THE EFFECTS OF HUMAN-INDUCED CHANGES ON THE AVIFAUNA OF WESTERN RIPARIAN HABITATS

Robert D. Ohmart
Center for Environmental Studies
Arizona State University
Tempe, AZ 85287-3211

INTRODUCTION

This paper examines avifaunal changes caused by major human-induced environmental modifications of riparian habitats in the 11 Western states. By major induced changes, I include water management activities (dams, reservoirs, instream flow reductions, flood control and dewatering of rivers), domestic livestock grazing, and agriculture. Others are recreational activities, mining, and timber harvesting, but because of space limitations they are excluded here. Not all of the above human-induced activities have had equal impacts on riparian habitats, but all have been significant and, in many instances, their effects on the resource are irreversible and irretrievable. Some losses may be offset with revegetation efforts, some are near or beyond rectification, and, in some cases, reversal is possible with simple management changes. If the western North American avifauna, as we know it, is to be conserved for future generations then wise use of riparian habitats is essential in the near future. A minimum of 95% of the riparian habitats in the West have been lost, altered, or degraded by human-induced change. Along the lower Colorado River alone, over 95% of the native gallery forest has been extirpated and the existence of many bird species is in jeopardy (Rosenberg et al. 1991).

When I refer to a riparian habitat, I mean it "...is one which occurs in or adjacent to drainageways and/or their floodplains and which is further characterized by species and/or life-forms different from that of the immediately surrounding non-riparian climax" (Lowe 1984:82). In more simple terms, it is the alluvial floodplain along either side of the channel (permanent or intermittent flow) and the vegetation growing there. Arid-adapted upland species are prevented from encroaching into the floodplain because of intermittent flooding, high water table levels, and high available soil moisture. Riparian vegetation is prevented from entering the uplands because of lack of available soil moisture. In arid Western environments the transition between riparian and upland habitats is usually less than a meter.
Riparian plant species have their roots located in the capillary fringe just above the water table and generally are confined to floodplain habitats. Mesquites (Prosopis spp.) are located on higher or second terraces where flooding does not occur annually, and when it does duration is less than two weeks. Mesquite may also occur in the upland where its stature is that of a small shrub and not a tree. Cottonwoods (Populus spp.) and willows (Salix spp.) occupy lower or first terraces along the stream. They normally occur along permanent streams but will occasionally grow along intermittent streams if the water table is near the channel surface even though the channel is dry. Depth to the water table is critical to the occurrence of a number of riparian trees and shrubs.

Most riparian trees and shrubs do poorly in soil or water where the salinity approaches or exceeds 3 EC's. There are some exceptions to this and most of these species are in the Chenopodiaceae. Most riparian plants evolved with low salinity water and melting spring snow pack generally producing annual floods.

Annual floods are a key element to healthy, functioning riparian systems. Floods deposit new alluvial soils, cover or wash away organic material, irrigate and bring new soil nutrients onto the floodplain, and leach accumulated salts toward the stream and eventually out of the system. If the flood event is heavy the channel may move by eroding on one side and depositing new materials on the other. Riparian vegetation is adapted to pioneering into new soils with rhizomes, stolons, and wind- and water-disseminated seeds. Seedlings quickly establish on wet soils with high water tables to begin stabilizing newly deposited soils.

IMPORTANCE OF RIPARIAN HABITATS TO BIRDS

Prior to addressing the importance of riparian habitats to birds I want to briefly discuss the extent of riparian habitats in the West and what habitat components are most important to birds in general. On an areal extent, riparian habitats represent less than 1% of the total Western landscape. Their amount varies in different elevational settings; in montane situations with large wet meadows they may reach 2% and in very arid environments they may be <0.1%. Regardless, they are tiny when compared to the extent of other habitat types.
In our studies of riparian habitats along the lower Colorado River in western Arizona, one of the many questions we were seeking answers to was, What are the most important vegetative components to birds? One of our ultimate objectives was to build habitats that possessed all of these habitat components, yet transpired less water and had less resistance to flow during floods than native or natural communities.

To gain the above information we sampled bird species composition and densities along 800-m or 1,600-m lines three times each monthly for over 10 years. More than 100 census lines were located in relatively homogeneous plant communities between Davis Dam and the U.S.-Mexican boundary (443 km). We also quantified numerous vegetation variables in each censused area so that we could test vegetation variables with avian use values. We counted trees and shrubs in belts along each entire census line, including data on height, species, and if parasitized by mistletoe (Phoradendron californicum).

After data collection and analysis we were able to identify the most important plant community components for birds in general, and in many instances specific components for individual species. I present and briefly discuss major habitat components important to birds to make it easier to understand why some changes are so devastating to them. These components, in approximate order of importance, are tree species and densities, foliage height diversity, foliage volume, patchiness, habitat patch size, shrubs and shrub densities, and mistletoe.

Importance of specific tree species and their densities is a component that has not been examined in other avian community studies. Most investigators pool vegetation variables, which masks the importance of this variable to birds. We were able to document the importance of this variable by comparing tree species contributions to contributions of horizontal and vertical patchiness and foliage volume. Bird species responded with greater frequency to number of particular tree species than any other variable (Rice et al. 1984). This should not be surprising to ecologists since our North American avifauna evolved with particular tree species which may provide nest sites, forage areas, and cover.

Exotic trees such as salt tamarisk (Tamarix aphylla) may have similar vertical profiles, foliage volumes,
and horizontal patchiness but never attain the same avian values as forests of cottonwoods (Populus fremontii) and willows (Salix gooddingii). Though I specifically reference desert riparian tree species, the data are abundantly clear that other species in the genera Populus and Salix are extremely important to birds (Thomas 1989, Winternitz 1980, Winternitz and Cahn 1983).

The vertical foliage profile is the horizontal layers of vegetation stacked on one another. Each layer of vegetation tends to have a cadre of species associated with it (Ohmart and Anderson 1982), and if that layer is missing 10 or more species of birds will generally not be found. In our Colorado River studies we found that birds responded to four layers of vegetation. The canopy or overstory layer (≥7.6 m) had 19 species associated with it, 10 species with the 4.8-7.6 m layer, 13 species with the 1.5-4.8 m layer, and 11 species associated with the 0.15-1.5 m layer. The overstory was composed of foliage specialists that were generally missing when this layer was absent or poorly represented (Ohmart and Anderson 1982).

Foliage volume is the amount of surface area of vegetation per cubic volume of space. The greater the amount of vegetation in each of the vertical layers the higher the density of most birds. Some species appear to need dense vegetation to create suitable habitat. This appears to be most critical in the overstory layer in desert riparian habitats where many of the visiting insectivorous breeding birds nest in the hottest summer months. This dense canopy layer appears to be vital in ameliorating summer temperature extremes for these breeding species (Hunter 1988). Foliage volume is related to insect abundance (Anderson and Ohmart unpubl.), so higher vegetation volumes support more individuals and species of birds.

Intraspecific patchiness or the differential height of tree tops in a mixed-tree species forest creates high patchiness values. Exactly why this attracts more bird species is conjecture, but Wiens (1989) suggests it provides more niches for species. Patchy environments support more species than monocultures with low patchiness values (Ohmart and Anderson 1982).

Habitat patch size is an important avian component in continuous forest habitats (Blake and Karr 1984, Temple and Cary 1988, Fasborg et al. 1989) and it appears to be as well in riparian habitats.
Seldom are riparian habitats continuous patches, but large blocks of riparian forests contain higher avian values than a 0.5 ha or less (Anderson and Ohmart 1985).

Many shrubs were found to play important roles in attracting birds. Quail bush (Atriplex lentiformis) attains heights of 3-4 m and a mature plant may cover a 10-m² area. The dense evergreen foliage disallows light penetration and drying of the litter accumulated under the shrub. Thrashers, towhees, quail, and other ground-foraging birds feed on the insects in the litter and use the dense foliage as escape cover and shade (Anderson et al. 1978, Anderson and Ohmart 1985). Foliage-gleaning insectivores are heavily attracted to the abundant insect fauna on the leaves. In winter, this shrub retains its leaves while most riparian tree and shrub species are deciduous. The litter and foliage insects are important food resources for wintering birds, while the dense foliage provides roosting cover at night.

Wolfberry (Lycocton spp.) has similar values to birds as quail bush except that it does not begin to equal the size of the latter. The berries produced in the spring are relied heavily on by frugivorous birds. Moderate densities of quail bush and wolfberry greatly enhance riparian values for birds (Anderson and Ohmart 1985).

Infestations of mistletoe in honey mesquite (Prosopis glandulosa) communities may add as many as seven or eight species to this community type (Anderson and Ohmart ms.). Phainopepla (Phainopepla nitens), Northern Mockingbird (Mimus polyglottos), Cedar Waxwing (Bombycilla cedrorum), Western Bluebird (Sialia mexicana), American Robin (Turdus migratorius), and Sage Thrasher (Cremnoptila montana) rely heavily on the fruit of this plant during the winter months. Mistletoe and other berries make up ≥90% of the above species' winter diet.

Riparian habitats, though tiny in areal extent, have been reported to support as many breeding pairs of birds/unit area as the best avian habitats in the United States (Carothers et al. 1974, Stamp 1978). Johnson et al. (1977) reported that of 166 breeding species in west Texas, southern New Mexico, and southern Arizona 51% were completely dependent on riparian habitats, while another 20% were partially dependent on it. In California, Gains (1977) reported that 43% of the species breeding in
cottonwood-willow-dominated habitat had "a primary affinity" to this habitat type. The cottonwood-willow habitat along the Verde River in central Arizona provided the only breeding habitat for over 50% of the total species breeding in that riparian environment. Across an altitudinal cline between 1,200 m and 2,750 m, Knopf (1985) reported in a two-year study which examined over 100 species that 82% of all species were observed in riparian sites (Carothers and Johnson 1975). In southeast Oregon riparian areas were of principal importance for 62% of the birds (Kindschy 1976).

Even more impressive than citing literature is to ask yourself, Where have I gone birding in the West (excluding the Pacific Ocean) and saw the greatest number of species at highest densities? In Arizona that is easily answered with Cave Creek in the Chiricahua Mountains, Sonora Creek near Patagonia, Ramsey Canyon in the Huachuca Mountains, the San Pedro River in southeastern Arizona, the Verde River in central Arizona, Oak Creek, etc. Flycatchers, trogons, many hawks, hummingbirds, becads, and others are found primarily along our riparian habitats in Arizona.

Has riparian habitat loss and degradation been so severe that the future of this large (>50%) segment of birds that are dependent on this habitat in jeopardy? An honest answer is that we are not sure, but many riparian birds are in trouble. For example, the Yellow-billed Cuckoo (Coccyzus americanus) and Summer Tanager (Piranga rubra) have virtually been extirpated from the West Coast and the lower Colorado River (Rosenberg et al. 1981). The extimus race of the Willow Flycatcher (Empidonax traillii) is a Candidate 1 Species on the endangered species list and soon to be listed. Recent and unpublished breeding bird surveys show the Yellow-billed Cuckoo declining throughout the West (William C. Hunter pers. comm.). Most state game and fish agencies have listings of birds they consider endangered. In Arizona, 40% of the birds on the list are riparian species (Troy Corman pers. comm.) and in New Mexico over 50% of the species are aquatic or riparian (John Hubbard pers. comm.).

Recently, much concern has been expressed over declining populations of neotropical migratory birds (Morton and Greenberg 1989, Askins et al. 1990). Reasons for these declines have been linked to human-induced activities such as tropical deforestation, forest fragmentation, and general habitat
In the West there are two major habitats that support the main breeding populations of these migrants — riparian habitats and montane forests. Riparian habitats have suffered dramatically from the above activities and continue to do so. Desert riparian forests are tropical deciduous woodlands with subtropical affinities (Lowe and Brown 1982). The Arizona Nature Conservancy (1987) listed the cottonwood-willow forest as the rarest forest community type in North America.

**WATER MANAGEMENT-INDUCED HABITAT CHANGES**

Water has been and will always be essential to human survival in the arid West. Settlement patterns exemplify this and the most successful ones are built along and are water-dependent on riparian systems. Western water law is predicated on first rights and beneficial use. Riparian habitats have generally been viewed as a nuisance, therefore, little or no concern was ever given to their needs.

**RESERVOIRS**

The period of exploitation of the West began slightly before the turn of the century. As agriculture expanded on rich alluvial soils, the problems of a constant water supply and the annual threat of floods were resolved with storage reservoirs. Virtually every major stream in the West has one or more reservoirs.

Dams create a multitude of problems for riparian habitats and are essentially the death knell for two of the most valuable avian habitat components — cottonwoods and willows and vertical profile. Initially the backed-up water flooded and killed all the vegetation in the conservation pool. The dam itself stopped natural flooding, which is essential to cottonwood and willow reproduction. If floods (now termed controlled-releases from dams) do occur they are usually too late for successful reproduction of trees or of such long duration that native vegetation drowns in the process (Hunter et al. 1987, Rosenberg et al. 1991).

Most reservoirs in the West were not built in fjords but in large bowl-like settings. The large surface area of the reservoir in hot, arid environments promotes high annual evaporative water losses. Fradkin (1984) reports almost a million acre-feet of water is lost annually from Lake Mead. This water
exits as distilled water, leaving the salts behind. The higher salinity water is released for downstream riparian habitats and, as I pointed out earlier, most riparian plants suffer as salinities increase.

Below the dam, water releases are generally predicated on downstream needs for irrigation, cities, or power generation. Floods for watering the alluvial floodplain have been stopped, and now minimum releases will cause the water table to be lowered to further stress the downstream vegetation. Further, the higher saline waters will also have their effect. With time a high vertical profile forest of >30 m cottonwoods and willows will be reduced to tree species seldom exceeding 10 m and with lower foliage volumes.

An example of the effects of water management activities can be seen in a number of neotropical migrants along the lower Colorado River. Swarth (1914) reported the Yellow-billed Cuckoo fairly common along the Gila and lower Colorado River drainages. Grinnell's (1914) trip was too early to record this, but he essentially covered our study area by raft. He collected specimens and took notes on the vertebrates in this area in 1912. Grinnell (1914) noted the paucity of water birds and the abundance of many species whose numbers have declined dramatically. Dams eliminated cottonwood-willow reproduction, while many mature tree communities succumbed to fires without floods to wash away litter, increased salinities, and reduced instream flows. The steamboat era in the late 19th century significantly reduced mature soft-wood species for fuel use, but historical photographs and written testimony demonstrate abundant cottonwood-willow regeneration all along the river up until Hoover Dam was operational in 1936 (Ohmart et al. 1971). Our bird census data was collected monthly from over 10 years spelling out the rapid demise of some of these species (Rosenberg et al. 1991).

The Yellow-billed Cuckoo showed a dramatic decline in numbers going from 242 birds in 1976 to 18 in 1988, a 93% reduction. The breeding race of the Willow Flycatcher had already been extirpated when our work began. The breeding habitat that I have observed this species in consists of dense and patchy mature willows with very moist, even boggy soil conditions. These habitats probably disappeared from the Colorado River in the 1950s and 1960s when dredging was almost a continuous activity. Vermilion Flycatchers (Pyrocephalus rubinus) were reported by Grinnell (1914) as common
and, though seldom wrong, he predicted this species would become more common as patches of forest were opened. He failed to realize the extent to which the forest would be cleared nor to the drying that would occur from channelization. This species, common and increasing in 1912, now numbers about 10 pairs from Yuma, Arizona, to Needles, California. In 1978, we recorded 203 Belf's Vireos (*Vireo bellii*) and in 1988 the population was down to 88. The prolonged releases with very high water tables killed much of the preferred habitat for this species.

As habitats are modified and the results are negative for some species they are positive for others. Grinnell (1914:72-73) observed,... the little open water sometimes attracted a few transient ducks and mudhens, but so far as known no water birds outside the Ardeidae remain to breed anywhere along the Colorado River." From his notes in 1910 and our river census data in 1978 we were able to compare waterfowl changes that occurred in that 70 years. A selected few that Grinnell did not report but we found in relatively high numbers were 620 American Wigeon (*Anas americana*), 278 Bufflehead (*Bucephala albeola*), 1,743 Common Goldeneye (*B. clangula*), and 591 Common Merganser (*Mergus merganser*). Grinnell observed 8 species while we observed 19 whose total population was 5,238 individuals (Anderson and Ohmart 1988, Ohmart et al. 1988). There are numerous other waterbirds, both wading and deep-water, that are attracted to the reservoirs that now dot the Colorado River (Rosenberg et al. 1991). Also as marsh habitats developed along canals and in deltas behind dams, a race of Clapper Rail (*Rallus longirostris yumanensis*) spread north from the Colorado River's delta in Mexico (Ohmart and Smith 1973). The secretive Black Rail (*Laterallus jamaicensis*) also found habitat created by water storage seeps near Imperial Dam (Replinger and Ohmart 1977). Unfortunately, we viewed the zenith of waterfowl numbers as recreational and homesite development are now reducing these species. The Clapper Rail too, as selenium values approach and exceed safe reproductive levels (Radtke et al. 1988, Kepner unpubl. data).

Once a dam was in place, more sophisticated water managers sought channelization to straighten the river which more expeditiously lowered the water table. After straightening the river from one reservoir to the next the sloughing banks must be stripped of vegetation and then riprapped or
concreted to reduce dredging costs. Dredge spoil material was generally placed in low wet areas supporting emergent vegetation which were frequently old oxbows or backwaters.

In the 1960s, engineers began viewing large trees along rivers as wasting or transpiring large quantities of water. The theory was, if you removed the tree or wick water would be saved for beneficial use downstream. For the next 20 years many trees were removed along streams by federal agencies while other projects were not funded. Even today, thousands of hectares along the Pecos River in New Mexico are kept cleared of riparian vegetation to conserve or salvage water (Hildesbrandt and Ohmart 1982), yet no definitive data supports water savings.

Dewatering of rivers very quickly eliminates native trees and favors the shorter-statured exotic saltcedar (Tamarix chinensis). Fortunately, this activity has not been widespread, but portions of the Gila River in western Arizona and over 443 km of the Rio Grande in west Texas are dewatered. Even in a highly deteriorated state these barely surviving riparian habitats support more species and higher bird populations than adjacent uplands (Engel-Wilson and Ohmart 1978).

Groundwater pumping, which lowers water tables and kills riparian vegetation, has been localized but its effects are quick and dramatic (Minckley and Brown 1982). Large mesquite bosques in Arizona that supported huge breeding colonies of White-winged Doves (Zenaida asiatica), large populations of Lucy’s Warbler (Vermivora luciae), Abert’s Towhees (Pipilo aberti), and a multitude of other species are now gone (Phillips et al. 1984).

Federal and state flood control dikes are commonplace throughout the West to protect those who foolishly built in floodplains. Washes were scraped the channel of vegetation with dozens before dirt dams were built. Much of the riparian vegetation above the dam has returned, but that below has died as water tables dropped.

Most of the above human-induced losses to riparian vegetation are irreversible. Some are retrievable through restoration efforts, but there are strict limitations in this arena. Revegetation is expensive and there are more dead examples than living ones (see Riparian Habitat Restoration section).
DOMESTIC LIVESTOCK GRAZING

Most people do not think of this human-induced change to riparian habitats until they see a stream that has not been grazed. Carothers (1977:3) stated "the most insidious threat to the riparian habitat today is domestic livestock grazing." I firmly believe that statement and the following data will give you an appreciation of the magnitude of the problem just on public lands in the West. The Bureau of Land Management (BLM) and the U.S. Forest Service combined manage millions of hectares of public lands under domestic livestock grazing. BLM reported that on 0.52 million ha (1.3 million ac) of riparian habitats and 78,400 km (49,000 mi) of streams from 10 of the 11 state offices, only 7% of the total were meeting management objectives, 8% were not meeting them, and 85% were unknown (GAO 1982). In my 20+ years of experience with this agency I feel very comfortable in stating that the 85% unknown can be added to the 8% not meeting objectives. The U.S. Forest Service reported that 93,339 km (58,000 mi) of riparian habitats within grazing allotments in Western rangelands were not meeting forest objectives (GAO 1982).

A very brief history of the grazing industry will give the reader a feel for the evolution of domestic livestock grazing on public lands. Early in the 1700s the Spanish brought all classes of domestic livestock to the arid Southwest, but cattle and horses were most important. Their presence ensured transportation, a food supply, and leather in a harsh, unpredictable environment. In the 1880s and well into the 1900s there was no management of public lands and everything was there for the taking. Grass was free and those who controlled the water controlled the forage. The cattle industry expanded rapidly in the 1880s as new railroads carried beef east to a new market. A $5 calf brought $50 a few months later after running on free pasture. In Arizona, by 1883-84 the Governor wrote "every running stream and permanent spring were settled upon, ranch houses built, and adjacent ranges stocked" (Report of the Governor 1886:21). By 1891, it was estimated that 1.5 million head were on Arizona ranges (Report of the Governor 1896:22).

Three years of drought started with poor summer rains and reduced winter rains. Cattle began dying in the hot dry months of May and June of 1892 and by late spring 1893 losses were "staggering"
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(Report of the Governor 1898:22). Land (1934) stated, "Dead cattle lay everywhere. You could actually throw a rock from one carcass to another." Arizona rangelands were left barren and unprotected to wind and water erosion (Hastings and Turner 1965). Adjacent states suffering from the same drought were probably hit equally as hard as Arizona. The timing and consequences of such resource damage was similar in all 11 Western states (Adams 1975, Behnke 1978, Meehan and Platts 1978, GAO 1988). Overgrazing continued into the 20th century and though better management was begun in the 1930s, many grazing allotments are overstocked today (GAO 1988).

Cattle are strongly attracted to riparian areas where water, forage, and shade are all close at hand. Cattle will spend 5 to 30 times longer in riparian habitats than adjacent uplands based on areal extent (Skovlin 1984). Cattle congregate in riparian habitats during the summer months or plant growing season (Severson and Boldt 1978). In a study with light-to-moderate stocking rates, cattle removed 20% of the vegetation in the upland and double or almost 45% of the vegetation along the stream (Goodman et al. 1983). Where ranges are overstocked, herbage removal approaches 100% in riparian habitats (Platts and Nelson 1985). Cottam and Evans (1945) examined vegetational differences between Red Butte and Emigration canyons near Salt Lake City, Utah. Both were privately owned and grazing began shortly after 1847. The U.S. Government purchased Red Butte in 1888 and began protecting it from grazing to insure a clean water supply. The total density of vegetation in Emigration Canyon was 55% of that of Red Butte. Ten native perennial grasses were found in Red Butte and not in Emigration Canyon. Cottam and Evans (1945:178) stated, "These facts would seem to emphasize the danger of complete extermination of rare and highly palatable species in overgrazed areas."

The effects of unmanaged cattle grazing on riparian habitats is very perceptible the first five or so years. After that the changes are very slow and hardly noticeable until about 80 to 100 years later when the last overmature forest begins dying and falling. When cattle first graze a system they trample the banks which, when combined with erosion, widens the stream. A stream protected from grazing for 50 years showed a 94% reduction in channel width (Clifton 1989). All palatable vegetation from the ground to about 1.5 m (5 ft) is consumed and this will occur annually, encouraging the spread of less...
valuable vegetation to cattle and wildlife. As the channel widens it carries more of the floodwater whose 
now greater scouring force further widens the banks, as well as eroding the channel bottom making it 
deeper. More and more of the channel bottom is scoured away until the stream bottom is either 
bedrock or large cobble. The lowered channel bottom reduces the water table level in the floodplain 
and upland species such as juniper (*Juniperus* spp.) and big sage (*Artemisia tridentata*) begin extending 
into the floodplain terrace.

When cattle first grazed the stream bottom they consumed everything in reach. Those trees tall 
enough to escape being eaten were destined to be the last significant recruitment to the riparian forest 
community. Our best estimate of tree life expectancy is about 100 years, so those trees are now 
mature and many are reaching decadence. Tree species most important to birds, cottonwoods and 
willows, can no longer reproduce. The understory has been eliminated because of overgrazing, and the 
midstory and canopy layers are reduced in foliage volume and height as these old trees die and fall. All 
of the most important avian vegetation elements have slowly been eliminated as has the avifauna.

Upper Black Canyon in the Aldo Leopold Wilderness Area, Gila National Forest, New Mexico, typifies 
many streams at mid-elevations in the West (Fig. 1):

The process of riparian degradation exceeds a human life span and, to my knowledge, there 
are no pristine examples to use as yardsticks. Little concern was expressed for riparian habitats until 
about 15 years ago when the first symposium (Johnson and Jones 1977) was held to focus attention on 
these habitats. Since then numerous symposia have highlighted these habitats plus conservation 
groups have begun to pressure legislators for stricter laws. Better management must come soon for 
highly degraded systems or the next 20 years will show the accelerated collapse of the last forest trees.

Elmore (1982) reports the elimination of extensive willow stands in Oregon from grazing, and the same 
holds true in much of Arizona and New Mexico (Ohmart pers. obs.).

Much research has been conducted on Western riparian habitats in the past 10-15 years 
(Skovlin 1984), and agencies have been forced into protecting stream reaches for endangered native 
tROUT. The resiliency of riparian habitats is remarkable after only 8 years of cattle exclusion (GAO 1988,
Chaney et al. (1991). In Grand Gulch, southeastern Utah, prior to 20 years of rest, the stream was entrenched to bedrock (in places over 20 m), the floodplain terraces were covered with annuals, and the stream was dominated by saltcedar. Today, the stream is grading, coyote willow (Salix exigua) stems equal or exceed 30/m², sedges and grasses mat the alluvial soils preventing erosion and trapping sediment, and all ages classes of cottonwoods abound (Ohmart pers. obs.).

It is advocated that riparian habitats can heal with better management of cattle in riparian systems (Elmore 1992) and, in general, that is true. What is not explained is that the healing process is at least three or four times longer than what it would be with total exclusion. For example, on Mahogany Creek in Nevada bank stabilization, the return of understory, and the proliferation of young cottonwoods and willows is amazing in 10 years (GAO 1988). Stream flow has increased by 400% and stream depth by 50%. That rapid of a response could never occur with cattle present, even during limited times through the growing season. Along Date Creek in Arizona, where the growing season is eight or more months, stream gradient is moderate and stream sediment loads high for bank building; after 24 years of only dormant season grazing this reach is just now in the stage of rapid recovery (Figs. 2 and 3). As can be seen in the photograph, the foreground shows year-round grazing, while that on the other side of the fence receives only winter grazing. The vegetative condition along Date Creek and other streams under grazing protection by The Nature Conservancy are very unique compared to most Arizona streams.

A time of crisis is rapidly approaching for most riparian habitats in the West. This could have been prevented if permittees and federal agencies had started showing concern and better management in riparian habitats 20 years ago or even 10. They have not, therefore, unless heavily degraded streams receive total rest for 8 to 10 years the seed source for riparian trees along many streams may be eliminated. GAO (1988) succinctly and correctly presented the problem when they reported we know the solution to improving riparian habitats, but the reluctance to change by permittees and agencies slows and, in many instances, has stopped management improvement. Ironically, where riparian management has been improved permittees have reported savings in reduced feed costs,
permanent water supplies where streams were intermittent, cattle better used upland forage, and generally better livestock health and higher calving rates (GAO 1988, Ohmart pers. obs.).

If public pressure is not exerted on permittees and federal agencies there will not be a change in the status quo. Both must be pushed out of their comfort zone and into public scrutiny. The 1993 change in the Presidency of this country will help, but public pressure for better management of our public lands and specifically riparian resources must come about if we are to maintain and improve bird species numbers and populations in riparian habitats in the West.

A classic example of how dramatic some neotropical species can increase in densities with exclusion of cattle grazing comes from the San Pedro River in southeastern Arizona. Approximately 40 miles of river were obtained by BLM in the 1980s through land swaps. Though the area was grazed, all cattle had to be off the now National Conservation Area by 1 January 1987. The river, at that time, supported good mature stands of cottonwood-willow forests. Census lines, as I described previously, were established in 1985 and data have been collected three times monthly each year to present. The birds listed below are understory species and the removal of cattle allowed this layer to begin replenishing itself (Dave Krueper pers. comm.). Generally, the Yellow Warbler (Dendroica petechia) is considered a canopy specialist, yet still forages some in the midstory. With the vegetative release of the understory the Yellow Warbler expanded its foraging into all layers as its density increased by about six-fold.

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<td>Western Wood-Pewee (Contopus sordidulus)</td>
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RIPARIAN HABITAT RESTORATION

REVEGETATION:

When we began the first efforts to revegetate floodplain habitats along the Colorado River in western Arizona I felt this approach had much merit, especially below dams where cessation of natural floods prevented tree regeneration. I viewed native stock being used since native material should be best adapted both edaphically and biologically. Our 1977 pioneering efforts began on a 28-ha site where the soil was dredge-spoil sugar sand. We began work on a second 20-ha site on the Cibola National Wildlife Refuge with clay soils that had to be root plowed to rid the area of saltcedar. Research designs were such that different agricultural treatments were used which we deemed might produce healthy growing vegetation. Unfortunately, we had only two growing seasons of funding to assess the success of a site which would require 30 or more years to reach maturity (Anderson and Ohmart 1982). The Bureau of Reclamation only provided funds for tree planting and could not be convinced that salinity, depth to water table, or soils were important to the effort. The Extension Service at University of California Riverside helped us analyze these samples and to them we are grateful.

The success of properly planted trees was rewarded with a mean vertical growth of cottonwoods being ≥3 m/year. A never-ending succession of Bureau of Reclamation and BLM personnel visited the sites. Almost immediately 0.3 ha revegetation sites erupted all along the 433 km length of the lower Colorado River floodplain. Early revegetation efforts were by agency personnel with basic site preparation steps being omitted and no consideration to water table depth, soil type or salinity. Later, almost $2 million were expended to a landscape/lewn maintenance group in Yuma, Arizona, to mitigate habitat losses from the Central Arizona Project. To date, more than 40 revegetation sites dot the floodplain from the Mexican boundary to Davis Dam, and most represent dead examples of what not to do. Our original sites continue to mature but were hurt irreparably in 1983 when two full years of water releases for flood control raised water table levels to the point that much of the native vegetation drowned.
Interagency squabbles and engineers regaining control in the Reagan/Watt years would not allow all mitigation efforts to be pooled at our 28-ha site to build a large gallery forest similar to what once occurred along the Colorado River (Ohmart et al. 1977). The small postage-stamp size efforts all died and were a tremendous waste of tax and wildlife dollars.

Salinity levels in the alluvial soil along the Colorado River makes most revegetation efforts not worthwhile. High salt levels come from wicking of salts to the soil surface with prolonged high water tables in 1983 and the surface deposition of salt by the widespread saltcedar communities. Over 70% of the lower Colorado River floodplain is unsuitable for planting cottonwoods or willows (Anderson 1988).

We revegetated a 4-ha site on the Rio Grande in west Texas for the International Boundary and Water Commission in 1986 (Anderson and Ohmart 1988). In 1987, the Bureau of Reclamation began releases from Elephant Butte Dam which extended over a year, drowning out the vegetation. The risks of trying to re-establish native habitats below dams, and especially forests large enough (40 ha or more) to help bird species declining in numbers, may be too great for the investment.

The best conservation strategy might be to concentrate on rivers that have no dams, e.g., the San Pedro in southeastern Arizona, and to examine the feasibility of dam removal where only one dam is present. Even the latter may not be possible in that once a dam goes in the amount of housing development and agricultural dispersion in the floodplain is uncontrollable.

If revegetation is selected as a viable method of restoring riparian habitats below dams, an indepth assessment should be made as to cost, risks, feasibility, and the long-term benefits of the effort. Once these factors are known it is highly doubtful the project would go forward.

AGRICULTURE

This habitat change is primarily manifested along larger rivers where rich alluvial soils provide productive farmlands. Reservoirs provide a constant water supply and seemingly never ending canals allow agricultural expansion to the entire floodplain. The lower Colorado with its extensive floodplains,
year-round growing season, and abundance of reservoirs is the pinnacle of this industry along Western rivers.

Cottonwood-willow, honey mesquite, and all other represented communities are root plowed and the dead vegetation piled and later burned. Hectare after hectare of riparian habitat is treated in this fashion until available land or water becomes a limiting factor. The avian habitat covering the farmland is dead and gone, but the farming practices will also have consequences on the remaining vegetation that was not cleared. For example, the water used in irrigation must drain from the field carrying leached salts, pesticides, and herbicides. A labyrinth of return canals collect and accumulate these waters to eventually carry them back to the river. This higher saline water slowly makes its way into the water table to eventually become the supply used by the remaining vegetation.

With this habitat conversion a breeding passerine fauna is eliminated and waterfowl, shorebirds, and other mostly nonpasserine species are attracted to this more open habitat. Virtually all of the species enhanced by the habitat change on the lower Colorado River were wintering birds with few remaining in the valley to breed. Space does not allow detail of these changes but see Anderson and Ohmart (1982), Ohmart et al. (1985), and Rosenberg et al. (1991) for indepth information of these changes.

The changes brought about by agricultural activities along larger rivers have been very negative to songbirds and positive primarily to wintering species. It would appear that agricultural conversions have been extensive enough to be a factor in the possible decline of neotropical migrants.

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LITERATURE CITED


Bird Observatory, Woods Hole, MA.


FIGURE CAPTIONS

Figure 1. Upper Black Canyon in the Aldo Leopold Wilderness Area in the Gila National Forest in New Mexico. Note the size and degraded condition of the channel, the lack of herbaceous ground cover, down cottonwoods, the few live cottonwoods remaining, and the invasion of upland conifers onto the dry floodplain. Photograph by R. D. Ohmart on August 30, 1992.

Figure 2. Date Creek near Wickenburg, Arizona. Cattle graze year-round in the foreground and only in the nongrowing season on the other side of the fence. Photograph by J. Feller on October 3, 1992.

Figure 3. Date Creek near Wickenburg, Arizona. Stream grazed only in the nongrowing season for 24 years. At flood stage the alluvial soils are covered by the grasses and sedges to disallow erosion and trap sediment. Photograph by J. Feller on October 3, 1992.