

A Neotropical migrant, southwestern willow flycatchers spend only three to four months on their breeding grounds. The remainder of the year is spent on migration and in wintering areas south of the United States. Figure 2 presents a generalized breeding chronology for the southwestern willow flycatcher, and is based on Unitt (1987), Brown (1988), Whitfield (1990), Skaggs (1996), Sogge (1995), Maynard (1995), Sferra et al. (1997), and Sogge et al. (1997b). Record or extreme dates for any stage of the breeding cycle may vary as much as a week from the dates presented. In addition, flycatchers breeding at higher elevation sites or more northerly areas usually begin breeding several weeks later than those in lower or southern areas.

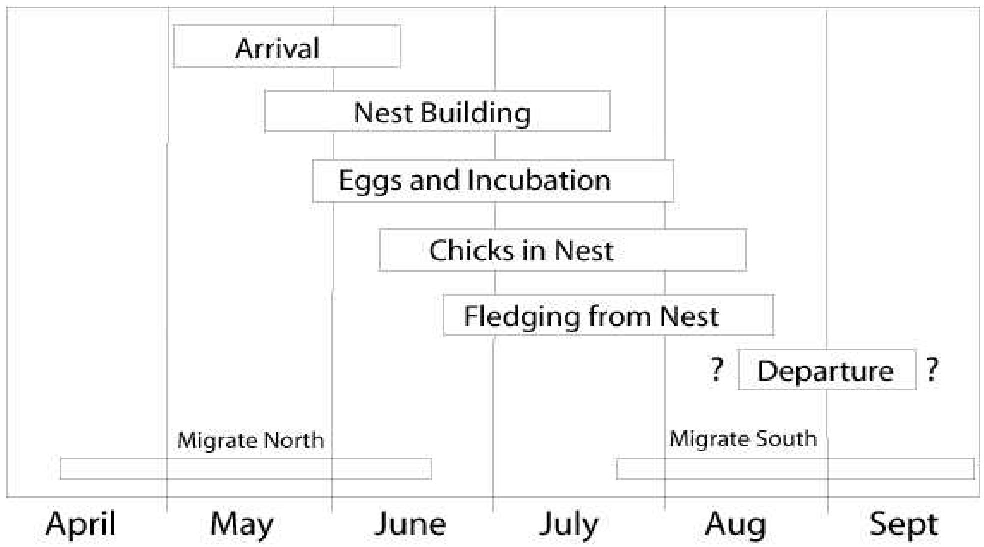

Figure 2. Generalized breeding chronology of the southwestern willow flycatcher (modified from Sogge et al. 1997a). Dates for a given stage may vary a week or more at a given site or during a given year.

Southwestern willow flycatchers typically arrive on breeding grounds between early May and early June, although a few individuals may establish territories in very late April (Willard 1912, Ligon 1961, Maynard 1995, Skaggs 1996, Sferra et al. 1997). Because arrival dates vary geographically and annually, northbound migrant willow flycatchers (of all subspecies) pass through areas where *E.t. extimus* have already begun nesting. Similarly, southbound migrants (of all subspecies) in late July and August may occur where southwestern willow flycatchers are still breeding (Unitt 1987). Therefore, it is only during a short period of the breeding season (approximately 15 June through 20 July) that one can assume that a willow flycatcher seen within *E.t. extimus* range is probably of that subspecies.

Relatively little is known regarding movements and ecology of adults and juveniles after they leave their breeding sites. Males that fail to attract or retain mates, and males or pairs that are subject to significant disturbance (such as repeated cowbird parasitism, predation, etc.) may leave territories by mid-July (Sogge 1995, Sogge et al. 1997b). Fledglings probably leave the breeding areas a week or two after adults, but few details are known.

3. Mating and Territoriality

Male flycatchers generally arrive first at a breeding site, and establish a territory by singing and interacting aggressively with other flycatchers. Willow flycatchers are strongly territorial, and will sing almost constantly when establishing territories. Females tend to arrive later (approximately a week or two). It is not known exactly what factors a female uses to select a territory, though it may be related to habitat quality or potential quality of the male. Second-year males arrive at about the same time as females (M. Whitfield, unpubl. data).

Males are usually monogamous, but polygyny rates of 5% - 20% have been documented (Whitfield and Enos 1996, Sferra et al. 1997, Paradzick et al. 2000, McKernan and Braden 2001). Polygynous males typically have two females in their territory. Genetic evidence shows that territorial males mate with females in other territories (i.e., engage in extra-pair copulations; Pearson 2002, E. Paxton unpubl. data). Data from color-banded populations (Whitfield 1990 and unpubl. data; Paxton et al. 1997, Kenwood and Paxton 2001) show that between-year mate fidelity is low, and that during a breeding season some flycatcher pairs break up and subsequently pair and breed with other individuals.

Southwestern willow flycatchers are strongly territorial. Flycatcher territories are often clumped together, rather than spread evenly throughout a habitat patch. This has led some authors to label willow flycatchers as "semi-colonial" (McCabe 1991), although they do not fit the strict definition of a colonial species and regularly breed at sites with only one or a few pairs (Sferra et al. 1997, Sogge et al. 1997a and 1997b, Paradzick et al. 1999). Territory size varies greatly, probably due to differences in population density, habitat quality, and nesting stage. Estimated breeding territory sizes generally range from approximately 0.1 ha to 2.3 ha (0.25-5.7 ac), with most in the range of approximately 0.2 - 0.5 ha (0.5-1.2 ac) (Sogge 1995, Whitfield and Enos 1996, Skaggs 1996, Sogge et al. 1997b). Territories of polygynous males are often larger than those of monogamous males. Whitfield (unpubl. data) observed instances of individual polygynous males using multiple singing perches several hundred meters (>600 ft) apart. Flycatchers may use a larger area than their initial territory after their young are fledged, and use non-riparian habitats adjacent to the breeding area. Even during the nesting stage, adult flycatchers sometimes fly outside of their territory, often through an adjacent flycatcher territory, to gather food for their nestlings.

4. Site Fidelity

Evidence gathered during multi-year studies of color-banded populations shows that although most southwestern willow flycatchers return to former breeding areas, flycatchers regularly move among sites within and between years (Netter et al. 1998, Kenwood and Paxton 2001, M. Whitfield unpubl. data). From 1997 through 2000, 66% to 78% of flycatchers known to have survived from one breeding season to the next returned to the same breeding site; conversely, 22% to 34% of returning birds moved to different sites (Luff et al. 2000). Both males and females move within and between sites, with males showing slightly greater site fidelity (Netter et al. 1998). Within-drainage movements are more common than between-drainage movements (Kenwood and Paxton 2001). Typical distances moved range from 2 to 30 km (1.2 - 18 mi); however, long-distance movements of up to 220 km have been observed on the lower Colorado River and Virgin River (McKernan and Braden 2001). In some cases, willow flycatchers are faced with situations that force movement, such as when catastrophic habitat loss occurs from fire or flood. Several such cases have been documented, with some of the resident willow flycatchers moving to remaining habitat within the breeding site, some moving to other sites 2 to 28 km (1.2 - 16.8 mi) away (Paxton et al. 1996, Owen and Sogge 1997), and others disappearing without being seen again.

5. Nests, Eggs, and Nestling Care

The flycatcher builds a small open cup nest, constructed of leaves, grass, fibers, feathers, and animal hair; coarser material is used in the nest base and body, and finer materials in the nest cup (Bent 1960). Nests are approximately 8 cm (3.15 in) high and 8 cm wide (outside dimensions), and have 2 to 15 cm (1-6 in) of loose material dangling from the bottom (or none, in tamarisk-dominated habitats). Females build the nest over a period of four to seven days, with little or no assistance from the male. Most nests are used only once, although females will often use some fibers and materials (particularly the lining) from the original nest when constructing a subsequent nest during the same season (McCabe 1991). Although uncommon, re-use of nests has been documented at several breeding sites in Arizona (Yard and Brown 1999, Arizona Game and Fish unpubl. data). Typical nest placement is in the fork of small-diameter (e.g., ≤1 cm or 0.4 in), vertical or nearly vertical branches. Occasionally, nests are placed in down-curving branches. Nest height varies considerably, from 0.5 m to 18 m (1.6 to 60 ft), and may be related to height of nest plant, overall canopy height, and/or the height of the vegetation strata that contain small twigs and live growth. Most typically, nests are relatively low, e.g., 2 to 7 m (6.5 to 23 ft) above ground.

Willow flycatcher eggs are buffy or light tan, with brown markings circling the blunt end. Eggs are approximately 18 mm long and 14 mm wide (0.45 x 0.35 in), and weigh about 1.6 g (0.05 oz) (McCabe 1991). Females typically lay one egg per day, until the nest contains 3 or 4 eggs. Incubation begins after the last egg is laid, and lasts 12 to 13 days. Most incubation is by the female, although male incubation is also known (Gorski 1969, H. Yard, B. Brown, and Arizona Game and Fish Department unpubl. data). Most eggs in a nest hatch within 48 hours of each other (McCabe 1991).

The female provides most of the initial care of the young. As demand for food increases with nestling growth, the male also brings food to the nest. Generally, only the female broods the young. Nest attendance decreases with nestling age, with females spending less than 10 percent of their time at the nest after nestling day 7 (Arizona Game and Fish Department unpubl. data). Nestlings fledge 12 to 15 days after hatching.

Fledglings stay close to the nest and each other for 3 to 5 days, and may repeatedly return to and leave the nest during this period (Spencer et al. 1996). Fledglings typically stay in the general nest area a minimum of 14 to 15 days after fledging, possibly much longer. Both parents feed the fledged young, though in some cases one parent may do all of the feeding (M. Whitfield unpubl. data). Dispersal distances and interactions with parents after this period are not well known.

6. Renesting

Second clutches within a single breeding season are uncommon if the first nest is successful. Most attempts at renesting occur if the young fledge from the first nest by late June or very early July. Renesting is regularly attempted if the first nest is lost or abandoned due to predation, parasitism, or disturbance; a female may attempt as many as four nests per season (Smith et al. 2002). Replacement nests are built in the same territory, and may be close to (even in the same plant) or far from (up to 20 m/65 ft) the previous nest (McCabe 1991, Sogge et al. 1997b). Clutch size decreases with each nest attempt (Holcomb 1974, McCabe 1991, Whitfield and Strong 1995). Some flycatchers may move hundreds of meters or even several kilometers to renest (Netter et al. 1998).

7. Post-Breeding Dispersal

Dispersal after the nesting cycle is poorly understood. Adults that are successful in raising young may remain at breeding sites through mid-August to early September. Pairs with unsuccessful first and/or second nests sometimes abandon their territories midway through the breeding season. Some of these birds are known to attempt renesting, either nearby or at another site, with movements of up to 30 km (18.6 mi) documented (Netter et al. 1998). Unpaired males may remain on territory through the early part of the breeding season but leave by mid-July (Sogge 1995, Sogge et al. 1997b).

8. Demography

Demography is the science of the interrelated life history factors that determine how populations grow, shrink, or change in other ways. Some basic understanding of the overall demography of a species is usually needed to interpret or estimate trends in any single parameter, such as population size, reproduction rates, or age class distributions. For example, to know that extremely high mortality of the young is normal for a species of tree helps explain why each adult may produce thousands of young annually. For imperiled species like the southwestern willow flycatcher, knowledge of demography often reveals that certain factors are of particular importance in conservation. For the flycatcher, many key demographic parameters are only beginning to be understood in detail. However, the current level of knowledge is sufficient to identify several parameters that should receive attention in recovery efforts. As our knowledge of demography increases, we will be better equipped to estimate and evaluate population trends. Key demographic factors for the flycatcher are discussed below, with comments regarding their relevance to recovery, and to evaluating and estimating population trends. This discussion draws heavily on Stoleson et al. (2000); see that publication for more information.

Age Classes

The importance of the relative proportions of birds of various ages (age class distribution) to population dynamics is not known for the flycatcher. Several observations are relevant to its significance as a demographic factor. Flycatchers breed the next spring after hatching, i.e., all flycatchers arriving on the breeding grounds are potential breeders, including those hatched the prior year (Paxton et al. 1997, Whitfield unpubl. data). Age may affect breeding success or productivity, though preliminary data from the Kern River showed no differences in the number of young fledged between yearling females and older females (Whitfield unpubl. data).

Sex Ratios

The ratio of males to females can have obvious importance in a population, as it determines what proportion is truly reproducing. However, with the flycatcher this is confused by known instances of polygyny, extra-pair copulation, and mate reshuffling (Paradzick et al. 1999, Netter et al. 1998, McKernan and Braden 2001, Pearson 2002). Unpaired males are present in the breeding season in some areas (Parker 1997, Sogge et al. 1997b, Paradzick et al. 1999, Whitfield unpubl. data).

Fecundity

Fecundity is the reproductive performance of an individual or population. For the southwestern willow flycatcher, fecundity is a product of probability of breeding, clutch size, hatching success, nesting success, and number of nesting attempts per season. Flycatcher fecundity is reduced, to varying degrees across its range, by factors such as nest predation and brood parasitism by the brown-headed cowbird. In some areas, probability of breeding may be diminished by skewed sex ratios (Stoleson et al. 2000). As is often the case with rare species, increasing fecundity of the flycatcher could be important to recovery. This might be accomplished through increasing habitat availability and quality, reducing brood parasitism, and if suitable techniques can be developed, decreasing rates of nest predation.

Longevity

Based on observations and recaptures of banded southwestern willow flycatchers, it is likely most live 1 to 3 years, with many living 4 years, and some individuals surviving 5 to at least 8 years (E. Paxton and M. Whitfield, unpubl. data). Sedgwick (2000) documented an *adastus* willow flycatcher surviving at least 11 years in the wild. Extensions of survivorship should increase populations by keeping individuals present in the population longer, and by gaining more reproductive years from those individuals. Increasing adult survivorship may be difficult, but possibilities include decreasing unnaturally high levels of predation, and improving the quality of breeding, migration, and wintering habitat.

Immigration and Emigration

Recent studies suggest immigration and emigration among flycatcher breeding sites may be fairly common. Using color-banded birds, movements among breeding sites have been documented, both within and between drainages, and within and between years (Langridge and Sogge 1997, Paxton et al. 1997, Netter et al. 1998). In east-central Arizona, Netter et al. (1999) reported that 13% of banded birds present in 1997 had moved to new sites in 1998. Distances moved range from 0.4 to 190 km (0.25 to 118 mi). Movements within drainages were most common, with a mean distance moved of 14 km (8.7 mi). Banding studies along the lower Colorado River and Virgin River drainages (McKernan and Braden 2001) have documented between-year adult movements of 13 - 100 km (8 - 62 miles); returning birds banded as nestlings moved 14 - 220 km (9 - 138 miles) from their natal sites. Between-year movements between drainages may be less common, but distances moved are considerable. Examples (from Netter et al. 1998): from the San Francisco River 40 km (25 mi) to the headwaters of the Little Colorado River; and to a site 90 km (56 mi) to the northeast; from the Verde River 190 km (118 mi) to the Gila River; from Tonto Creek 94 km (58 mi) to the Gila River.

E. Foraging Behavior and Diet

The willow flycatcher is an insectivore. It catches insects while flying, hovers to glean them from foliage, and occasionally captures insects on the ground. Flycatchers forage within and above the canopy, along the patch edge, in openings within the territory, above water, and glean from tall trees as well as herbaceous ground cover (Bent 1960, McCabe 1991, B. Valentine pers. comm., M. Whitfield pers. comm.). Willow flycatchers employ a "sit and wait" foraging tactic, with foraging bouts interspersed with longer periods of perching (Prescott and Middleton 1988). Southwestern willow flycatcher foraging rates are highest early and late in the day, and during the nestling period (SWCA 2001).

All North American *Empidonax* flycatchers appear to have generally similar diets during the breeding season, consisting of small to medium-sized insects (Beal 1912). The willow flycatcher is somewhat of a generalist. Wasps and bees (Hymenoptera) are common food items, as are flies (Diptera), beetles (Coleoptera), butterflies/moths and caterpillars (Lepidoptera), and spittlebugs (Homoptera) (Beal 1912, McCabe 1991). Plant foods such as small fruits have been reported (Beal 1912, Roberts 1932, Imhof 1962), but are not a significant food during the breeding season (McCabe 1991). Diet studies of adult southwestern willow flycatchers (Drost et al. 1997, DeLay et al. 2002) found a wide range of prey taken. Major prey items were small (flying ants) to large (dragonflies) flying insects, with Hymenoptera, Diptera and Hemiptera (true bugs) comprising half of the prey items. Willow flycatchers also took non-flying species, particularly Lepidoptera larvae. Plant material was again negligible.

F. Competitors

The extent to which competition affects southwestern willow flycatcher distribution and abundance is unknown. Resources for which competition might exist include nest sites and food. The flycatcher may experience competition from other species (interspecific), or from other willow flycatchers (intraspecific).

The greatest potential for interspecific competition might be expected from other *Empidonax* flycatchers, being closely related and similar in morphology and food habits. Where willow flycatchers (subspecies other than *extimus*) and other *Empidonax* flycatchers breed in the same habitats, they often maintain mutually exclusive territories (Frakes and Johnson 1982, McCabe 1991). However, Gorski (1969) concluded that "competition is almost lacking" between the closely related willow and alder (*E. alnorum*) flycatchers. In its breeding range, the southwestern willow flycatcher is often the only *Empidonax* flycatcher breeding in its nesting habitat. Competition also has not been demonstrated between the southwestern willow flycatcher and other flycatchers that commonly occur in or near to its habitat, e.g., the pacific-slope flycatcher (*E. difficilis*), ash-throated and brown-crested flycatchers (*Myiarchus cinerascens* and *M. tyrannulus*), black phoebe (*Sayornis nigricans*), and western wood-pewee (*Contopus sordidulus*). Other, less-related species are even less likely to be significant competitors, e.g., yellow warblers (*Dendroica petechia*) (McCabe 1991). Although willow flycatchers and other riparian species experience degrees of overlap in diet and nest site selection, interspecific territoriality is rarely observed, and many cases of overlapping territories are known.

As is often true, within-species (intraspecific) competition is likely the most intense. One resource for which intraspecific competition may exist is mates. Male willow flycatchers exhibit strong intraspecific territoriality. At many breeding sites, some males are polygynous (i.e., mate with more than one female in their territory) while others fail to secure mates (Stoleson et al. 1999, Smith et al. 2002). This implies that females may be limited at some sites, and that males compete for reproductive opportunities, with some (paired) being more successful than others (unpaired) . The ecological, evolutionary, and demographic effects of this competition are not well known.

G. Predation and Predators

Southwestern willow flycatchers are probably influenced by predation, but predation rates are within the typical range for open-cup nesting passerine birds (Newton 1998). However, for an endangered bird "normal" predation rates may exert disproportionately greater stresses on populations. Nest success may be particularly affected, and most of what is known about flycatcher predation involves nest predation. Predation can be the single largest cause of nest failure in some years (Whitfield and Enos 1996, Paradzick et al. 1999). In a New Mexico population, Stoleson and Finch (1999) attributed 37.3% of 110 nest failures to predation. Predation of southwestern willow flycatcher eggs and nestlings is documented for the common kingsnake (*Lampropeltis getulus*) (Paxton et al. 1997, McKernan and Braden 2001, Smith et al. 2002), gopher snake (*Pituophis melanoleucus affinis*) (Paradzick et al. 2000, McKernan and Braden 2001), Cooper's hawk (*Accipiter cooperii*) (Paxton et al. 1997), red-tailed hawk (*Buteo jamaicensis*) (Whitfield and Lynn 2000), great horned owl (*Bubo virginianus*) (Stoleson and Finch 1999), western screech owl (*Otus kennicottiii*) (Smith et al. 2002), yellow-breasted chat (*Icteria virens*) (Paradzick et al. 2000), and Argentine ants (*Linepithema humili*) (Famolaro 1998, B. Kus pers. comm.). Other potential predators of flycatcher nests include other snakes, lizards, chipmunks, weasels, racoons, ringtailed cats, foxes, and domestic cats (McCabe 1991, Sogge 1995, Langridge and Sogge 1997, Paxton et al. 1997, Sferra et al. 1997, McCarthey et al. 1998, Paradzick et al. 2000). Predatory birds such as jays, crows, ravens, hawks (especially accipiters), roadrunners, and owls may hunt in flycatcher habitat. Brown-headed cowbirds effectively function as predators if they remove flycatcher eggs during parasitism. Cowbirds are also known to kill nestlings of other songbirds (Sheppard 1996, Tate 1967, Beane and Alford 1990, Scott and McKinney 1994), and may act as predators on southwestern willow flycatcher chicks (M. Whitfield and AGFD unpubl. data). Although acts of nest predation by cowbirds have been documented on other species, available evidence indicates that cowbirds are not frequent predators of flycatcher nests; rates of nest predation have not declined in response to cowbird control (Whitfield et al. 1999, Whitfield 2000; Appendix F).

Predation of adults of most passerine birds is not often observed, and virtually no data of this kind of predation exists for the southwestern willow flycatcher. However, adult (and fledgling) flycatchers are vulnerable to predation by many of the animals discussed above, especially by predatory birds. Incubating females are particularly vulnerable, especially at night. Although no data are available, flycatchers are also likely to be exposed to predation during migration and on their tropical wintering grounds.

H. Disease and Parasites

1. Disease and Invertebrate Parasites

Although all wild birds are exposed to disease and various internal and external parasites, little is known of the role of disease and parasites on most species or populations. Disease and parasites may be significant factors in periods of environmental or physiological stress, during certain portions of a life cycle, or when introduced into a new or naive host (Karstad 1971, Atkinson and van Riper 1991, van Riper 1991). The willow flycatcher (various subspecies) is known to be a host to a variety of internal and external parasites. These include blood parasites such as *Haemoproteus*, *Leucocytozoon*, *Microfilaria*, *Tyrpanosoma* and *Plasmodium* (Bennett et al. 1982, C. van Riper and M. Sogge, unpubl. data); blow fly (*Protocalliphora* sp.) (Boland et al. 1989, Sabrosky et al. 1989, McCabe 1991, AGFD unpubl. data); and nasal mites (Pence 1975). Most bird species, including *Tyrannid* flycatchers, are susceptible to viral pox (Karstad 1971). Although these parasites likely occur in southwestern willow flycatchers, there is no information on what impact they have on infected birds or populations. McCabe (1991) identified mites *(Ornithonyssus sylviarum*) in 43% of flycatcher nests, and blowfly larvae in 32% of nests, but noted no significant negative effects from either. Conversely, Whitfield and Enos (1998) documented mortality of nestlings (southwestern willow flycatchers) due to severe mite infestation.

2. Cowbird Brood Parasitism

The southwestern willow flycatcher also experiences brood parasitism by the brown-headed cowbird (*Molothrus ater*) and cowbird impacts on some (but not all) populations are sufficiently large to warrant management efforts (See Appendix F). The cowbird lays its eggs in the nests of other species. The “host” species then incubate the cowbirds eggs and raise the young. Because cowbird eggs hatch after relatively short incubation and hatchlings develop quickly, they often outcompete the hosts’ own young for parental care. Cowbirds may also remove eggs and nestlings of host species from nests (or injure nestlings in nests), thereby acting as nest predators. Cowbirds can therefore have negative effects on reproductive success of flycatcher females and populations. Various factors have increased the range and numbers of the brown-headed cowbird, and potentially its impacts on hosts, over the pre-European condition, although these effects may have peaked several decades ago. Factors facilitating increased cowbird impacts include increased cowbird numbers through expansion of suburban and agricultural areas, and increases in cowbird access to riparian habitat via narrowed riparian zones and fragmentation. These issues are dealt with in depth in Appendix F.

Besides possibly contributing to the endangerment of the southwestern willow flycatcher and several other songbirds (e.g., least Bell’s vireo, golden-cheeked warbler, black-capped vireo), brood parasitism is a potential impediment to recovery. However, it is important to be aware that the presence of cowbird parasitism does not necessarily mean it is having critical or even significant effects on a given flycatcher population. Several factors influence the degree to which cowbird parasitism is a problem, including: parasitism rate; flycatcher response to parasitism (e.g., abandonment and renesting); and net reproductive success per female flycatcher. Once these factors are considered, the effect of parasitism is typically less than what seemed to be the case initially. See additional discussion below, in “Reasons for Decline and Current Threats” and Appendix F.

I. Status and Trends of Populations and Habitat

1. Current Flycatcher Populations

Developing a current population estimate is challenging. The population presents a moving target, both spatially and temporally. Because not all sites are re-surveyed in every year, the estimate generated here is a composite of known populations for different years at different sites. In each case, the most recent or more thorough year's data were used as the "current" population. This estimate is qualified by the knowledge that numbers of birds at a given site fluctuate from year to year, that inter-site dispersal takes place, and that some occupied sites have been destroyed or damaged in recent years, causing the former residents to relocate and forego breeding. Also, survey and monitoring effort has increased substantially from 1993 to the present, but varies among regions. Another confounding factor is the taxonomic identity of willow flycatchers at the edge of the range of the southwestern subspecies.

When the southwestern willow flycatcher was listed as endangered in 1995, approximately 350 territories were known to exist (Sogge et al. 2001). As of the 2001 breeding season, the minimum known number of southwestern willow flycatchers was 986 territories (Table 4). The numbers in Table 4 do not include flycatchers suspected to occur on some Tribal and private lands. Though much suitable habitat remains to be surveyed, the rate of discovery of new nesting pairs has recently leveled off (Sogge et al. 2001). A coarse estimate is that an additional 200 to 300 nesting pairs may remain undiscovered, yielding an estimated total population of 1,200 to 1,300 pairs/territories. Unitt (1987) estimated that the total flycatcher population may be 500 to 1000 pairs; thus, nearly a decade of intense survey efforts have found little more than slightly above the upper end of Unitt's estimate. The surveys of the 1990s have been valuable in developing a rangewide population estimate, but cannot identify a rangewide trend over that period. However, some local trends may be evident, as discussed below.

Table 4. Known numbers of southwestern willow flycatcher territories by State. Data are from Sogge et al. 2002, based on last reported survey data for all sites where flycatchers were known to breed, 1993-2001.

	State							
	Arizona[1]	California[1]	Colorado	Nevada	New Mexico	Utah	Texas	Total
Number of Territories	359	256	37	73	258	3	0	986

[1]Flycatchers on the lower Colorado River are all included in Arizona's total.

2. Trends in Habitat and Flycatcher Distribution

California

Unitt (1984, 1987) concluded the flycatcher was once fairly common in the Los Angeles basin, where habitat is virtually absent now. The South Fork of the Kern River is one of the few places where riparian habitat has increased substantially over the last 20 years. Approximately 250 ha of riparian habitat has regenerated along the South Fork Kern River since the early 1980s (Whitfield et al. 1999). However, despite an apparent abundance of suitable habitat and cowbird trapping, the flycatcher population on the South Fork Kern River has fluctuated from 38 territories in 1997 to 23 in 1999 (Whitfield et al. 1999). Downstream from the South Fork Kern River, willow flycatchers were common breeders in the extensive riparian habitat along the Kern River and Buena Vista Lake in the early 1900s (Linton 1908). Today, essentially all of the riparian habitat is gone and there are no recent reports of breeding willow flycatchers. However, it is uncertain whether the *E.t. extimus* subspecies bred there. Outside of the Kern River, the three largest flycatcher populations in California reside along the Owen's River from below Pleasant Valley Reservoir to Warm Springs Road, along the San Luis Rey River downstream of Lake Henshaw, and along the Santa Margarita River at Camp Pendleton. Limited willow flycatcher surveys have been conducted on the Owen's River in the early and mid 1990s, the most recent survey conducted in 2001 documented a minimum of 24 territories (Whitfield unpubl. data). Changes in land use along the San Luis Rey River, including the removal of grazing from Forest Service lands in the early 1990s, have improved the extent and quality of riparian habitat for southwestern willow flycatchers, which have increased from 12 territorial males in the late 1980s (Unitt 1987) to over 40 in 1999 (Kus et al. 1999, W. Haas, pers. comm.). In contrast, the flycatcher population at Camp Pendleton has remained fairly constant at under two dozen territories for the past two decades, despite the availability of additional apparently suitable habitat to support population expansion. The remaining flycatcher populations in southern California, most of which number fewer than five territories, occur at scattered sites along drainages that have changed little during the past 15 years.

Arizona

All of Arizona's major rivers and their tributaries where southwestern willow flycatchers were known to have bred have changed, often dramatically (Tellman et al. 1997). Rivers such as the Colorado, Gila, Santa Cruz, San Pedro, and Verde rivers have suffered extensive dewatering, and loss and fragmentation of riparian habitats. Consequently, many areas where the flycatcher was formerly locally abundant now support few or none. Following are just a few examples. The flycatcher was once abundant near the confluence of the Gila and Colorado rivers (T. Huels in litt., transcripts of H. Brown's field notes), but is now rare (McKernan and Braden 1999 and 2001, Paradzick et al. 1999 and 2000). Historically known along the Santa Cruz River near Tucson (Swarth 1914, Phillips 1948), flycatchers no longer breed there and suitable habitat is essentially lacking. The Verde Valley once hosted large amounts of dense, mesic riparian habitats in which flycatchers bred (E.A. Mearns historical field notes, Swarth 1914). Conversion to agriculture and phreatophyte control programs dramatically reduced riparian vegetation, and fewer than 10 flycatcher territories persist on the Verde River (Paradzick et al. 1999). Recently, newly developed habitat supporting a relatively large breeding population at the

Colorado River inflow to Lake Mead was inundated, and flycatchers no longer breed at that site (McKernan and Braden 1998, 1999, 2001). Two riparian areas continue to support substantial numbers of flycatchers. Over 150 flycatcher territories have been found along the lower San Pedro River and nearby portions of the Gila River (AGFD unpubl. data), where flycatchers have been known since the early 1900s (Willard 1912, Phillips 1948). Riparian habitat at the Tonto Creek and Salt River inflows to Roosevelt Lake hosts approximately 140 territories (Smith et al. 2002); these habitats probably developed only recently and are subject to inundation and possible destruction when reservoir levels are raised. The largest breeding population (21 territories) currently known along the lower Colorado River is found at Topock Marsh (McKernan and Braden 2002).

New Mexico

Loss of flycatcher populations and habitat likely has been most severe in the Rio Grande Valley, where the taxon may have been widespread and fairly common, including in the vicinities of Espanola and Las Cruces (Hubbard 1987), two areas where suitable habitat and flycatchers are no longer found; a remnant population found in upper Elephant Butte Reservoir in the early 1970s was lost to rising lake levels (Hubbard 1987). Along the San Francisco River, habitat degradation likely lead to the loss of breeding flycatchers in the vicinity of Glenwood. The large population along the Gila River reported by Egbert (1981) and Montgomery et al. (1985), and identified by Hubbard (1987) as a stronghold remains one of the largest known southwestern willow flycatcher population rangewide (Skaggs 1996, Stoleson and Finch 1999, Sogge et al. 2001).

Texas

In Trans-Pecos Texas, loss of suitable habitat and presumed breeding flycatcher populations almost certainly has been severe along the Rio Grande, especially the now-dry reach from below El Paso to the confluence with the Rio Conchos at Presidio. The last reported nesting in the region occurred in the Davis Mountains in 1890 (Oberholser 1974). In this century, there are few if any reports of occurrence between the dates 18 June and 21 July (Phillips 1948, Wauer 1973 and 1985, Oberholser 1974, Unitt 1987), implying breeding flycatchers are scarce or absent. However, no formal surveys have been conducted in recent years to determine presence or absence of breeding flycatcher populations or to evaluate potential flycatcher habitat.

Utah

Although Behle (1985) describes the willow flycatcher as a common summer resident statewide, there are few historical or current records in the southern portion of the State within the range of *E. t. extimus*. Historically, southern Utah's largest flycatcher populations may have been those along the Colorado River and its tributaries in Glen Canyon (Behle and Higgins 1959); these are now inundated by Lake Powell. The flycatcher also bred along the Virgin River in the St. George area (Behle et al. 1958), and along the San Juan River (Unitt 1987). Recent surveys have found the flycatcher absent as a breeding species on the Green and Colorado Rivers in the Canyonlands National Park area (M. Johnson unpubl.

data), on the San Juan River (west of the New Mexico border; Johnson and O'Brien 1998), and portions of the Manti-La Sal National Forest (Johnson 1998). Flycatchers have recently bred in small numbers along the Virgin River near St. George (Langridge and Sogge 1998, F. Howe unpubl. data), and single territories have been located at sites in the Panguitch Lake area (U.S. Forest Service unpubl. data) and within Bryce Canyon National Park (Schreier 1996).

Nevada

Southern Nevada is predominantly an arid region with few riparian areas, and nearly all rivers in the State empty into lakes that have no outlet or lose their waters by absorption and evaporation as they spread over valley floors (Linsdale 1936). Riparian habitat, and therefore breeding flycatchers, were probably found primarily along portions of major drainages such as the lower Colorado River, the Virgin River and its major tributaries, and areas where spring-fed riparian and wetland habitat flourished. Although some portions of the Virgin River retain substantial amounts of riparian vegetation, riparian habitats in most areas have been severely reduced and degraded, such that suitable flycatcher breeding habitat is even more rare than in the pre-settlement past. Unitt (1987) reported only three historical southwestern willow flycatcher breeding locations: Indian Springs, Corn Creek, and the Colorado River at the southern tip of the State. Recent surveys have discovered mostly small breeding populations along the Virgin River, Muddy River, Amargosa River, Meadow Valley Wash, and Pahranagat River drainages (McKernan and Braden 1998, 1999, 2001; Micone and Tomlinson 2000). Some of the flycatchers breeding at the Virgin River inflow to Lake Mead are subject to inundation by fluctuating lake levels (McKernan and Braden 1999 and 2001). At two breeding sites (Key Pittman Wildlife Management Area and Mesquite West), breeding habitat has recently become established and occupied (McKernan and Braden 2001, Gallagher et al. 2001).

Colorado

Southwestern Colorado hosts the headwaters of several major drainages, including the San Juan River and the Rio Grande, which flow through relatively broad valleys and once supported extensive riparian habitats. There are also many smaller streams which were once heavily wooded. However, much of the riparian habitat in these areas has been reduced and heavily impacted. Statewide, willow flycatchers were locally common (Bailey and Niedrach 1965), but it is difficult to reconstruct the historical distribution and abundance of *E. t. extimus*. Phillips (1948) makes no mention of flycatchers from the southwest portion of the State. Bailey and Niedrach (1965) describe two willow flycatchers collected in San Juan County, but these are not confirmed as breeders. Recent surveys suggest that willow flycatchers are very localized and uncommon within the probable range of *E. t. extimus* in southwestern Colorado. Within the range of *E. t. extimus*, breeding flycatchers have been confirmed only on tributaries to the San Juan (Williams Creek Reservoir, Los Pinos River, and Piano Creek) and at Alamosa National Wildlife Area and McIntire Springs, within the Rio Grande drainage in the San Luis Valley (Owen and Sogge 1997, Sogge et al. 2001). However, much riparian habitat remains unsurveyed, and additional breeding populations may be present. Recent genetics research (Paxton 2000) affirms that flycatchers in the San Luis Valley are affiliated with *E. t. extimus*, but uncertainties remain about the subspecies status of willow flycatchers elsewhere in extreme southwestern Colorado.

Mexico

As discussed above ("Range and Distribution"), it is possible the flycatcher was abundant on the delta of the Colorado River in Mexico prior to establishment of numerous dams upstream. Currently, surface water delivery to the delta is minimal or absent for long periods; habitat is much reduced and altered. Similarly, the flycatcher is likely to have occurred in northern Chihuahua along the Rio Grande, where habitat is now reduced and altered due to upstream dams. Historic record of breeding flycatchers on the Rio Grande at Fort Hancock, Texas, suggests occurrence in adjacent Chihuahua; the Rio Grande now is typically dry in that region.

J. Reasons for Listing and Current Threats

Section 4(a)(1) of the ESA lists five factors that must be considered when determining if a species should be designated as threatened or endangered. These factors are: A. The present or threatened destruction, modification, or curtailment of its habitat or range; B. Overutilization for commercial, recreational, scientific, or educational purposes; C. Disease or predation; D. The inadequacy of existing regulatory mechanisms; and E. Other natural or manmade factors affecting its continued existence. A species may be determined to be an endangered or threatened species due to one or more of the five factors. The southwestern willow flycatcher was determined to be endangered by numerous threats causing extensive loss of habitat (factor A), lack of adequate protective regulations (factor D; see Section III.), and other natural or manmade factors including brood parasitism by the brown-headed cowbird (factor E) (USFWS 1995).

The reasons for the decline of the southwestern willow flycatcher and current threats it faces are numerous, complex, and inter-related. The major factors are summarized below by categories, in approximate order of their significance. For additional discussions see USFWS (1995) and Marshall and Stoleson (2000). However, these factors vary in severity over the landscape and at any given locale, several are likely to be at work, with cumulative and synergistic effects. The most significant impact should be expected to vary from site to site. And because of their inter-relatedness, distinctions between different types of impacts are sometimes ambiguous or artificial. This is true even for divisions presented here, "Habitat Loss and Modification" and "Changes in Abundance of Other Species." For example, urban and agricultural development may cause both habitat degradation and changes in the abundance of cowbirds, domestic cats, and non-native vegetation. When assessing and addressing the impacts to any riparian ecosystem, the cumulative and inter-related impacts of all potential factors should be considered.

1. Habitat Loss and Modification

The primary cause of the flycatcher's decline is loss and modification of habitat. Its riparian nesting habitat tends to be uncommon, isolated, and widely dispersed. Historically, these habitats have always been dynamic and unstable in place and time, due to natural disturbance and regeneration events such as floods, fire, and drought. With increasing human populations and the related industrial, agricultural, and urban developments, these habitats have been modified, reduced, and destroyed by various mechanisms. Riparian ecosystems have declined from reductions in water flow, interruptions in natural hydrological events and cycles, physical modifications to streams, modification of native plant communities by invasion of exotic species, and direct removal of riparian vegetation. Wintering habitat has also been lost and modified for this and other Neotropical migratory birds (Finch 1991, Sherry and Holmes 1993). The major mechanisms resulting in loss and modification of habitat involve water management and land use practices, and are discussed below.

Dams and Reservoirs

Most of the major and many of the minor southwestern streams that likely supported southwestern willow flycatcher habitat are now dammed (Appendix D Table 2). Operation of dams modifies, reduces, destroys, or increases riparian habitats both downstream and upstream of the dam site. Below dams, natural hydrological cycles are modified. Maximum and minimum flow events both can be altered. Flood flows are reduced in size and frequency below many dams. Base flows can be increased or decreased depending on how the dam is operated. High flows are often reduced or shifted from that of the natural hydrograph below dams managed for downstream water supply. Daily water fluctuations can be very high below dams operated for hydroelectric power. The more or less annual cycle of base flow punctuated by short-duration floods is lost. In so doing, dams inhibit the natural cycles of flood-induced sediment deposition, floodplain hydration and flushing, and timing of seed dispersal necessary for establishment and maintenance of native riparian habitats. Lack of flooding also allows a buildup of debris, resulting in less substrate available for seed germination, and increasing the frequency of fires. Because of evapoconcentration, natural levels of salt and other minerals are often artificially elevated in downstream flow and in downstream alluvial soils. These changes in soil and water chemistry can affect plant community makeup (see below). Upstream of dam sites, riparian habitats are inundated by reservoirs, as beneath Lake Powell, where Behle and Higgins (1959) considered the flycatcher to be common. In some locales, this effect is partially mitigated by temporary development of riparian habitats at inflow deltas, where source streams enter the reservoirs. However, these situations tend to be vulnerable, often inundated or desiccated as reservoir management raises and lowers the water level, resulting in unstable flycatcher populations, such as at Elephant Butte Reservoir in New Mexico, Roosevelt Lake in Arizona, Lake Mead on the Colorado River, and Lake Isabella on the Kern River in California. Although large flycatcher populations do occupy reservoir habitat, they may not be as numerous or as persistent as those that occupied miles of pre-dammed rivers. For further discussion, see Appendices H and I.

Diversions and Groundwater Pumping

Surface water diversions and groundwater pumping for agricultural, industrial, and municipal uses are major factors in the deterioration of southwestern willow flycatcher habitats (Briggs 1996) (Appendix D Table 2). The principal effect of these activities is simple reduction of water in riparian ecosystems and associated subsurface water tables. Examples: (1) Of the Colorado River's approximate flow of 16 million acre-feet (maf) per year, human consumptive use accounts for almost 11 maf and reservoirs evaporate 1.5 maf, leaving little for riparian and aquatic ecosystems. Agriculture uses over two-thirds of the water diverted or pumped from the lower Colorado River basin, with at least 40% of this share used to grow livestock feed (Morrison et al. 1996); (2) Pacific River Institute's report on Colorado River Water, including statistics on magnitude of groundwater overdraft in AZ, NV, and CA, population and water consumption projections, and proportion of water used by agriculture; (3) CEC report's conclusion about the impacts of groundwater overdraft on the San Pedro Riparian National Conservation area; (4) Explanation of Arizona Department of Environmental Quality's declaration of groundwater mining in the Prescott Active Management Area and the potential ramifications on the Verde River. Chemistry, especially salinity, of water and soils may also be significantly affected by these activities (see Appendix I).

Channelization and Bank Stabilization

Southwestern riparian ecosystems have also been modified through physical manipulation of stream courses. Channelization, bank stabilization, levees, and other forms of flow controls are carried out chiefly for flood control. These engineering activities affect riparian systems by separating a stream from it's floodplain. These control structures prevent overbank flooding, reduce the extent of alluvial-influenced floodplain, reduce water tables adjacent to streams, increase stream velocity; increase the intensity of extreme floods, and generally reduce the volume and width of wooded riparian habitats (Szaro 1989, Poff et al. 1997, see also Appendices H and I).

Phreatophyte Control

In some areas riparian vegetation is removed from streams, canals, and irrigation ditches to increase watershed yield, remove impediments to streamflow, and limit water loss through evapotranspiration (Horton and Campbell 1974). Methods include mowing, cutting, root plowing, and application of herbicides. The results are that riparian habitat is eliminated or maintained at very early successional stages not suitable as breeding habitat for willow flycatchers (Taylor and Littlefield 1986). Clearing or mowing habitat can also result in establishment of exotic plants species, which can further reduce suitability.

Livestock Grazing

Overgrazing by domestic livestock has been a significant factor in the modification and loss of riparian habitats in the arid western United States (USDA Forest Service 1979, Rickard and Cushing 1982, Cannon and Knopf 1984, Klebenow and Oakleaf 1984, General Accounting Office 1988, Clary and Webster 1989, Schultz and Leininger 1990, Belsky et al. 1999). If not properly managed, livestock grazing can significantly alter plant community structure, species composition, relative abundance of species, and alter stream channel morphology. The primary mechanism of effect is by livestock feeding in and on riparian habitats. Overutilization of riparian vegetation by livestock also can reduce the overall density of vegetation, which is a primary attribute of southwestern willow flycatcher breeding habitat. Palatable broadleaf plants like willows and cottonwood saplings may also be preferred by livestock, as are grasses and forbs comprising the understory, depending on season and the availability of upland forage. Livestock may also physically contact and destroy nests. This impact is documented for nests of *E.t. brewsteri* in California (Stafford and Valentine 1985, Valentine et al. 1988). Southwestern willow flycatcher nests in low-stature habitats could be vulnerable to this impact, e.g., nests in *Salix geyeriana* at higher elevation near Greer, AZ. Livestock also physically degrade nesting habitat by trampling and seeking shade and by creating trails that nest predators and people (see Recreation subsection below) may use. Furthermore, improper livestock grazing in watershed uplands above riparian systems can cause bank destabilization, increased runoff, increased sedimentation, increased erosion, and reduced capacity of soils to hold water. Because the impact of herbivory can be highly variable both geographically and temporally, proper grazing management strategies must be developed locally. For further discussion, see Appendix G.

Recreation

In the warm, arid Southwest, recreation is often concentrated in riparian areas because of the shade, water, aesthetic values, and opportunities for fishing, boating, swimming, and other activities. As regional human populations grow, the magnitude and cumulative effects of these activities is considerable. Effects include: reduction in vegetation through trampling, clearing, woodcutting and prevention of seedling germination due to soil compaction; bank erosion; increased incidence of fire; promoting invasion by exotic plant species; promoting increases in predators and scavengers due to food scraps and garbage (ravens, jays, grackles, skunks, squirrels, domestic cats, etc.); promoting increases in brood-parasitic cowbirds; and noise disturbance. Recreational development also tends to promote an increased need for foot and vehicle access, roads, pavement, trails, boating, and structures which fragment habitat (i.e., verandas, picnic areas, etc.). Effects of these activities on southwestern willow flycatchers certainly vary with different situations. Reductions in density and diversity of bird communities, including willow flycatchers (*E. t. adastus*), has been associated with recreational activities (Aitchison 1977, Blakesley and Reese 1988, Szaro 1980, Taylor 1986, Riffell et al. 1996). For additional discussion see Appendix M.

Fire

Fire is an imminent threat to occupied and potential southwestern willow flycatcher breeding habitat. Although fires occurred to some extent in some of these habitats historically, many native riparian plants are neither fire-adapted nor fire-regenerated. Thus, fires in riparian habitats are typically catastrophic, causing immediate and drastic changes in riparian plant density and species composition. Busch (1995) documented that the current frequency and size of fires in riparian habitats on two regulated rivers (Colorado and Bill Williams) is greater than historical levels because reduced floods have allowed buildup of fuels, and because of the expansion and dominance of the highly-flammable tamarisk. Tamarisk and arrowweed (*Tessaria sericea*) recover more rapidly from fire than do cottonwood and willow. In recent years riparian wildfires destroyed occupied southwestern willow flycatcher sites on the Rio Grande in New Mexico, the San Pedro and Gila rivers in Arizona, and in the Escalante Wildlife Area in Colorado. For further discussion, see Appendix L.

Agricultural Development

The availability of relatively flat land, rich soils, high water tables, and irrigation water in southwestern river valleys has spawned wide-scale agricultural development. These areas formerly contained extensive riparian habitats. Agricultural development entails not only direct clearing of riparian vegetation, but also re-engineering floodplains (e.g., draining, protecting with levees), diverting water for irrigation, groundwater pumping, and applications of herbicides and pesticides, which may also affect the flycatcher and its habitat (Appendix D Table 2). For example, as recently as 1996, since the flycatcher's listing as endangered, up to 2 km (1.2 mi) of occupied flycatcher habitat was lost to agricultural development on the Santa Ynez River in California (USFWS in litt.). Agricultural development can also increase the likelihood or severity of cowbird parasitism, by creating foraging sites (e.g., short-grass fields, grain storage, livestock concentrations) in proximity to flycatcher nesting habitat (See Appendices E and F).

In many river reaches, the flood plain riparian habitat that is utilized by flycatchers is partly sustained by agricultural return flows (Appendix D Table 2). Natural functioning ecosystems would be more likely to sustain flycatcher populations over the long-term than artificial agricultural systems. With reductions in irrigated agriculture, additional water and land could be made available for restoration of flycatcher habitat. However, in the short-term, reductions in the agricultural return flows themselves can pose a threat to some flycatcher populations.

Strips of riparian vegetation that develop along drainage ditches or irrigation canals also potentially provide habitat for the flycatcher. Benefits are greatest when the vegetation is left undisturbed, as opposed to being periodically cleared, and where the riparian vegetation strips are dense, abundant, and relatively near natural flood plain habitat. However, riparian bird populations in small or temporary habitats may be population sinks, producing a net drain on the overall population; additional data are needed on source-sink dynamics of small and large flycatcher breeding sites.

Urbanization

Urban development results in many impacts to riparian ecosystems and southwestern willow flycatcher habitat. Urbanization in or next to flycatcher habitat provides the catalyst for a variety of related and inter-related direct and indirect effects which can cause loss and/or the inability to recover habitat.

At the broad perspective, urban development creates demands for domestic and industrial water use. These demands are satisfied by diverting water from streams and groundwater pumping, which de-water streams and aquifers. Municipal water management often involves constructing reservoirs, structures to control floods, and structures to control and alter stream courses and washes to protect floodplain development. These alter stream hydrology.

Urban development can ultimately begin the slow degradation of habitat by instigating further activities that remove natural river processes and/or adding other stresses to riparian areas. Urbanization provides the need for increased transportation systems that include bridges, roads, and vehicles detrimental to riparian habitat and riparian inhabitants. In recent years, placement of bridges have resulted in the loss of seven known flycatcher territories in New Mexico and Arizona, and the possible road-kill of a southwestern willow flycatcher in Arizona (Marshall and Stoleson 2000). Developments can also cause nearby private landowners that previously promoted conservation of their land to sell for development purposes. Also, as a result of dense riparian vegetation in proximity to development, some communities may choose to remove brush and/or other mid-story or sub-canopy vegetation to reduce or remove the risk of fire. Increased urbanization tends to promote a greater need for commercial development, which subsequently results in increased growth. Furthermore, urban development also increases the demand for recreational use of remaining riparian areas (see Recreation section above, and Appendix M).

Establishing housing developments near rivers promotes additional risks to the health of rivers, riparian habitat, and persistence of nesting flycatchers. Developments increase trash, bird feeders, and people, and as a result, the increased presence of predators such as cowbirds (see section 2., "Brood Parasitism," below), house cats, and possibly a proliferation/concentration of other natural predators of flycatchers (i.e., great-tailed grackles, common ravens). Developers may remove habitat nearest the floodplain which provides sound and visual barriers, possible fledgling dispersal habitat, and plants which may provide food, sheltering, perching, and foraging for the flycatcher. Urban development can also produce pollutants to the environment through run-off, waste, and other chemicals. Urbanization can also increase the presence of non-native vegetation in the riparian area from the planting of grasses, shrubs, and trees that out-compete native plants.

Treated municipal wastewater presently sustains several of the riparian habitat patches upon which the flycatcher depends (Appendix D Table 2). At sites where the alluvial aquifer has not been severely depleted, discharge of treated water into the river channel has allowed for restoration or rehabilitation of large expanses of riparian vegetation. Concentrations of nutrients and other pollutants can be high in the effluent, but the presence of functional riparian ecosystems or constructed wetlands at the discharge site generally serves to improve the water quality.

Release of municipal effluent into a stream channel or alluvial aquifer does not automatically produce or sustain high quality riparian habitat. Regional planning efforts throughout the flycatcher's range can help to maximize the environmental benefits of reclaimed water. Hydrogeologic assessments can identify sites where shallow water tables and thus phreatophytic riparian vegetation are likely to develop; landscape studies can identify sites likely to have high wildlife habitat value by virtue of proximity and connectivity to existing riparian patches. Ecological input can delineate appropriate temporal and spatial patterns for the water release.

2. Changes in Abundance of Other Species

Exotic Species

Several exotic (non-native) plant species have become established in southwestern willow flycatcher riparian habitats, with varying effects on the bird. Tamarisk is widespread and often dominant in southwestern riparian ecosystems, often forming dense monotypic stands. Southwestern willow flycatchers do nest in some riparian habitats containing and even dominated by tamarisk (McKernan and Braden 1999, Paradzick et al. 2000), and available data suggest that flycatcher productivity and survivorship are similar between native and tamarisk habitats. However, native riparian plant communities may be of greater recovery value than tamarisk, because tamarisk in some settings facilitates a periodic fire regime, can be detrimental to native riparian plants in other ways (Busch and Smith 1993), and may in some cases be of lesser value to bird communities overall (Rosenberg et al. 1991). However, this does not diminish the value of maintaining currently suitable and occupied tamarisk habitat. Tamarisk can mimic many of the ecological functions of native riparian plant species (Stromberg 1998), and in many cases supports a riparian obligate bird community that would not occur in areas where habitat conditions can no longer support native riparian vegetation. This is significant, because where tamarisk is strongly dominant, replacement with native species may be difficult or impossible without changes in current hydrologic regimes. Unlike some native tree species, tamarisk also maintains the fine branching structure as it grows to maturity, which may make it attractive to nesting flycatchers for a longer period of time. Furthermore, tamarisk flowers throughout much of the summer, which may be important in attracting pollinating insects (a major component of flycatcher diet) throughout the flycatcher's breeding season.

Throughout the western U.S., large tracts of tamarisk are being cleared for purposes including water salvage, flood water conveyance, and/or wetland restoration. Such actions pose a threat to southwestern willow flycatchers when conducted in areas of suitable habitat (occupied or unoccupied) and when conducted in the absence of restoration plans to ensure replacement by vegetation of equal or higher functional value.

Russian olive is also well-established in southwestern riparian systems, and is present in some current flycatcher nest sites. The foliage of Russian olive is more broad-leaved than tamarisk, and so may be similar to willows in the ways it affects microsite conditions of temperature and humidity. Other exotic trees, such as Siberian elm (*Ulmus pumilis*) and tree of heaven occur in southwestern riparian ecosystems but do not appear to have value as nesting habitat for the flycatcher. Because their distributions are highly localized, their impacts on the flycatcher may be limited to very local, perhaps minor changes in riparian community composition. In California, giant reed (*Arundo donax*) is spreading rapidly, and forms dense monotypic stands unsuitable for willow flycatchers. Also, many exotic herbs are established in southwestern riparian ecosystems, including bermudagrass (*Cynodon dactylon*) and rabbitfoot grass (*Polypogon monspeliensis*). For further discussion, see Appendices G and J.

Brood Parasitism

As summarized above in "Disease and Parasites," brood parasitism negatively affects the flycatcher, by reducing reproductive performance. Parasitism typically results in reductions in number of flycatcher young fledged per female per year. Brown-headed cowbirds have probably occurred naturally in much of the flycatcher's range, for thousands of years (Lowther 1993). However, they likely increased in abundance with European settlement, and established in southern California only since 1900 (Rothstein 1994b, Appendix F). It is possible that cowbird abundance has peaked, and may be declining in recent decades (Sauer et al. 1997). At normal levels, parasitism is rarely an impact on host species at the population level. However, for a rare host, parasitism may be a significant impact on production of young at the population level, especially with the high predation rates flycatchers and other small passerines experience. When combined with negative influences of predation, habitat loss, and overall rarity, parasitism can be a significant contributor to population decline.

The effects and management of cowbird parasitism with respect to the flycatcher are complex. Cowbird parasitism levels vary widely across the flycatcher's range (Table 5). A given intensity of cowbird parasitism may or may not have significant influence on the trend of a given flycatcher population. Similarly, cowbird control may or may not result in significant, or even measurable benefits to a population. This is in part because cowbird parasitism acts in concert with many other negative influences on the flycatcher, some related and some not. These include habitat degradation, predation, size of flycatcher population, etc. In some cases a single impact like cowbird parasitism may not appear significant, but the additive (or synergistic) effects with other impacts may be very significant, even critical.

Table 5. Rates of parasitism by brown-headed cowbirds on the southwestern willow flycatcher at selected locations. (Adapted from Whitfield and Sogge 1999; no cowbird control at these sites for these years.)

Region	Years	# of Nests	Mean Annual Parasitism
South Fork Kern River, CA	1987, 1989-1992	163	66%
Mesquite, NV	1997	5	40%
Virgin River Delta, NV	1997	14	21%
Mormon Mesa, NV	1997	3	0%
Grand Canyon, AZ	1982-1986, 1992-1996	25	48%
White Mountains, AZ	1993-1996	36	19%
San Pedro River, AZ	1995-1996	61	3%
Roosevelt Lake, AZ	1995-1996	17	18%
Verde River, AZ	1996	13	46%
Gila River Valley, AZ	1995, 1997	49	18%
Other sites, NM	1995	10	40%

Cowbird management may prove to be an important tool in recovering the flycatcher, because it can be ameliorated more easily than other threats such as habitat loss or nest predation. But cowbird control actions such as trapping programs should not be viewed as a reflexive panacea. Because of local conditions, even intensive control may not result in increasing a flycatcher population. For example, on the Kern River, a flycatcher population has decreased from 34 pairs in 1993 to 23 in 1999, despite trapping having decreased parasitism from an average of 65% prior to trapping to an average of 22% with trapping (Whitfield et al. 1999). This does not mean that trapping is a wasted effort here; it may be preventing more serious declines. Evidently other influences are at work, which should also be addressed. Although effects of cowbird parasitism can be ameliorated with management, cowbird control has both benefits and downsides, some of which may be significant (see Appendix F), so cowbird control should be instituted only when impacts exceed certain levels. Given that parasitism rates of 20-30% have barely detectable effects on host recruitment because of renesting after desertion or predation of parasitized nests (see Appendix F), managers should in most cases consider cowbird control only when adequate data show that parasitism on a local population exceeds these rates for two or more years (see Appendix F). Trapping exerts strong selective pressures on local cowbird populations to develop resistance to trapping. Such resistance could reflect a true evolved behavior based on genetic variation or a learned tradition. Resistance could take the form of a lessened attraction to groups of cowbirds (as are used to attract birds to the decoy traps), a reluctance to enter traps, and an ability to escape from the decoy traps commonly used in cowbird control programs (see Appendix F, Section d: Potential Downsides or Negative Aspects of Cowbird Control).

3. Vulnerability of Small Populations

Demographic Effects

The total number of southwestern willow flycatchers is small, with an estimated 1100-1200 territories rangewide (see section II.I., "Current Population and Trends"). These territories are distributed in a large number of very small breeding groups, and only a small number of relatively large breeding groups. These isolated breeding groups are vulnerable to local extirpation from floods, fire, severe weather, disease, and shifts in birth/death rates and sex ratios. Marshall and Stoleson (2000) noted that "Even moderate variation in stochastic factors that might be sustained by larger populations can reduce a small population below a threshold level from which it cannot recover. The persistence of small populations depends in part on immigration from nearby populations, at least in some years (Stacey and Taper 1992). The small, isolated nature of current southwestern willow flycatcher populations exacerbates the risk of local extirpation by reducing the likelihood of immigration among populations." The vulnerability of the few relatively large populations makes the above threats particularly acute. In recent years, several of the few larger populations have been impacted by fire (San Pedro River) and inundation by impounded water (Lake Mead, Lake Isabella). Also, the flycatcher appears to be a quasi-colonial species (McCabe 1991). At its few large breeding sites, many territories are often packed into relatively small areas, with significant levels of polygyny, extra-pair copulation, and pair re-shuffling (Paxton et al. 1997, Netter et al. 1998, Paradzick et al. 1999). These may be significant factors in maintaining genetic interchange. The presence of a threshold "colony size" may be an important catalyst for successful breeding sites to function.

Genetic Effects

Because the flycatcher exists in small populations, there has been concern over potential low genetic variation within populations, and possible inbreeding (Marshall and Stoleson 2000). If low genetic variation did exist, it could result in reduced fecundity and survival, lowered resistance to parasites and disease, and/or physiological abnormalities (Allendorf and Leary 1986, Hartl 1988). However, recent research has found substantial genetic variation within and among flycatcher breeding groups, and within and between watersheds (Sogge et al. 1998, Busch et al. 2000). The flycatcher may also be threatened by low effective population size, which is an index of the actual numbers of individuals breeding in a population and the number of offspring they produce. A species' effective population size may be much smaller than the absolute population size because of uneven sex ratios, uneven breeding success among females, polygyny, and low population numbers which exacerbate these factors (Marshall and Stoleson 2000).

4. Migration and Winter Range Stresses

As a neotropical migrant, the flycatcher spends more time in migration and on the wintering grounds each year than it does on its North American breeding grounds (Sedgwick 2000). Migrant and wintering flycatchers face a number of known and potential threats. For example, migration is a period of high energy demands, and migrating individuals must find suitable "stopover" habitat at which to replenish energy reserves needed for the next step of migration flight (Finch et al. 2000). Insufficient stopover habitat, and destruction or degradation of existing habitat, could lead to increased mortality during migration, and/or prolonged migration resulting in late arrival to wintering or breeding sites (with reduced fitness upon arrival). Recent winter surveys in portions of Central America (Koronkiewicz et al. 1998, Koronkiewicz and Whitfield 1999, Lynn and Whitfield 2000) have found that willow flycatcher wintering habitat is often located in lowland areas that are subject to heavy agricultural uses, many of which negatively impact key habitat components at wintering sites. We do not know if winter habitat is currently limiting for willow flycatchers (nor exactly how much habitat is needed overall), but we do know that the amount of native lowland forest and wet areas (e.g., lagunas, esteros, etc.) - habitats in which flycatchers currently overwinter - has decreased dramatically over the last 100 years (Koronkiewicz et al. 1998). Furthermore, agri-chemicals and pesticides are still widely used in many regions through which flycatchers migrate, and in wintering sites (Koronkiewicz et al. 1998, Lynn and Whitfield 2000), thereby exposing flycatchers to potential environmental contaminants during much of the year.