chat, 423 percent. Bock et al. (1993) found that 40 percent of the riparian bird species they examined, including the willow flycatcher (various subspecies), were negatively affected by livestock grazing. Increases in willow flycatcher numbers (various subspecies) have followed reduction, modification, or removal of cattle grazing. Taylor (1986) found a negative correlation between recent cattle grazing and abundance of numerous riparian birds, including the Great Basin willow flycatcher (E. t. adastus). In an area ungrazed since 1940, his bird counts were five to seven times higher than comparable plots where grazing was terminated in 1980. Taylor and Littlefield (1986) found higher numbers of Great Basin willow flycatchers correlated with minimal or nonexistent livestock grazing. Klebenow and Oakleaf (1984) listed the Great Basin willow flycatcher among bird species that declined from abundant to absent in riparian habitats degraded in part by overgrazing. Schlorff reported willow flycatchers returning to Modoc County, California, several years after removal of livestock grazing (pers. comm. cited in Valentine et al. 1988). Knopf et al. (1988) found that, during the summer, Great Basin willow flycatchers were present on winter-grazed pastures, but were virtually absent from summergrazed pastures

The Service believes that documentation of livestock impacts on other willow flycatcher subspecies is relevant to E. t. extimus, because linear riparian habitats in the arid range of E. t. extimus are especially vulnerable to fragmentation and destruction by livestock. As shady, cool, wet areas providing abundant forage, they are disproportionately preferred by livestock over the surrounding xeric uplands (Ames 1977, Valentine et al. 1988, A. Johnson 1989). Harris et al. (1987) believed that termination of grazing along portions of the South Fork of the Kern River in California was responsible for increases in riparian vegetation and, consequently, nesting E. t. extimus. Suckling et al. (1992) noted that most of the areas still known to support E. t. extimus have low or nonexistent levels of livestock grazing. More recent surveys (Muiznieks et al. 1994) have found *E. t. extimus* in areas with livestock grazing; however, these occur in widely dispersed, small groups whose nesting success is largely unknown, and where livestock grazing intensity and seasonality are also unknown.

Another likely factor in the loss and modification of southwestern willow flycatcher habitat is invasion by the exotic tamarisk. Tamarisk (also called saltcedar) was introduced into western North America from the Middle East in the late 1800's as an ornamental windbreak and for erosion control. It has spread rapidly along southwestern watercourses, typically at the expense of native riparian vegetation, especially cottonwood/willow communities. Although tamarisk is present in nearly every southwestern riparian community, its dominance varies. It has replaced some communities entirely, but occurs at a low frequency in others.

The spread and persistence of tamarisk has resulted in significant changes in riparian plant communities. In monotypic tamarisk stands, the most striking change is the loss of community structure. The multilayered community of herbaceous understory, small shrubs, middle-layer willows, and overstory deciduous trees is often replaced by one monotonous layer. Plant species diversity has declined in many areas, and relative species abundance has shifted in others. Other effects include changes in percent cover, total biomass, fire cycles, thermal regimes, and perhaps insect fauna (Kerpez and Smith 1987, Carothers and Brown 1991, Rosenberg et al. 1991, Busch and Smith 1993).

Disturbance regimes imposed by man (e.g., grazing, water diversion, flood control, woodcutting, and vegetation clearing) have facilitated the spread of tamarisk (Behle and Higgins 1959, Kerpez and Smith 1987, Hunter et al. 1988, Rosenberg et al. 1991). Cattle find tamarisk unpalatable. However, they eat the shoots and seedlings of cottonwood and willow, acting as a selective agent to shift the relative abundance of these species (Kerpez and Smith 1987). Degradation and, in some cases, loss of native riparian vegetation lowered the water table and resulted in the loss of perennial flows in some streams. With its deep root system and adaptive reproductive strategy, tamarisk thrives or persists where surface flow has been reduced or lost. Further, tamarisk establishment often results in a selfperpetuating regime of periodic fires, which were uncommon in native riparian woodlands (Busch and Smith

Manipulation of perennial rivers and streams has resulted in habitats that tend to allow tamarisk to outcompete native vegetation. Construction of dams created impoundments that destroyed native riparian communities. Dams also eliminated or changed flood regimes, which were essential in maintaining native riparian ecosystems. Changing (usually eliminating) flood regimes provided a competitive edge to

tamarisk. In contrast to native phreatophytes, tamarisk does not need floods and is intolerant of submersion when young. Diversion of water caused the lowering of near-surface groundwater and reduced the relative success of native species in becoming established. Irrigation water containing high levels of dissolved salts also favors tamarisk, which is more tolerant of high salt levels than most native species (Kerpez and Smith 1987, Busch and Smith 1993).

The rapid spread of tamarisk has coincided with the decline of the southwestern willow flycatcher. Although E. t. extimus has been documented nesting in tamarisk, it is not known whether, over the long term, reproductive success of southwestern willow flycatchers nesting in tamarisk has differed from the success of flycatchers nesting in native vegetation. Studies in Arizona have documented low breeding densities and low reproductive success for southwestern willow flycatchers nesting in tamarisk (Hunter et al. 1988, Muiznieks et al. 1994). These data, coupled with a possible decrease in the arthropod prey base and thermal protection for nests provided by tamarisk, suggest that tamarisk may provide poor quality nesting habitat. However, more extensive comparative studies are needed to determine the overall impact on the southwestern willow flycatcher of the conversion of native broadleafdominated riparian habitat to tamariskdominated habitat.

Other studies of riparian bird communities have documented changes in bird species diversity, corresponding with invasion by tamarisk.

Conversion to tamarisk typically coincides with reduction or complete loss of bird species strongly associated with cottonwood-willow habitats. These include the yellow-billed cuckoo (Coccyzus americanus), summer tanager (Piranga rubra), northern oriole (Icterus galbula), and the southwestern willow flycatcher (Hunter et al. 1987, Hunter et al. 1988, Rosenberg et al. 1991). While Brown and Trosset (1989) believed tamarisk may serve as an "ecological equivalent" to native vegetation, they noted that their study occurred where a tamarisk community became established where no native equivalent existed before.

Some authors believe tamarisk may not provide the thermal protection that native broadleaf species do (Hunter *et al.* 1987, Hunter *et al.* 1988). This could be important at lower elevations in the Southwest, where extreme high temperatures are common during the bird's midsummer breeding season. It is