Tamarisk in Riparian Woodlands: A Bird’s Eye View

Mark K. Sogge, Eben H. Paxton, and Charles van Riper III

Although nonnative plant and animal species are common in many ecosystems, the ecological ramifications of their presence are generally not well studied or understood. Yet in the conservation, resource management, and policy communities, there has for decades been a strong bias against nonnative species (Westman 1990; Davis et al. 2011). One reason for this sentiment is that plants and animals introduced into new ecosystems have sometimes had negative impacts on native species and their communities. Nonetheless, the realities and complexities of how nonnative species interact with native flora, fauna, and ecosystems are often oversimplified, and issues become framed as a “native good, alien bad” argument (Goodenough 2010). Nonnative species are frequently vilified and portrayed as “enemies of nature and man” (Davis et al. 2011; see also chapter 16, this volume), and become the targets of aggressive control or eradication programs. Policy and management actions—although generally based on good intent—can result in unintended ecological outcomes and consequences (Westman 1990; D’Antonio and Meyerson 2002; Goodenough 2010).

In this chapter we present a “bird’s eye” view of tamarisk (Tamarix spp., salt-cedar) and some issues surrounding management of this introduced plant in riparian habitats. We focus on birds not because they are the only wildlife group of concern or necessarily the most important aspect of the issue, but rather because they are a relatively well-studied group that can provide important insights into the role of tamarisk in riparian ecosystems, and because impacts on wildlife—especially birds—have been raised by all sides in the tamarisk management debate.
(DeLoach et al. 2000; Dudley and DeLoach 2004; Sogge et al. 2008; van Riper et al. 2008; Paxton et al. 2011; see also chapter 10, this volume). We begin with an overview of the perceptions and realities of bird use of tamarisk, and then discuss tamarisk control and its effects on birds. We close by describing some of the changing perspectives about the management of tamarisk and riparian habitats in western North America.

Early Views of Tamarisk and Birds

Riparian habitat—shrub and tree vegetation bordering streams, rivers, lakes and reservoirs—occupies less than 10% of the landscape yet is disproportionately important to wildlife, including many bird species (Knopf et al. 1988). Birds use riparian areas for breeding, migration stopovers, and wintering habitat in which they can find food resources, nest sites, shelter from inclement weather, protection from predators, and other ecological services. Native riparian habitats comprising primarily cottonwood (Populus spp.), willow (Salix spp.), and mesquite (Prosopis spp.) have declined greatly over the last 100 years with land conversion to agriculture, urbanization, overgrazing, and disruption of hydrologic processes via damming, water withdrawals, and diversions (Knopf et al. 1988; Graf 1992; but see also chapter 6, this volume). With this decline in native trees has come reduction of many riparian breeding bird populations (Johnson et al. 2010) and negative impacts on migrating species (McGrath and van Riper 2005; McGrath et al. 2008).

Tamarisk is a tree/shrub that was intentionally introduced into the United States from southern Europe, Asia, and North Africa in the 1800s, originally as an ornamental plant and subsequently to provide shade and erosion control in the arid west (see chapters 16 and 19, this volume). Since then, especially during the dam construction and water-diversion era of the 1940s to 1960s, tamarisk spread widely, and is now found in all western states (see chapter 1, this volume). Although there is currently no credible estimate of overall tamarisk abundance (Nagler et al. 2010; see also chapter 3, this volume), this introduced plant is among the most common riparian trees and/or shrubs along many river systems and reservoirs in Arizona, New Mexico, Utah, Southern California and Nevada, and in western Oklahoma and Texas. In some locations tamarisk can form large monocultures that cover thousands of hectares (e.g., the Pecos River and lower Colorado River). In areas along highly regulated and altered rivers, tamarisk can grow and persist where native riparian trees cannot (Shafroth et al. 2008; Stromberg et al. 2009; Nagler et al. 2010; see also chapters 5, 6, 9, and 24, this volume).

Because the decline of native riparian habitat occurred concurrently with the spread of tamarisk, this introduced plant has been portrayed as a key factor in the reduction of riparian breeding bird numbers (Kunzman et al. 1989; DeLoach et al. 2000). Through the 1980s and 1990s, there was a general view that tamarisk was
an undesirable habitat, despite data showing extensive use of tamarisk by birds. For example, Brown et al. (1987), Hunter et al. (1988), and Rosenberg et al. (1991) described riparian birds breeding in tamarisk riparian habitats along major river systems in New Mexico, Arizona, and Colorado. Although their studies showed that some birds were less abundant or absent in tamarisk when compared to native riparian vegetation, it was also clear that tamarisk supported larger local and regional bird populations than would have occurred when local native vegetation was absent. However, even after these results were published, the more positive aspects of bird use of tamarisk were largely overlooked, and managers and conservationists continued to focus on the shortcomings of tamarisk rather than on its habitat value for birds.

More evidence of the positive value of tamarisk to birds accumulated in the 1990s. Livingston and Schemnitz (1996) reported that tamarisk along the Pecos River in New Mexico supported diverse and abundant bird communities, adding to Howe's (1986) earlier report of yellow-billed cuckoo (*Coccyzus americanus*) populations in tamarisk habitats along that river. In addition, researchers began to document that the federally endangered southwestern willow flycatcher (*Empidonax traillii extimus*) was breeding in tamarisk and likely using it as migration stopover habitat (Sogge et al. 1997). Over the next decade, additional studies were published showing diverse riparian bird communities in tamarisk at a variety of river systems in the arid Southwest (see review in Sogge et al. 2008).

Despite peer-reviewed studies suggesting a more complex ecological relationship between birds and tamarisk, however, there continued to be a widespread view that this introduced plant was unsuitable and provided poor-quality habitat for birds, that only the southwestern willow flycatcher bred in tamarisk, and that tamarisk eradication would have overwhelmingly positive effects for birds and other wildlife (Kunzmann et al. 1989; DeLoach et al. 2000). That perception of tamarisk as a habitat "sink" continued to drive many aspects of resource management policy, practice, and legislation regarding tamarisk control (Shafroth and Briggs 2008).

**Birds' Use of Tamarisk: Patterns, Mechanisms, and Considerations**

Sogge et al. (2008), Paxton et al. (2011) and Bateman et al. (see chapter 10, this volume) detail the extent and nature of tamarisk use by breeding birds. We summarize here some major points and general considerations. First, tamarisk is an important component of avian habitat throughout many western riparian areas. However, the quality of tamarisk habitat varies among sites; geographic, structural, and hydrologic factors are key determinants of its habitat suitability in any given location (Hunter et al. 1988; Yard et al. 2004; Hinojosa-Huerta 2006; Walker 2006; see also chapter 10, this volume). While it is now widely known that the endangered southwestern willow flycatcher uses tamarisk as breeding habitat (USFWS 2002),
Ecology

this is not a “single-species” issue; approximately 50 different species of birds are documented as breeding in tamarisk (Sogge et al. 2008). These species use tamarisk differently, depending on their specific ecological needs, just as is true for native habitats (Paxton et al. 2008; Sogge et al. 2008; Paxton et al. 2011). Birds that use a range of native riparian habitats (“riparian generalists”; see figure 11.1) can be frequently found in tamarisk, while those with specialized riparian-habitat needs generally are not. For example, larger cavity nesters and raptors are generally not found breeding in tamarisk (Sogge et al. 2008) because tamarisk does not have stems that are big enough for cavities, or branches strong enough to support large nests, although the larger athel (Tamarix aphylla) may be an exception.

Why and how do birds use tamarisk? They seek food, including arthropods; shelter from predators and weather; song and foraging perches; and nest sites. They obtain these where available from tamarisk in much the same way as from any native riparian habitat. But because the ecological needs of birds vary depending on whether they are resident breeders, migrants, or are wintering, their use of habitats—native or tamarisk—will vary during these different annual stages. A bird’s use of tamarisk is also influenced by whether it can use several habitat types or depends solely on riparian vegetation. This complexity in behavior and habitat use is not always fully considered, and complicates the task of fully understanding how and where tamarisk provides resources for birds. Just as with the overall issue of whether tamarisk is good or bad generally (see chapters 1 and 18, this volume), the answer as to whether tamarisk is good habitat for birds is likely to be “it depends.”

Unfortunately, detailed studies comparing productivity, survivorship, and other parameters for birds that breed in tamarisk and native habitats are scarce (Sogge et al. 2008). However, we can look at these questions from the perspective of the southwestern willow flycatcher, one of the most extensively studied birds

FIGURE 11.1 The nest of an Abert’s towhee (a riparian generalist) in tamarisk near the Verde River in Arizona.
Source: Photo by Greg Clark; used with permission.
that uses both native and tamarisk vegetation in the Southwest. A medium-sized neotropical migrant that builds open-cup nests (see figure 11.2) and consumes a variety of arthropods, the willow flycatcher shares key life-history traits with many other riparian breeding birds; therefore, insights drawn from flycatcher studies can help us understand tamarisk use by other riparian avifauna. The flycatcher spends its breeding season within and adjacent to riparian woodlands, where relatively tall and dense stands provide shelter from predators and weather (USFWS 2002). Flycatchers breed extensively in dense tamarisk, where they nest in areas of high leaf cover and favor the high twig density and branching structure of tamarisk (see figure 11.3), even when native willows are present nearby (Allison et al. 2003; Ellis et al. 2008; Sogge et al. 2010). If tamarisk were ineffective as shelter or as a nest substrate, we would expect to see increased nest predation, failure, abandonment, and brood parasitism, or possibly increased adult mortality through predation. But this is not the case: long-term studies in central Arizona (Paxton et al. 2007; Ellis et al. 2008) have shown no difference in success of nests placed in native versus tamarisk habitat, nor in survivorship of adults that bred in tamarisk or young that are fledged within tamarisk habitat.

Tamarisk is sometimes perceived and portrayed as providing inadequate food resources for insectivorous birds (e.g., DeLoach et al. 2000), in large part because very few arthropods in the western United States develop on or directly consume tamarisk. However, the food resources it provides are dependent on how many insects and other arthropods can be found in tamarisk stands (which often include native plant components), not on the more restrictive question of how many develop in it. It is clear that tamarisk habitats can have abundant and diverse arthropod communities (Durst et al. 2008a; see also chapter 12, this volume). Arthropod species and abundance may differ in tamarisk compared to native or mixed habitat, but such differences are to be expected and do not necessarily

FIGURE 11.2 Southwestern willow flycatcher nest in tamarisk tree in Arizona.
Source: Photo courtesy of the U.S. Geological Survey.
mean that one is “inferior” for birds. What matters to the birds’ diet is whether
the arthropods that are present in a habitat are sufficient to meet energetic and
nutritional needs. The southwestern willow flycatcher, and likely other generalist
insectivore birds, will compensate for differing arthropod conditions by varying
their diet in different habitats (Durst et al. 2008b), and there is no evidence that
these differences result in any meaningful difference in flycatcher body condition
or productivity (Owen et al. 2005; Paxton et al. 2011).

DeLoach et al. (2000) proposed that because the willow flycatcher and other
southwestern riparian birds did not evolve with tamarisk as a habitat compo-
nent, tamarisk is inherently inferior or unsuitable habitat. However, the flycatcher
evolved with and historically used a variety of early-stage successional riparian
habitats—not just willows (Sogge et al. 2010). Thus, the flycatcher’s habitat selec-
tion behavior would have been shaped by the ability to take advantage of differ-
ent riparian plants and habitat structures, as long as these provided the necessary
features and resources. This flexibility in habitat use would be selectively advan-
tageous for any bird that favors dynamic habitat such as riparian systems in the
Southwest (USFWS 2002). Even a tight evolutionary linkage between a bird and

FIGURE 11.3 Southwestern willow flycatcher nest in tamarisk tree, surrounded by native willows,
along the Rio Grande in New Mexico.
Source: Photo courtesy of the U.S. Geological Survey.
a specific habitat would not necessarily mean that more recent alternatives are inherently inferior. For example, cavity nesting bluebirds (*Sialia* spp.) readily and very successfully use artificial nest boxes, which bear little resemblance to a real tree. Like nest boxes, tamarisk is a new habitat feature and does not in all ways mirror the native habitat the birds used before, but it can attract and provide habitat value for southwestern willow flycatchers and other birds.

It is interesting to note that southwestern willow flycatchers nesting in box elder (*Acer negundo*) along the Gila River in New Mexico (Stoleson and Finch 2003), or in live oak (*Quercus agrifolia*) along the upper San Luis Rey River in California (Haas 2003) did not raise concerns about habitat suitability, even though flycatchers’ use of these tree species is very rare, much more so than their use of tamarisk. This difference between how atypical native habitats are perceived compared to tamarisk may be another manifestation of the native good, alien bad paradigm (Goodenough 2010; Davis et al. 2011; see also chapter 16, this volume).

Much less is known about the use of tamarisk by migrating birds. However, at the most basic level, we know that birds often use a broader array of habitats during migration than they do for breeding (Walker 2008; Carlisle et al. 2009). So it is not surprising that tamarisk habitats are used by migrant birds, including many species that do not breed in them. These migrants are obtaining other resources such as shelter, food, roosting perches, and predator protection. But given how the habitat characteristics of tamarisk patches vary over the landscape, we should expect its use by migrants to vary spatially and among bird species, and to negate simple “tamarisk bad, native good” assumptions. From what is known to date, this appears to be the case. For example, migrating birds along the lower Colorado River prefer mixed native and tamarisk riparian habitats over either pure native or pure tamarisk riparian habitats (van Riper et al. 2008). This is largely because of the increased vertical plant diversity provided by the understory tamarisk, as is the case on the Rio Grande in New Mexico (Yong et al. 1998). In early spring migration, McGrath et al. (2008) found that Wilson’s warblers (*Wilsonia pusilla*) along the lower Colorado River forage preferentially on honey mesquite (*Prosopis glandulosa*), then switch to foraging almost exclusively in tamarisk later in the spring (Paxton et al. 2008). Contrary to what would be expected if tamarisk offered no benefits to birds, Cerasale and Guglielmo (2010) found that compared to pure native patches, mixed tamarisk/native riparian habitat on the San Pedro River, Arizona, offered superior refueling habitat for migrating Wilson’s warblers. Although these studies looked only at Wilson’s warblers, other insectivorous migrant birds may use and respond to tamarisk similarly (Walker 2008). Clearly, tamarisk provides habitat value to a wide range of migrating species, although as with breeding birds the degree and nature of use will vary by bird species, time of the migratory season, and specific characteristics of the tamarisk habitat. Given the high value and relative rarity of native riparian habitats as migratory stopovers, and the strong conservation interest in preserving overall migration habitat and connectivity (Knopf et al.
The importance of tamarisk as migratory bird habitat should not be summarily dismissed. This is an area in which new research or synthesis of existing information would greatly expand our understanding.

**Tamarisk Control and Birds: A Brief History**

Although tamarisk introduction was originally considered an environmental success, it later became the target of decades of control and eradication efforts (Shafroth et al. 2005; see also chapters 16 and 20, this volume), including the Salt Cedar and Russian Olive Control Demonstration Act, national legislation promoting elimination of tamarisk (summarized in chapter 17, this volume). Birds have been at the center of such tamarisk control efforts, both as a justification for tamarisk control (to improve habitat for birds and other wildlife) and as a brake on some control efforts because of concerns about habitat loss. Until recently, most tamarisk control efforts were small to moderate scale using mechanical removal, chemical spraying, or other localized techniques and were successful in removing or killing tamarisk trees (see chapter 20, this volume). But such measures are labor intensive, costly, and generally not considered practical on the large scale needed to control or eradicate the plant at landscape levels. Biological control was believed to promise a better option (DeLoach et al. 2006).

The history of saltcedar biocontrol is recounted in Dudley and DeLoach (2004), DeLoach et al. (2006), Dark (2009), and Bean et al. (see chapter 16, this volume), and here we summarize key points. Saltcedar biocontrol investigations began in California in the 1960s, and in 1986, the U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) began exploring for biocontrol agents in the native Eurasian range of tamarisk. In 1994, the biocontrol researchers asked APHIS for permission to release the tamarisk leaf beetle (*Diorhabda oblongata*) at multiple sites throughout the western United States. This timing coincided with the discovery that the southwestern willow flycatcher—which had been at the time proposed for endangered species status—was using tamarisk during migration and as breeding habitat at many sites in the Southwest. The U.S. Fish and Wildlife Service (USFWS) expressed concerns about negative impacts of tamarisk biocontrol on the flycatcher’s habitats and on other riparian wildlife species. APHIS consulted the USFWS, and in 1997 submitted a Biological Assessment that projected only beneficial or benign effects on the 50 plant and animal species that they assessed (including the southwestern willow flycatcher). APHIS then proposed releasing beetles at 10 sites at least 200 miles from any sites where southwestern willow flycatchers were known to nest in tamarisk, and a planned three-year research program and subsequent review before full implementation of the beetle biocontrol project. The USFWS concurred in 1998, and APHIS was granted permits to start the field cage trials in July 1999. That same
summer, and again in 2000, *Diorhabda* beetles were released into field cages at sites in Texas, Colorado, Wyoming, Montana, Nevada, California, and Utah. After the two-year field cage trials, APHIS conducted open field releases in 2001.

From 2001 to 2010, beetle propagation and release expanded and populations became well established at numerous sites across the southwestern United States. The spread of the beetle was facilitated by official releases by state and federal agencies, and unofficial relocations by local governments and private persons. Although it was projected that the *Diorhabda* beetles would expand their range only slowly, in some areas the natural and human-facilitated rate of spread surpassed expectations (DeLoach et al. 2006). The rapid spread in Utah, Nevada, and other release sites in the Southwest raised concerns about the program and its effects on the southwestern willow flycatcher and other birds and wildlife (e.g., Sogge et al. 2008; Dark 2009; Stromberg et al. 2009; Hultine et al. 2010), and prompted a 2009 lawsuit charging that agencies responsible for the *Diorhabda* release program did not adequately mitigate for impacts to the southwestern willow flycatcher (Center for Biological Diversity 2009; see also chapter 1, this volume). In addition, scientific research and other articles published after the beetle’s release called into question some of the predictions and assumptions underlying tamarisk control plans, including the high use of water by saltcedar, the potential for widespread regeneration of native riparian vegetation following tamarisk removal, the poor quality of tamarisk as bird habitat, and the view of only benign or positive effects of biocontrol on birds (e.g., Harms and Hiebert 2006; Walker 2006; Bay and Sher 2008; Nagler et al. 2009; Shafroth et al. 2008; Sogge et al. 2008; Stromberg et al. 2009; van Riper et al. 2008). Some newspapers, academics, and environmental organizations began to describe a more complex view of tamarisk and its management (e.g., Gelt 2008; Dark 2009; Glenn et al. 2009).

In 2010, a decade after first introducing *Diorhabda* beetles into the United States, APHIS terminated the beetle release program, citing concerns over impacts to southwestern willow flycatcher habitat (USDA 2010). Despite cessation of the formal APHIS biocontrol program, the *Diorhabda* beetle continues to thrive in the wild and to expand its range. As of 2011, the beetle was well established throughout much of the arid southwest, creating large-scale defoliation of tamarisk riparian areas along major rivers, including the Rio Grande near Albuquerque and the Colorado River in the Grand Canyon (see chapter 22, this volume).

**Tamarisk Control and Birds: Potential Impacts**

Although tamarisk control in general, and biological control in particular, was promoted as having many benefits and no expected risk (DeLoach et al. 2000), the actual results are much less certain (USFWS 2002; Stromberg et al. 2009; Paxton et al. 2011; see also chapter 22, this volume). Tamarisk is currently a major structural and ecological component of many western riparian areas, and provides some key
Ecology

ecological services. Its elimination or reduction will certainly alter riparian systems and the ways that birds and other wildlife use them (see chapter 10, this volume). Is it possible to predict how and to what degree tamarisk control may affect birds and other wildlife?

Clearly, the types and levels of impacts (positive and negative) will be strongly influenced by the scale and other aspects of tamarisk control (Sogge et al. 2008; Paxton et al. 2011). Locally targeted tamarisk control projects such as those that occur on many federal and state parks, wildlife refuges, and other lands primarily have local effects that are easier to assess and make it easier to ensure that the desired outcomes for bird and wildlife habitat occur. But in the past, many such projects focused on removal of tamarisk without including provisions to ensure restoration of native riparian vegetation (e.g., see Harms and Hiebert 2006). Therefore, to avoid unintended consequences to birds and other wildlife, even local projects would benefit from objective analysis of local conditions, knowledge of birds and tamarisk over the larger landscape, and use of the tamarisk control and riparian restoration guidelines and best practices that are now available (see chapters 23 and 24, this volume).

The effects of biocontrol are harder to predict but likely to be substantial because biocontrol is occurring over large areas of the landscape, is relatively uncontrolled once the beetles reach an area, and beetles will persist in areas with tamarisk. As noted by Bean et al. (chapter 22, this volume), the Diorhabda beetle could change western riparian areas as much as did the invasion of tamarisk itself. Therefore, it is important to recognize that the release of the Diorhabda beetle is a large-scale ecological experiment with unknown but potentially widespread consequences (Paxton et al. 2011; see also chapter 9, this volume).

In considering the effects of biocontrol on birds, Paxton et al. (2011) described a conceptual model that includes both short-term and long-term effects. For example, short-term defoliation by beetles will cause loss of foliage cover and cascading effects such as changes to the arthropod community (see chapter 12, this volume). The increased Diorhabda beetle populations will provide a food source to those insectivorous birds that can prey upon it (Longland and Dudley 2008), including nonriparian birds from adjacent habitats. But many chrysomelid beetles produce secondary compounds disfavored by birds (Hilker and Köpf 1994) so one cannot assume that all insectivorous species will eat it. As importantly, riparian birds need more than just a food source—for successful breeding they also need suitable vegetation structure and leaf cover, the precise things that the beetles eliminate as they defoliate the tamarisk (see figure 11.4). Short-term loss of tamarisk vegetation can discourage some riparian birds from nesting. It is also possible that the timing of tamarisk beetle defoliation can be an ecological trap for birds that build nests in leafy tamarisk early in the season, that fail when beetle defoliation occurs (Paxton et al. 2011; see figure 11.5).

The long-term effects of tamarisk control, particularly biocontrol, depend on what, and how quickly vegetation establishes after the tamarisk is defoliated,
removed, or killed (Shafroth et al. 2005; Sogge et al. 2008; Paxton et al. 2011). If tamarisk woodlands are quickly replaced by native riparian woodlands that provide the various ecological services needed by riparian birds, then the long-term impacts of tamarisk control will be either negligible or positive. On the other hand, if tamarisk-dominated woodlands are replaced by nonriparian vegetation (e.g., introduced herbaceous weeds or upland vegetation) or other vegetation without the same ecological services, there will be a net loss of habitat available to riparian birds (Sogge et al. 2008; Paxton et al. 2011). Research and monitoring of the outcome of tamarisk control will help us better understand the outcomes, and improve our approach to similarly complex challenges in the future. However,
the current scope of monitoring, research, restoration, and revegetation activities is limited compared with the anticipated geographic scope and pace of *Diorhabda* beetle spread and tamarisk defoliation.

**Conclusions**

Our acceptance of tamarisk as habitat for birds does not mean that all tamarisk habitats are equal in value to native habitats or that tamarisk serves as suitable habitat in all cases. Similarly, our discussion of the challenges of tamarisk control efforts does not mean that tamarisk management and native riparian restoration are not valid concepts or actions. In general, the stated objectives and desired outcomes for tamarisk removal are positive from a conservation and natural resource management perspective. However, it is important to recognize that control of nonnative species can be a technically and ecologically complex issue, especially in the context of native habitat restoration or involving biological control (Westman 1990; D’Antonio and Meyerson 2002; Harms and Hiebert 2006; Shafroth et al. 2008). Such is the case for management of tamarisk in the western United States (Shafroth et al. 2005; Stromberg et al. 2009; Davis et al. 2011; see also chapter 25, this volume). Eliminating tamarisk is itself straightforward compared to understanding and shaping what will take its place following removal. This is part of the challenging equation facing those who struggle with the conservation and management of inherently complex ecosystems.
The issues and controversies surrounding nonnative species can be as much about perception as they are about ecological reality (D’Antonio and Meyerson 2002; see also chapters 18 and 25, this volume). But resource managers seldom have the luxury to defer decisions and actions until all uncertainties are resolved; decisions must sometimes be made on the best available data, even though there may be different perspectives and risks. However, as additional research and field activities are conducted, our understanding of natural systems and their components improves. It is important to regularly assess the state of knowledge, and to reevaluate objectives and outcomes within an adaptive management framework. We must ask ourselves: what have we learned? In the case of tamarisk ecology, habitat use by birds, and riparian system restoration, substantial new science has been conducted in recent decades and information synthesized in ways that allow us to better understand the complexities and challenges (e.g., see Bay and Sher 2008; Shafroth et al. 2008; Sogge et al. 2008; Stromberg et al. 2009; Shafroth et al. 2010; Paxton et al. 2011).

Many researchers, including Westman (1990), Shafroth et al. (2005), van Riper et al. (2008), Nagler et al. (2009), Stromberg et al. (2009), Davis et al. (2011), and others describe the need to approach the management of tamarisk and other nonnative species from an ecological, not just a weed control, perspective. This means moving beyond the simple question of how to efficiently eliminate an undesirable “weedy” invasive plant. It requires considering the full suite of roles—positive and negative—that tamarisk plays in the environment, and recognizing its current value to birds and other wildlife. Such an approach is consistent with the increasing calls for a more objective and nuanced view of nonnative species, their role in ecosystems, and their management (Walker 2006; Stromberg et al. 2009; Goodenough 2010; Shafroth et al. 2010; Davis et al. 2011). It is time to recognize that for many bird species, and likely other wildlife, there are many locations where tamarisk has habitat value and contributes ecological services. Indeed, in some areas tamarisk may be the only option for a functioning riparian forest.

The general perception of the value of tamarisk as habitat for birds in the arid western United States has changed from being almost universally negative to a much more nuanced view that recognizes some benefits as well. This change of attitude of tamarisk as bird habitat is mirrored in other aspects of the tamarisk issue. As a result, riparian habitat management alternatives are being proposed that go beyond the simple elimination of tamarisk (Shafroth et al. 2005; Sogge et al. 2008; Stromberg et al. 2009; Shafroth et al. 2010; Paxton et al. 2011; see also chapters 23 and 24, this volume) including:

- Basing decisions about tamarisk control on a comprehensive and objective understanding of its ecological roles, using current scientific data—not its ancestry or provenance, perceived risks, and outdated information
- Recognizing that tamarisk control will benefit some birds and other wildlife species but negatively affect others, and that those effects will vary based on site-specific, species-specific, and project-specific characteristics
In conserving and managing riparian systems via nonnative species control, focusing on the final outcome of riparian restoration, not tamarisk control as the first step (see chapter 23, this volume)

- Developing explicit, measurable goals and objectives, site-specific plans, and postimplementation monitoring and maintenance for all riparian restoration projects
- Staging and balancing tamarisk removal and native habitat restoration, geographically and over time, to avoid rapid loss of tamarisk habitats for birds and other wildlife until native habitats can be developed.
- Managing some riparian areas for mixed native-tamarisk habitat, rather than total elimination of tamarisk
- Proactively protecting existing stands of native riparian vegetation in areas where tamarisk may be subject to defoliation by *Diorhabda* beetles, to provide refugia for birds and wildlife affected by large-scale tamarisk loss
- Conducting riparian restoration activities within an adaptive management framework, in which outcomes are objectively evaluated and modifications made based on monitoring results.

As we think about riparian habitat management, it is helpful to recognize that birds are not burdened with our human value system, which tends to favor native versus introduced species (Davis et al. 2011). Instead, birds—and most other wildlife—will use whatever types of habitat that can provide for their basic requirements. In the case of many riparian bird species, and the southwestern willow flycatcher in particular, the ability to use tamarisk as riparian habitat has allowed them to persist in their historic range and in some cases to spread in areas where they would not occur otherwise. It is hard to argue that tamarisk has not provided some real ecological or conservation benefits.

**Literature Cited**


