Wildfire, Exotic Vegetation, and Breeding Bird Habitat in the Rio Grande Bosque

D. Max Smith, Graduate Student, Department of Zoology, University of Oklahoma and Oklahoma Biological Survey, Norman, OK
Jeff F. Kelly, Assistant Professor of Zoology, University of Oklahoma and Heritage Zoologist, Oklahoma Biological Survey
Deborah M. Finch, Project Leader, USDA Forest Service Rocky Mountain Research Station, Albuquerque, NM

Abstract—*Wildfires in the Middle Rio Grande bosque have likely increased in frequency due to absence of the natural flood regime and current drought conditions. Native cottonwoods (*Populus *spp.) do not tolerate or recover from wildfire as well as exotic vegetation, particularly salt cedar, also known as tamarisk (*Tamarix *spp.). There is concern that this change in the primary disturbance process from flood to fire will shift vegetative succession away from structurally diverse mesic native communities to structurally simple xeric exotic shrub-lands, which provide inferior habitat for riparian-dependent animals. In 2003, we initiated a study to evaluate effects of wildfire on quality of riparian habitat for birds breeding in the Middle Rio Grande bosque. Our research focusing on the effects of wildfire on exotic and native woody plants, arthropods and breeding birds will provide managers with information about post-wildfire dynamics of riparian vegetation and breeding bird use.*

Introduction

For several decades, conservationists have given considerable attention to riparian ecosystems in the southwestern U.S. (Knopf 1988). Riparian corridors may be the most biologically diverse habitats on earth (Naiman 1993), contributing greatly to the biodiversity of the southwestern U.S. deserts (Cartron and others 1999). Unfortunately, anthropogenic activities have largely reduced riparian forests from their former extent (Cartron and others 2000, Postel 2000) by replacing them with exotic vegetation (Lovich and De Gouvenain 1998, Knopf and Olson 1984), altering hydrological regimes (Shafroth 2002), and grazing (Krueper 1996). Southwestern riparian forests are also experiencing increasing frequency of wildfires, considered by many to be a novel and serious factor in riparian forest conservation (Bush 1995).

Cottonwood (*Populus deltoides*) -dominated forests ("bosque") along the Middle Rio Grande were historically shaped by regular flood events. Floods influenced river sinuosity, providing safe sites for native vegetation regeneration (Whitney 1996). Construction of dams, levees, and irrigation ditches in the early twentieth century inhibited regular flooding (Whitney 1996). As a result, cottonwood seedling establishment has nearly ceased within the bosque (Howe and Knopf 1991). Exotic, less flood-dependent vegetation, such as saltcedar or tamarisk (*Tamarix ramossisima*) has proliferated through the understory, out-competing native vegetation (Lovich and De Gouvenain 1998, Sher and others 2000).

Unlike flooding, wildfire was not a common disturbance in the Middle Rio Grande Bosque until modern times (Bush 1995, Stromberg and others 2002). During the last century, conditions within Rio Grande riparian forests have become more susceptible to wildfire due to increased production of salt cedar and other invasive plants (Racher 2003), accumulation of woody debris (Bush 1995), and long-term drought (New Mexico Drought Planning Team 2003). Riparian wildfires also gained public awareness and notoriety when four riparian wildfires burned within the city limits of Albuquerque, New Mexico during the summers of 2003 and 2004.

The inverse relationship between wildfire and frequency of flooding represents a shift in the disturbance regime of the Middle Rio Grande bosque and other riparian forests. It is critical that managers understand the effects of more fire and less flooding on the plant and animal communities inhabiting riparian forests in order to conserve southwestern biological diversity. In 2003, we initiated a study evaluating quality of breeding bird habitat resulting from wildfire along the Middle Rio Grande. The objectives of the study were to document

the recovery of native and exotic vegetation following fire, identify changes in food resources for birds, and compare numbers and success of birds breeding in burned and unburned sites.

Methods

A full description of methods is described in our 2003 Annual Report (USDA Forest Service, Rocky Mountain Research Station, and Oklahoma Biological Inventory 2003). We selected four wildfire sites with nearby controls at Bernardo, Rio Grande Complex, Chavez, and San Pedro burns. Starting in 2001, bird point counts, nest searches and monitoring of nest contents were conducted at three of the burn sites during the bird breeding season. In March 2003, a total of 63 nest boxes were distributed among three wildfire sites and nearby unburned gallery forest. In August 2003, nest boxes were placed at the fourth wildfire site, Bernardo, which burned in April 2003; nest boxes were also placed in adjacent unburned forests at this site. Nest boxes were checked regularly to determine use. Four arthropod pitfall traps were installed around nest boxes in order to quantify availability of food resources. Pitfall traps were continuously operated from June to August 2003. In addition, 45 cicada (F. Cicadidae) traps were established in unburned forests and in wildfire areas. To better understand post-fire succession on burned plots, native and exotic re-sprouts were tagged in 2003 and monitored in 2004.

Results

Response of Riparian Vegetation to Wildfire

Native riparian vegetation is primarily adapted to flood disturbance and is not believed to respond well to wildfire. Stuever (1997) found that low intensity fires along the Middle Rio Grande killed 50 percent of cottonwood trees. Moderate intensity fires killed 75 percent of cottonwoods, and all burned cottonwoods died in high intensity fires. In the Middle Rio Grande bosque, we observed that native and exotic tree and shrub species can re-sprout from their roots after fires (table 1). However, many cottonwood root sprouts do not establish following emergence and in some areas, cottonwoods do not re-sprout at all (Stromberg and others 2002). At one of our study sites, we found 60 percent mortality in cottonwood re-sprouts during the first year following a wildfire in 2003 (table 2).

Table 1. Re-sprouting vegetation monitored in wildfire sites in the Middle Rio Grande Bosque (species are listed in order of relative abundance).

Native Plant Species
Rio Grande cottonwood (*Populus deltoides*)
Gooding's willow (*Salix goodingii*)
Seepwillow (*Baccharis glutinosa*)
Coyote willow (*Salix exigua*)
New Mexico olive (*Foresteria neomexicana*)
False indigo (*Lycium torreyi*)
Screwbean mesquite (*Prosopis pubescens*)
Exotic species
Saltcedar (*Tamarix ramosissima*)
Russian olive (*Eleganus angustifolia*)
White mulberry (*Morus alba*)
Siberian elm (*Ulmus pumila*)
Tree of Heaven (*Ailanthus altissima*)

Saltcedar and other exotic species may be more fire-adapted than native species. Following wildfire, saltcedar re-sprouts faster than cottonwood (Stromberg and others 2002), and these re-sprouts flower in as early as three months, while cottonwood re-sprouts take up to eight years to flower (Smith pers obs). One hundred percent of the saltcedar re-sprouts we marked in 2003 survived to 2004. The density of saltcedar foliage was higher at more burned sites (3 of 4) than unburned sites (fig. 1). These observations suggest that salt cedar may be more fire-adapted than cottonwood and can rapidly colonize recent burns.

Despite the effective response of saltcedar to wildfire, native vegetation persisted in our wildfire study sites. Mean height of re-sprouts was greater for cottonwood than for saltcedar at sites that burned at least three years prior (fig. 2 A-D). We also found evidence that survival

Table 2. Percentage of cottonwood and saltcedar stems that survived between 2003 and 2004 at four wildfire sites. Stems were randomly located and marked during the summer of 2003 and re-located during the summer of 2004.

Site	Year of wildfire	2003-2004 % cottonwood survival	2003-2004 % saltcedar survival
Bernardo	2003	40%	100%
Chavez	2002	79%	100%
Rio Grande Complex	2000	100%	100%
San Pedro	1996	83%	100%

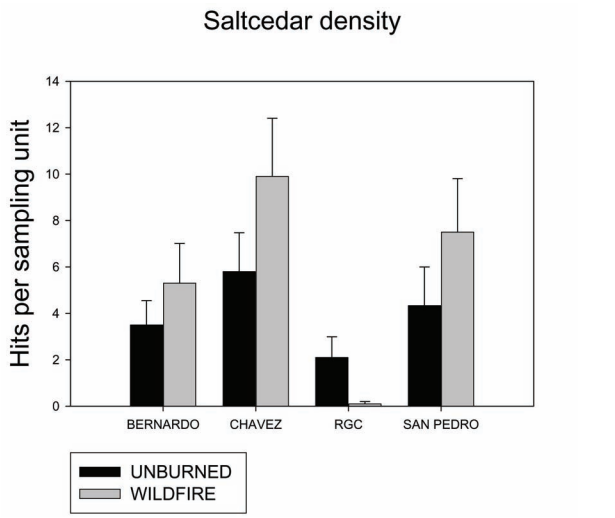

Figure 1. Saltcedar density at unburned and wildfire sites. We counted saltcedar hits against a one inch diameter pole at 4 locations within each vegetation sampling unit. Sampling units were systematically located within wildfire and unburned sites.

of cottonwood re-sprouts might increase in subsequent years following a fire (table 2). We suggest that, where some cottonwood trees persist after a wildfire, management to enhance initial cottonwood re-sprouts might be effective in inhibiting the spread of monotypic salt cedar.

Wildfire, Riparian Areas, and Birds

Riparian forests provide breeding habitat for nearly half of the bird species found in the Southwest (Cartron and others 1999). Bird diversity has been correlated with structural diversity of riparian vegetation and the presence of cottonwoods (Carothers 1974). Vegetation structure has also been shown to influence nesting success in southwestern riparian forests (Powell and Steidl 2000). Scott (2003) showed that structural vegetation diversity and avian diversity are highest when riparian areas experience geomorphic change associated with flooding. Little is known about how riparian breeding birds respond to replacement of flooding disturbance by wildfire because such studies are in their infancy.

The Middle Rio Grande bosque provides habitat for birds in a variety of nesting guilds. Higher numbers of shrub-associated species and lower numbers of cottonwood-canopy species were detected at point-count locations in wildfire sites than in unburned sites (table 3; for scientific bird names, see Finch and others 2003). If post-fire succession results in exotic-dominated shrublands, we hypothesize that populations of widespread, shrub-associated species such as mourning doves (*Zenaida macroura*), yellow breasted chats (*Icteria virens*), and spotted towhees (*Pipilo maculatus*) will

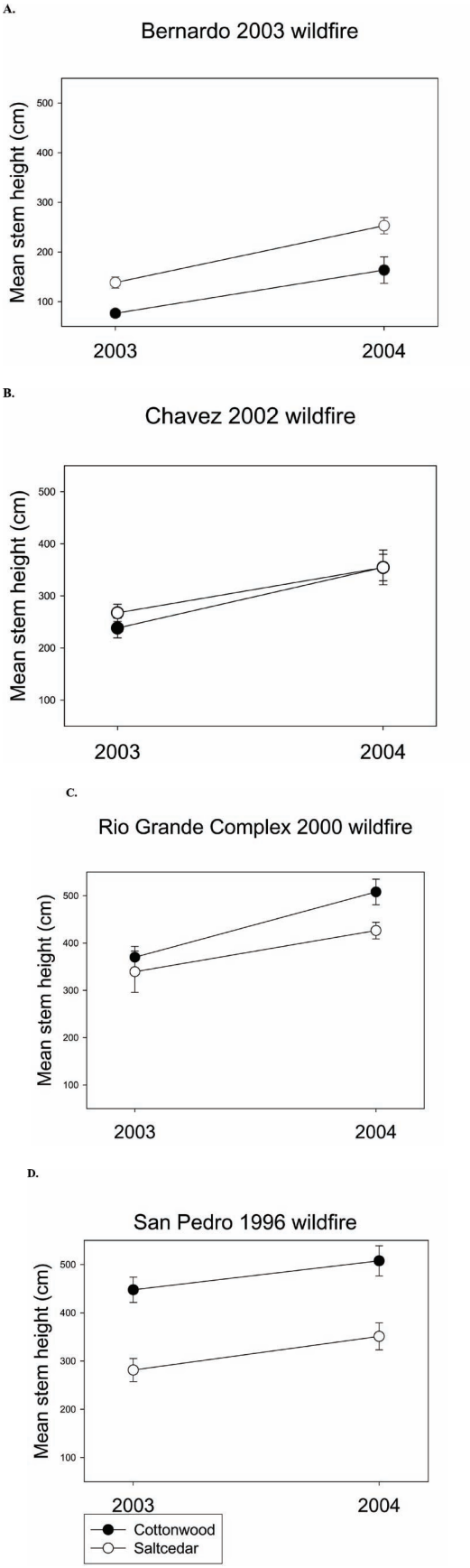

Figure 2 (A-D). Growth of cottonwood and saltcedar re-sprout stems at three wildfire sites. We randomly located and measured the heights of re-sprouted stems in 2003 and re-measured them in 2004.

Table 3. Total and average number (pt. ct. station/5 surveys) of avian species detected at Middle Rio Grande fire effects and control sites.*

Species	# of Individuals Burned	Control	Total	Avg./pt - Burned	Avg./pt - Control
Canada Goose	3	4	7	0.11	0.25
Wood Duck	1	0	1	0.04	0.00
Gadwall	2	0	2	0.07	0.00
Mallard	46	20	66	1.64	1.25
Northern Pintail	3	2	5	0.11	0.13
Ring-necked Pheasant	43	23	66	1.54	1.44
Gambel's Quail	7	1	8	0.25	0.06
American White Pelican	3	0	3	0.11	0.00
Great Blue Heron	3	1	4	0.11	0.06
Snowy Egret	9	0	9	0.32	0.00
Black-crowned Night-Heron	4	0	4	0.14	0.00
Turkey Vulture	40	0	40	1.43	0.00
Cooper's Hawk	7	4	11	0.25	0.25
Swainson's Hawk	2	1	3	0.07	0.06
Red-tailed Hawk	1	0	1	0.04	0.00
American Kestrel	29	2	31	1.04	0.13
Killdeer	8	0	8	0.29	0.00
Spotted Sandpiper	1	0	1	0.04	0.00
White-winged Dove	1	0	1	0.04	0.00
Mourning Dove	242	79	321	8.64	4.94
Yellow-billed Cuckoo	6	1	7	0.21	0.06
Greater Roadrunner	26	1	27	0.93	0.06
Black-chinned Hummingbird	134	140	274	4.79	8.75
Broad-tailed Hummingbird	4	0	4	0.14	0.00
Rufous Hummingbird	1	0	1	0.04	0.00
Ladder-backed Woodpecker	4	4	8	0.14	0.25
Downy Woodpecker	9	6	15	0.32	0.38
Hairy Woodpecker	12	2	14	0.43	0.13
Northern "Red-shafted" Flicker	38	19	57	1.36	1.19
Western Wood-Pewee	32	25	57	1.14	1.56
Dusky Flycatcher	8	0	8	0.29	0.00
Black Phoebe	2	0	2	0.07	0.00
Ash-throated Flycatcher	88	99	187	3.14	6.19
Western Kingbird	43	2	45	1.54	0.13
"Solitary" Vireo	6	0	6	0.21	0.00
Warbling Vireo	1	0	1	0.04	0.00
American Crow	20	20	40	0.71	1.25
Chihuahuan Raven	1	0	1	0.04	0.00
Common Raven	18	17	35	0.64	1.06
Tree Swallow	8	0	8	0.29	0.00
Violet-green Swallow	1	6	7	0.04	0.38
Northern Rough-winged Swallow	2	1	3	0.07	0.06
Bank Swallow	7	0	7	0.25	0.00
Cliff Swallow	17	3	20	0.61	0.19
Barn Swallow	24	6	30	0.86	0.38
Black-capped Chickadee	12	38	50	0.43	2.38
Bushtit	12	9	21	0.43	0.56
White-breasted Nuthatch	25	38	63	0.89	2.38
Bewick's Wren	105	85	190	3.75	5.31
House Wren	1	0	1	0.04	0.00
Ruby-crowned Kinglet	5	0	5	0.18	0.00
American Robin	38	2	40	1.36	0.13
Gray Catbird	20	1	21	0.71	0.06
Northern Mockingbird	2	0	2	0.07	0.00
European Starling	16	1	17	0.57	0.06
Phainopepla	2	0	2	0.07	0.00
Orange-crowned Warbler	1	0	1	0.04	0.00
Virginia's Warbler	2	0	2	0.07	0.00
Lucy's Warbler	11	12	23	0.39	0.75
Yellow-rumped "Audubon's" Warbler	8	1	9	0.29	0.06
MacGillivray's Warbler	1	0	1	0.04	0.00
Common Yellowthroat	43	2	45	1.54	0.13
Wilson's Warbler	6	0	6	0.21	0.00
Yellow-breasted Chat	220	38	258	7.86	2.38
Summer Tanager	35	46	81	1.25	2.88

Table 3. *Continued.*

Species	# of Individuals Burned	Control	Total	Avg./pt - Burned	Avg./pt - Control
Western Tanager	3	0	3	0.11	0.00
Spotted Towhee	195	88	283	6.96	5.50
Chipping Sparrow	10	0	10	0.36	0.00
Lark Sparrow	7	0	7	0.25	0.00
White-crowned Sparrow	4	0	4	0.14	0.00
Black-headed Grosbeak	115	117	232	4.11	7.31
Blue Grosbeak	133	47	180	4.75	2.94
Lazuli Bunting	6	0	6	0.21	0.00
Indigo Bunting	19	0	19	0.68	0.00
Red-winged Blackbird	117	11	128	4.18	0.69
Western Meadowlark	8	23	31	0.29	1.44
Yellow-headed Blackbird	2	0	2	0.07	0.00
Common Grackle	10	1	11	0.36	0.06
Great-tailed Grackle	20	2	22	0.71	0.13
Brown-headed Cowbird	223	46	269	7.96	2.88
Bullock's Oriole	12	5	17	0.43	0.31
House Finch	23	3	26	0.82	0.19
American Goldfinch	1	4	5	0.04	0.25
Lesser Goldfinch	28	22	50	1.00	1.38
Guinea Fowl (exotic)	5	11	16	0.18	0.69
Peacock (exotic)	2	2	4	0.07	0.13
Total Individuals	2475	1144	3619	88.39	71.50
Total Species	86	52	86		

* For bird scientific names, see Finch and others, 2003.

persist. Low detection rates of cottonwood-associated species such as summer tanagers (*Piranga rubra*) in wildfire sites suggest that riparian specialist species may decline following fire. Current research on the success of individual species nesting in burned and unburned sites should provide insight into the suitability of burned riparian forests for all breeding birds.

Along with vegetation, arthropod prey is a critical component of breeding bird habitat (Sherry and Holmes 1995). Insectivorous birds depend on riparian habitat more than those of other guilds (Knopf and others 1988) possibly because of the presence of arthropods (Delay and others 1999). Due to differences in structure and plant-arthropod interactions, exotic and native riparian vegetation support different arthropod densities and communities (Delay and others 1999, Mund-Meyerson 1991). If wildfire alters native and exotic plant densities, it is likely that arthropod communities will be altered as well. To determine if wildfire affects breeding bird habitat by altering arthropod abundance, arthropods important to breeding birds must be identified and sampled in wildfire sites.

Annual cicadas have been identified as an important resource for breeding birds (Rosenberg and others 1982). Like its cottonwood hosts, the cicada (*Tibicen dealbata*), is likely adapted to regular flood disturbance and not wildfire. This cicada emerges in high densities each summer and provides timely food for a variety of birds, including the yellow-billed cuckoo (*Coccyzus americanus*), a species whose breeding may be timed to take advantage of this resource (Rosenberg and others 1982). Our research on the effects of wildfire and exotic vegetation on the density and phenology of annual cicadas will provide insight into the dependability of this resource after wildfire.

Other arthropod groups that warrant research include foliage arthropods and litter arthropods. Wildfires often result in increased abundance of understory vegetation (Stromberg and others 2002). Saltcedar foliage, in particular, increases in density following wildfire (fig. 1). New growth after fire may provide additional resources for foliage-gleaning birds, depending on the abundance and type of arthropods found on re-sprouted stems. In 2003, we observed more foliage-gleaning bird species (6 of 20 observed species) than species of other guilds at wildfire sites. Fewer foliage-gleaning species were observed at unburned sites than burned sites (fig. 3). We found more nests of ground-gleaners (38 of 83 nests) than other guilds at wildfire sites. Fewer nests of ground-gleaners were found at unburned sites than burned sites (fig. 3). Much of the arthropod biomass in riparian forests is found in ground litter (Cartron and others 2003), a foraging substrate that is drastically reduced following wildfires. The cricket, *Gryllus alogus*, is a detritivore that prefers moist leaf litter (Cartron and others 2003) and is frequently fed upon by birds during the breeding season (Smith pers obs). *Gryllus alogus* represents a suite of

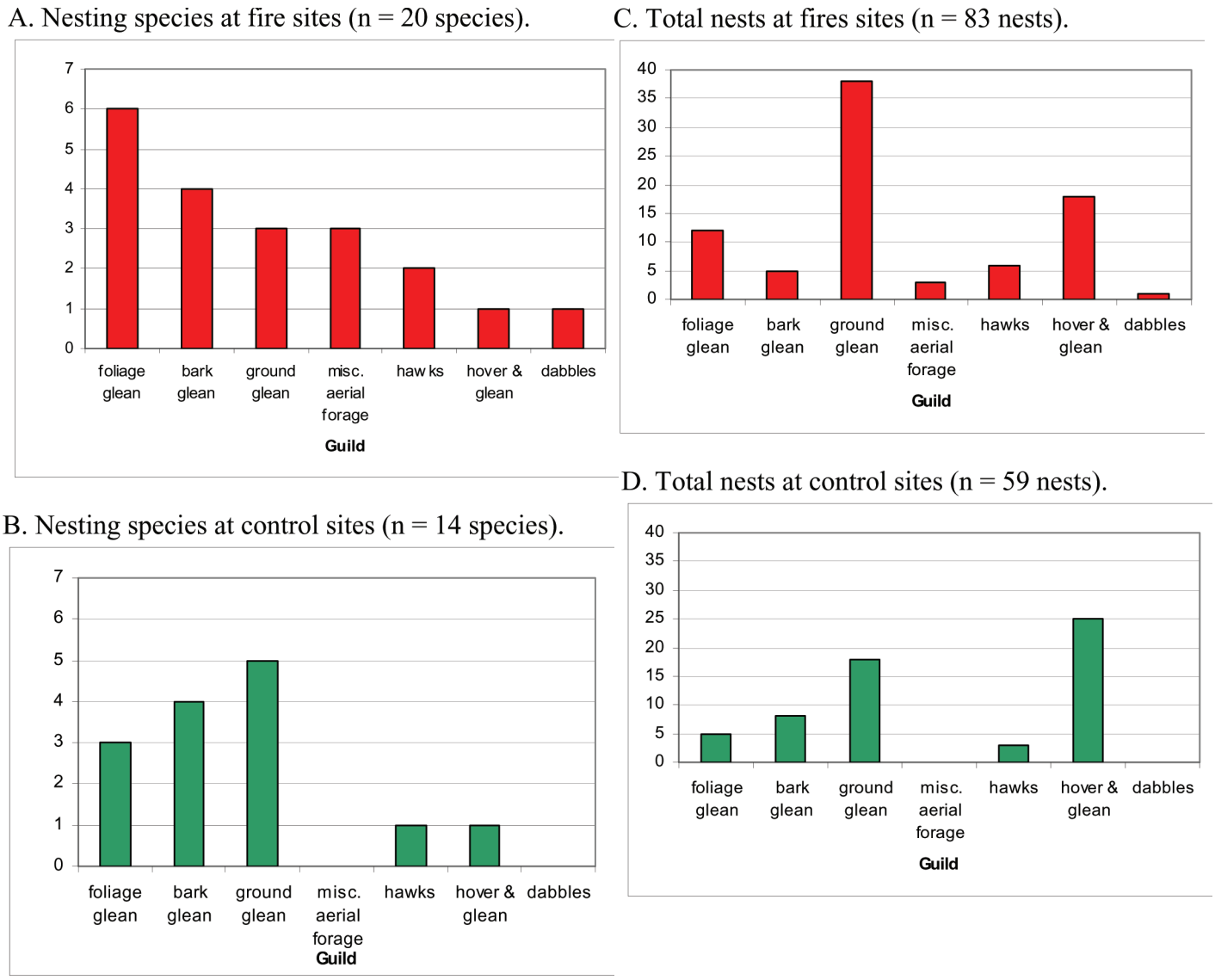

Figure 3 (A-D). Comparison of nesting species at fire and control research sites by Foraging Guild.

arthropods whose reduction following wildfires could have serious consequences for obligate ground-foragers such as spotted towhees and for generalists such as Bewick's wrens (*Thryomanes bewickii*), which forage frequently on the ground.

Conclusions

Wildfire is becoming a frequent disturbance in the Middle Rio Grande Bosque. Riparian trees and shrubs are top-killed during fires and forests typically recover by re-sprouting rather than by seedling establishment. Our data suggest that native vegetation recovers from wildfire with varying success between sites. Native re-sprouts grew from 2003 to 2004 at burned sites, suggesting that native vegetation can survive, at least over the short term. Continued monitoring is necessary to determine the long-term effects of wildfire on the structure of riparian vegetation. The factors that aid the post-fire survival of native trees, such as cottonwoods, must be understood for managers to ensure the persistence of communities tied to this vegetation type. Exotic species, especially saltcedar, appear to be fire-adapted; therefore, exotic vegetation control, controlled flooding, and pole-plantings may be required to maintain native vegetation at sites with low plant survival.

Native vegetation and arthropods are essential habitat requirements for the diverse array of birds found in riparian forests. Low post-fire survival of native vegetation could result in declines of species such as yellow-billed cuckoos and willow flycatchers (*Empidonax traillii*) (Stromberg and other 2002). In this situation, many cosmopolitan species that currently breed in southwestern

riparian forests will continue to utilize burned habitat. However, the well-known bird diversity of these forests is likely to decline with the loss of native trees used by canopy-nesting and cavity-nesting species. Further research on the relationships between arthropods, exotic vegetation, and wildfire is needed to evaluate the quality of post-wildfire habitat for riparian birds. In addition, the use of different vegetation types and arthropods by various foraging guilds must be monitored to predict long-term consequences of wildfire for insectivorous birds.

Figure 4. Section of Middle Rio Grande Bosque near Abeytas, NM. This photo was taken four weeks after the fire. Note the saltcedar re-sprouts in the foreground. Native vegetation has not yet re-sprouted. Photo by Max Smith.

Figure 5. Section of Middle Rio Grande Bosque near Abeytas, NM. This photo was taken two years after the fire. The understory is dominated by saltcedar re-sprouts while a few cottonwoods re-sprouts are present. Photo by Max Smith.

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Figure 6. Section of Middle Rio Grande Bosque near Los Lunas, NM. This Photo was taken three years after the fire. Unlike other wildfire sites, this area is dominated by native cottonwood and coyote willow re-sprouts. Photo by Max Smith.

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