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Effects of livestock management on Southwestern riparian ecosystems

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Abstract.-Riparian habitats historically constituted 1% of the land mass in western North America. Within the past 100 years, an estimated 95% of this habitat has been altered, degraded or destroyed due to a wide variety of land use practices such as river channelization, clearing for agriculture, livestock grazing, water impoundments and urbanization. Many authors now concur that the single most important land management practice impacting western riparian ecosystems has been unmanaged domestic livestock grazing. Over 70% of the western United States is currently being grazed by livestock in habitats ranging from sea level to alpine meadows. Unwise grazing practices have been shown to negatively affect Southwestern riparian vegetative composition, ecosystem function, and ecosystem structure. This has resulted in negative impacts on native wildlife populations including insects, fish, reptiles, amphibians, birds, and mammals. Negative impacts due largely from over a century of heavy domestic livestock utilization in riparian ecosystems has resulted in the decline of many wildlife populations. Studies have shown that up to 70% of avian species in the desert Southwest depend upon riparian habitats for survival at some stage of their life. Over torty percent of Arizona's state-listed bird species are considered to be riparian obligate species. Ninety percent of Arizona's native fish species are now extinct, extirpated, or Federally or state listed. Many other vertebrate species have declined in recent years due to alteration of riparian habitats, and may soon be considered for Federal listing. To prevent future listings and to reverse population declines of sensitive wildlife species, land management agencies need to implement appropriate practices within riparian ecosystems.

INTRODUCTION

"...(t)hey tell a story of bare dirt, manure, eroded gullies and endless fences slicing through what once was open, wild rangeland. This story is all too familiar to those who know and love the American West. From Canada to Mexico and beyond, few arid and semi-arid landscapes west of the 100th meridian have been free of the influence of livestock, whose 'management' has contributed to loss of native vegetation, invasions by alien plants, decline of native fishes due to dewatering of streams for irrigation and degradation of riparian zones, eradication of native carnivores and prairie dogs, diseases in native herbivores, and major changes in fire frequency, hydrology, soils and other ecosystem properties. Many conservationists claim that livestock has done more damage to the native biodiversity of western North America than all the chainsaws and bulldozers combined.... Overall, agriculture - especially livestock production - has had a much greater influence on the ecosystems of western North America than development. Yet, the response of conservationists to the problem of livestock has been sluggish, perhaps because the cumulative effects of livestock grazing are much less visible to most people than clearcuts, subdivisions, or shopping malls...." (Noss 1994)

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The American Southwest encompasses portions of 12 states within the western United States and northern Mexico, including Baja California Norte, Baja California Sur, Chihuahua, Coahuila, Sonora, Arizona, California, Colorado, Texas, New Mexico, Nevada and Utah (Rinne and Minckley 1991). The region is primarily composed of the Chihuahuan and Sonoran Deserts, with smaller portions of the Mohave and Great Basin Deserts at the western and northern boundary. Isolated mountains, plateaus, rivers and streams are dispersed throughout the region. Elevations range from below sea-level to higher than 3500 m. Yearly temperatures may vary up to 70" C between winter and summer extremes. Precipitation averages less than 5.0 cm per year in the driest portions of the Southwest, and may exceed 120 cm in the mountains. Typically evaporation exceeds precipitation by a factor of up to five times the total yearly rainfall, and surface water in streams or rivers is often present for only portions of the year (Krueper 1993). Most of the vegetative life-zones of the western United States are present, often within relatively few miles of one another along an elevational gradient of up to 2500 m. These habitats include alpine tundra, coniferous forests of ponderosa pine and Douglas fir, madrean-oak woodlands, chaparral, Chihuahuan grasslands, and Upper and Lower Sonoran Deserts. The major watersheds within the Southwest support rivers which dissect portions of this seemingly inhospitable region. The rivers include the Colorado, Gila, Little Colorado, Rio Grande, and Pecos in the United States, and the Rio Conchos, Rio Yaqui, Rio Sonora, and Rio Concepcion in northern Mexico.

Riparian habitats within this region historically tied all other vegetative life zone together within a matrix of "interconnectedness." High elevation riparian habitats of aspen, maple and alder stands grade to mid-elevation sycamore, walnut and ash, which connect with cottonwood and willow dominated riparian habitats at the lower elevations. Water from ice melt in the southern Rockies of New Mexico eventually empties into the Gulf of California through the Gila and Colorado River drainages, a journey of over 1500 km. The life blood of the Southwest is water which is readily available for use by vegetative and wildlife populations. Historically, the major rivers were the large arteries of the Southwest, while the smaller cienegas, streams and oases of lush riparian habitats were the circulatory sinews which connected the entire region. Throughout the region, periodic dry spells occur relatively frequently, impacting grasslands and deserts and stressing native plant and wildlife populations in all ecosystems. In a dry year, or after a series of drought years, riparian ecosystems buffer the effects bv providing cover, food and water for native wildlife. In these lean years of thermal and water stress, the need for water is often greatest when it is least available (Wiens and Dyer 1975).

Most studies of livestock grazing influences in the western United States have concentrated on effects of grassland change and how these changes have affected game animals such as mule deer (*Odocoileus hemionus*), pronghorn (*Antilocapra americana*), or elk (*Cervus canadensis*). Almost totally lacking are complete, in-depth research projects which measure influences of livestock grazing on native vegetation and the resultant change on nongame vertebrate species. In addition, if these studies have been initiated, they are typically of a short-term nature, often being completed within two years or less. Long-term studies of greater than five years which measure vegetative and animal population response in the absence of livestock utilization in western riparian ecosystems are virtually lacking.

Because of competing economic, social and conservation interests, the issue of public land grazing in the West has emotionally charged proponents and opponents alike (Bock et al., 1993). Public land managers often are the targets when conservationists pit themselves against the livestock industry and vice versa. The issue of public land grazing is equally as volatile as the issues which embroil the Pacific Northwest and its remaining old growth forests. The romantic image of the cowboy on the range has been ingrained into the consciousness of generations of Americans. The tough, pioneer spirit of early Western settlers was, and still is, admired by millions of people. The cowboy was, and still is, perceived as a rugged individualist, struggling to tame a wild country and bring civilization and order to an untamed land. This mythos continues to factor into our everyday lives, and has been promulgated by influences from Hollywood to Wall Street. It is a tough image to change. And with the image of the

cowboy comes his trusted horse and domestic livestock running across the open rangelands of the West.

IMPORTANCE OF RIPARIAN HABITATS

Riparian can be simply defined as the vegetation or habitats that are associated with the presence of water, whether it is perennial, subsurface, intermittent or ephemeral in nature (Krueper 1993). The Bureau of Land Management (BLM) expands the definition to include wetlands:"Wetlands include both natural and intentionally created areas adjacent to, and influenced by, streams (whether waters are surface, subsurface, or intermittent), springs, lake shores, marshes, potholes, swamps, muskegs, lake bogs, wet meadows, and estuarine areas. Riparian areas are a form of wetland transitional between permanently saturated wetlands and upland areas."(BLM Manual 1737).

The BLM currently administers over 270 million acres of public land in 13 western states. This total surface acreage is greater than the U.S.Forest Service (USFS), the National Park Service (NPS), and the U.S. Fish and Wildlife Service (USFWS) combined. Of the 270 million acres of surface lands, 23 million acres (8.5%) are considered riparian or wetland areas. Over ninety percent of this total is within the state of Alaska. In the arid states of Arizona and New Mexico, the BLM manages over 25 million acres, of which 70,530 acres are considered riparian or wetland habitats, along 1660 miles of stream. This constitutes less than three-tenths of one percent of the total Bureau-administered lands in Arizona and New Mexico (BLM files).

The importance of western riparian areas cannot be overstated or overemphasized. Western riparian ecosystems are among the rarest habitat types in the Western Hemisphere. Of the 106 forest types identified in North America, the western cottonwood (*Populus*)-willow (*Salix*) forest association has been identified as the rarest (Dan Campbell, 1988 pers. comm.). Western riparian ecosystems are highly fragmented and discontinuous due to the nature of the topography in which they are found. Even with such a limited and discontinuous distribution, up to 80% of vertebrates use riparian habitats in the desert Southwest at some stage of their life. Over fifty percent of the nesting bird species in the American Southwest use riparian habitats as the primary habitat for breeding purposes (Johnson et al. 1977). Within the San Pedro Riparian National Conservation Area (NCA) in southeastern Arizona, 526 mammal, bird, reptile, amphibian and fish species have been recorded (Table 1). Of that total, 356 species (68%) have been found using the riparian zone within the NCA for feeding, resting, water or breeding requirements (Krueper unpub. data). A minimum of 67 species (13%) are considered to be riparian obligates. Thomas et al. (1979) attributed the high wildlife species density and diversity totals of riparian habitats to the presence of highly varied vegetative structure and what they termed "ecotonal" or edge associations. The high species diversity values recorded within the San Pedro NCA are believed to be due to the availability of water, prey items (insects), high vegetative density and diversity, and the fact that it is located at the juxtaposition between several major floral and fauna1 ecoregions.

Table 1. Vertebrate species totals recorded within the San Pedro Riparian National Conservation Area, Cochise Co., Arizona and associated riparian occurrence, 1995. (BLM files)

Taxa	Non-rip.[1]	Facult.[2]	Obligate[3]	Totals
Fish	0	0	13	13
Amphibians	0	5	3	8
Reptiles	16	14	7	37
Birds	149	189	39	377
Mammals	5	75	5	85
Totals	170	289	67	526

[1] *Non-riparian. Non-riparian associated. Although may be found using riparian habitats it is not required for survival.*

[2] *Facultative. Requires use of riparian habitat at some stage of its life cycle.*

[3] *Obligate. Riparian obligate species.*

There is no doubt about the value of healthy riparian ecosystems, and yet these systems have traditionally been the most heavily impacted through human over-utilization, abuse or neglect (Fleischner 1994). Carothers and Johnson (1975) candidly noted the recognized value of riparian habitats in the American Southwest, yet

"it seems incredible that man travelled along, camped and trapped on, settled in and drew water from riverine ecosystems since the beginning of history without having a better understanding of the great importance of these rivers. Historians and archaelogists have consistently pointed out the importance of rivers to civilization. We heartily agree and then use them for garbage and sewage effluent disposals, dry them up, denude them of native vegetation, turn them into canals or simply dam them. For decades, just as nongame management has been subservient to game management, other values on watersheds have been disregarded while 'water management' and salvage projects receive the principal focus. This is especially true when we review the lack of concern for maintenance of natural riparian ecosystems compared to the ever increasing concerns for supplying large metropolitan areas in the Southwest with additional water for domestic, agricultural, industrial and recreational uses."

While Carothers and Johnson are accurate in their assessment of current riparian habitat management, it must be stressed that the insidious and cumulative impacts of unmanaged livestock use in Southwestern riparian ecosystems for several hundred years has probably been the single most important factor in riparian ecosystem degradation (Wagner 1978, Ohmart 1995).

Riparian habitats historically constituted 1% of the land mass in western North America. Within the past 100 years, an estimated 95% of this habitat has been altered, degraded or destroyed due to a wide variety of land use practices such as river channelization, unmanaged livestock utilization, clearing for agriculture, water impoundments and urbanization (Krueper 1993, Fleischner 1994, Ohmart 1994). Many authors now concur that the single most important land management practice impacting western riparian ecosystems has been unmanaged domestic livestock grazing (Noss 1994).

HISTORIC RANGE MANAGEMENT IN THE SOUTHWEST

Historically, the largest ungulates found in the lower elevations of the Southwest were pronghorn, mule deer and white-tail deer (*Odocoileus virginianus*). Elk were common in the higher elevations of the southern Rocky Mountains, extending south to northern Arizona and New Mexico. Desert bighorn sheep (*Ovis canadensis*) were restricted to isolated desert mountain ranges and rarely wandered to lower elevations. Large, heavy ungulates such as bison *(Bison bison)* were not present in the grasslands of the arid Southwest. The ecosystems of the Southwest had evolved in the absence of large ungulate herds (Bock et al., 1993).

Over four hundred and fifty years ago, Fray Marco de Niza became the first Spanish explorer to cross what is now the United States/Mexico International Boundary near the headwaters of the San Pedro River in Cochise Co., Arizona. Following de Niza's glowing reports of the existence of the legendary seven golden cities of Cibola and El Dorado somewhere to the north, Francisco Vasquez de Coronado set forth with a large expedition in 1542 to locate the fictional cities. Accompanying the expedition were several hundred horses for transportation, and 5,000 sheep and 150 head of cattle to be used as food during the journey (Allen 1989a). Although the expedition was a failure and all livestock were either eaten or died from the rigors of the journey, the initial exploration and ecological exploitation of the Southwest had begun.

One hundred and fifty years passed after the unsuccessful Coronado Expedition before the first serious attempt at colonization of the interior Southwest was initiated under the leadership of Padre Eusebio Francisco Kino. In the late seventeenth century, Padre Kino initiated successful animal husbandry practices within mission settlements along the Santa Cruz River in an attempt to encourage native inhabitants to raise stock, farm agriculture and settle around the missions. In 1697, Padre Kino distributed livestock to missions along the San Pedro River, Tucson, and Nogales, and shortly thereafter cattle ranching had spread to all missions and native villages in what is now southeastern Arizona.

Within several generations, cattle ranching had become the primary economic force in the region. Livestock were primarily concentrated in the lush riparian areas of the Santa Cruz and San Pedro watersheds. Allen (1989a) stated that "the significance of the mission era to modern range management lies in the introduction of livestock to the area and the beginnings of the pastoral culture, not to any widespread impacts on the surrounding range." The precedent of livestock utilization within riparian habitats had been initiated.

Allen (1989a) estimated that 100,000 cattle were grazing the headwaters of the San Pedro River and Bavispe Rivers in southern Arizona and northeastern Sonora by 1694. Within another generation, the entire portion of inhabited southern Arizona deserts had cattle and Mexican haciendas had been established throughout the region (Hastings and Turner 1965). In the mid-eighteenth century, native peoples revolted and many of the missions and ranches were abandoned. Livestock roamed freely throughout the area until Spanish forts were established to control fierce Apache raiding parties in the early nineteenth century. Although the Mexican military presence in the region deterred Apache raiding on the re-established haciendas, periodic attacks resulted in a considerable number of feral livestock. Allen (1989a) estimated that when the San Bernardino Ranch was abandoned in the 1830s, over 100,000 head of cattle were allowed to run wild. By 1846, all of the haciendas had bowed to the pressures of Apache raiding parties and had been abandoned again.

After the conclusion of the United States/Mexico War in 1848, settlers began to stream into the region, bringing with them livestock for economic gain as they pioneered the region. After the Civil War, huge numbers of cattle were moved from rangelands in Texas to provide food for the army during the Apache Wars. The end of the Apache Wars in the 1870s signalled the beginning of an unprecedented buildup of domestic livestock in Territorial Arizona. Hastings and Turner (1965) estimated that over one and a half million cattle were present in Arizona by 1891, most of which were south of the Gila River. Ohmart (1995) corroborated these numbers and also estimated that neighboring New Mexico supported two million head of cattle at the same time.

As with all regions in the West, the vagaries of weather combine to create periods of time under which conditions of great environmental stress occur. Drought and catastrophic rainfall patterns are of regular occurrence in the Southwest, and during the later part of the late nineteenth century a natural disaster occurred that was exacerbated by decades of unmanaged livestock management:

> "Livestock, introduced to the region by ranchers, had become abundant. As the uplands desiccated, cattle concentrated near streams and rivers. But even that tactic soon failed, and 75% of all livestock in Arizona were thought to have died from thirst or starvation by 1875. Ranges were severely damaged, so erosion prevailed when a wet cycle began....deep arroyos were cut from downstream to upstream, incising valley fills so deeply that water tables were drained. Marshes and riparian plants were left high and dry, and disappeared. The erosive power was concentrated downward by high channel walls." (Rinne and Minckley 1991).

The period of drought followed by damaging rains occurred throughout the western United States. Even after this ecological disaster, cattle ranching continued to hasten the demise of the region as numbers again increased. Increased numbers of cattle and sheep placed more ecological stress on riparian ecosystems which were already severely compromised. Severe erosive flooding occurred in 1887, 1890, 1891, 1905, 1906, and 1916 (Dobyns 1981), and with each flood event, stream and river channels became more incised and riparian habitat destruction increased.

Historians and ecologists unequivocally agree that the cattle numbers present in the arid grasslands of southern Arizona at this time far exceeded the carrying capacity of the rangelands, and the inevitable result of such practices was severe degradation of the uplands and riparian habitats of the entire region. Overstocking of the range during the late nineteenth century throughout the western United States initiated accelerated erosion and downcutting of streams and rivers, thereby lowering the water table and permanently altering the hydrologic functioning of riparian ecosystems. Most Southwestern riparian ecosystems have not recovered, and many authorities believe that they will never be able to return to a condition that resembles historic condition and function. Allen (198913) observed that even in 1936, over forty years after the disastrous drought and erosive flooding events of the late nineteenth century, Secretary of Agriculture H.A. Wallace testified to the United State's Senate that:

> "There is perhaps no darker chapter nor greater tragedy in the history of land occupancy and use in the United States than the story of the western range.... (R)ange depletion (is) so nearly universal under all conditions of climate, topography, and ownership that the exceptions serve only to prove the rule."

In short, "(t)he impact of countless hooves and mouths over the years has done more to alter the

type of vegetation and landforms of the West than all the water projects, strip mines, power plants, freeways and subdivision developments combined (Fradkin 1979).

CURRENT CONDITION OF SOUTHWESTERN RIPARIAN HABITATS

Over 70% of the western United States is currently being grazed by livestock in habitats ranging from sea level to alpine meadows. Livestock grazing is the most widespread economic use of public land in the American West (Bock et al. 1993). The vast majority of the 270 million acres of public land under domestic livestock use in the interior West are managed by the BLM and the USFS. According to Fleischner (1994), 7 million head of livestock graze the 16 western states, and of the entire BLM holdings in the West, 94% is currently being grazed. The loss of biological diversity on these lands has recently sparked renewed interest by the concerned public, who questions the validity of multiple use management on a sustained basis as required by law. Horning (1994) stated that livestock grazing in the western United States has contributed directly and indirectly to the decline of over 340 species of plants and animals which are currently listed or are candidate species under the Endangered Species Act.

Riparian habitats are the most modified land type in the American West (Bock et al. 1993). Nearly all public land in the western United States is currently or has been historically grazed. Riparian systems are found throughout the region, and because of the paucity of water, palatable forage and lack of shade in adjacent habitats, riparian areas are heavily impacted by domestic livestock. Due to habitat alteration, natural riparian communities persist only as isolated remnants of what was once a vast, interconnected web of rivers, streams, marshes and vegetated washes. Horning (1994) stated that grazing is the single most important factor in the destabilization of riparian and aquatic eosystems because cattle remove the protective riparian vegetation, and break down streambanks, thus increasing silt loading, widening streams, and destabilizing the water buffering qualities during temperature extremes in winter and summer.

Over 410 million acres of public and private rangelands, constituting 21 percent of the United States outside of Alaska, are considered to be in unsatisfactory condition (Wuerthner 1993). Wuerthner (1993) also stated that according to a 1990 Environmental Protection Agency report on the rangelands of the western United States, riparian areas are in the worst condition in history, and that the principle agent for this degradation is grazing. According to a 1991 BLM document, only 0.8% of riparian habitats in Arizona and 6.0% in New Mexico are considered to be meeting riparian habitat objectives (USDI BLM document 1991). The remaining lands are either not meeting riparian habitat objectives or are considered to be in "unknown status."

The BLM initiated its Riparian-Wetland Initiative of the 1990's which set goals and national strategies to upgrade or improve the ecological condition of wetland and riparian habitats on lands the agency manages. The principle objective of the initiative is to restore to "proper functioning condition" 75% of its riparian and wetland habitats by 1997. Proper functioning condition is determined when a riparian habitat:

1. Purifies water by removing sediments and other contaminants;
2. Reduces risk of flooding and associated damage;
3. Reduces stream channel and streambank erosion;
4. Increases available water and stream flow duration by holding water in stream banks and aquifers;
5. Supports a diversity of plant and wildlife species;
6. Maintains habitat for healthy fish populations;
7. Provides water, forage, and shade for wildlife and livestock;
8. Creates recreational opportunities such as fishing, camping. picnicking and other activities.

To achieve proper functioning condition by 1997, the BLM set four major goals:

1. To restore and maintain riparian and wetland areas so that at least 75 percent are in proper functioning condition by 1997;

2. To protect riparian and wetland areas and associated uplands through proper land management and by avoiding or mitigating negative impacts;
3. To carry out a riparian and wetland information and outreach program that includes training and research to raise awareness and understanding of the importance of healthy riparian habitats; and
4. To maintain existing and form new public-private partnerships to supplement and accelerate the agency's work by drawing on the talents of volunteers and using non-Federal funding (USDI BLM document 1991).

While the goals and objectives established by the Riparian-Wetland Initiative are laudable, they are also very general and non-specific. The very definition of "proper functioning condition" is open to interpretation by a wide variety of specialists or special interest groups which often lobby for support of continued traditional and consumptive uses in the interest of short-term gain rather than for the long-term benefit of riparian-related resources. Many of the remnant riparian ecosystems in the arid Southwest, although classified as being in fair to good condition within the context of the Riparian-Wetland Initiative, are actually considered "functioning, but at risk" of total collapse under current management practices (R. Ohmart, pers. comm.)

IMPACTS OF LIVESTOCK IN SOUTHWESTERN RIPARIAN HABITATS

Wuerthner (1994) recently summed up the cumulative impacts of livestock grazing in the Western United States by claiming that "(a)griculture - both livestock production and farming - rather than being compatible with environmental protection has had a far greater impact on the western landscape than all the subdivisions, malls, highways, and urban centers combined." Noss (1994) stated that livestock management practices have "contributed to loss of native vegetation, invasions by alien plants, decline of native fishes due to... degradation of riparian zones, ..and major changes in hydrology, soils and other ecosystem properties. Many conservationists claim that livestock has done more damage to the native biodiversity of western North America than all the chainsaws and bulldozers combined. Livestock grazing on public lands is rapidly becoming one of the hottest and most polarized environmental issues in the United States."

Domestic livestock are disproportinately attracted to riparian areas. High moisture and nutritive content of riparian vegetation are critical to livestock especially during dry summer months when upland vegetation is relatively desiccated and unpalatable. Add to that the availability of open water and shade during the hottest months, and it is no wonder why domestic livestock remain in riparian habitats for much of the season. In many areas of the West, the concentration of livestock in riparian habitats is exacerbated due to steep canyons, narrow riparian corridors and limited accessibility (Dahlem 1979). The result in many western riparian areas are beaten out riparian systems which are devoid of understory vegetation which most wildlife species depend upon for survival and productivity.

Livestock grazing can alter vegetative structure and composition of riparian habitat. Ryder (1980) stated that grazing, especially by livestock and big game, frequently changes plant species composition and growth form, density of stands, vigor and seed production of plants. Grazing and browsing can alter the growth form of individual plants, making shrubs and young trees grow "bushier" by removing terminal buds and stimulating more lateral branching. While the resulting growth form may benefit some species of wildlife temporarily, continued grazing on already stressed vegetation or on vegetation which has not evolved under grazing pressure can injure or even kill shrub or tree species. Unlike grasses, many species of forbs, shrubs and trees are not adapted to continual or persistent grazing and browsing pressure during the growing season (Ryder 1980). This loss of vegetation alters the vegetative density and diversity of the community, most often shifting the community from a climax condition to an earlier successional stage. Under these conditions, wildlife species which are adapted to an older, more mature vegetative ecological state will be selected against while those species which have more general habitat requirements will be selected for.

Differences between riparian habitats in good condition and degraded condition should be extremely evident to even the untrained eye. But with over 300 years of grazing pressure within riparian areas of the lowland Southwest, healthy riparian stands are virtually non-existent. Comparisons of healthy versus degraded riparian habitats are by default a moot point. A commonly heard complaint from ranchers is that the riparian areas which they are utilizing "have always looked like this." Ecological decline from overgrazing is a slow, insidious process which causes a decline in the abundance and diversity of native riparian vegetation over several generations, and is usually not evident to even skilled observers unless exceptional care is exercised. As the native plants die off, riparian areas are typically invaded by exotic plants such as Russian Olive (*Elaeagnus angustifolia*) and saltcedar (*Tamarix chinensis*) which are significantly less productive for wildlife habitat, watershed protection and wildlife forage needs.

Western riparian habitats are extremely vulnerable to overgrazing (Rucks 1978, Platts and Nelson 1985, Platts 1991, Ryder 1980, Ohmart 1994). Unmanaged grazing practices have been shown to negatively affect Southwestern riparian vegetative composition, ecosystem function, and ecosystem structure (Platts 1991, Ohmart 1994, Horning 1994, Ohmart 1995). Effects of grazing most often depends upon the intensity, duration and location of the activity. Domestic livestock typically concentrate in riparian areas where forage, water and shade are readily available. Heavy use in sensitive riparian habitats during the growing season or in years of drought accelerates degradation of riparian systems. Cattle, like all animals, must eat to survive, and in lean years they can strip a formally productive and functioning allotment into a wasteland if stocking rates are not immediately reduced. High intensity grazing also profoundly alters breeding avifaunas from the "natural" state, generally in the direction of decreased species numbers and complexity (Wiens and Dyer 1975).

Trampling of vegetation by large ungulates or even humans can impact vegetation by removing protective cover and affecting sensitive soil components, resulting in increased exposure of soil to eroding wind and water (Stoddart et al. 1975, Chaney et al 1990). Rauzi and Smith (1973) documented decreased water infiltration rates in heavily grazed habitats versus lightly grazed habitats. Lusby (1979) reported increased runoff and sediment discharge from desert rangelands of western Colorado under conditions of livestock grazing, which eventually impacts riparian ecosystem function and condition. Kuss and Hall (1991) found that trampling of vegetation and the surface layers of sensitive soils causes significant damage to floral and soil structural components even with one passage of a human through undisturbed landscapes. The weight of a two-hundred pound human being, and its resultant impact to the floral and soil components, pales in comparison to the effect of repeated use by domestic livestock which may weigh 5 to 7 times as much as a human. Early studies which measured the recovery rates of human-induced trampled habitats estimated that "50 to several hundred years may be required for the impacted communities to recover original floristic composition and density" (Kuss and Hall 1991). Their data suggested that even limited trampling delivered at one time can be as damaging as increasing levels of use delivered over a much longer time.

IMPACTS OF LIVESTOCK ON WILDLIFE POPULATIONS

Negative impacts due largely from over a century of heavy domestic livestock utilization in arid Southwestern riparian ecosystems have resulted in the decline of insect, fish, reptile, amphibian, bird, and mammal populations. Excessive historic grazing practices have significantly altered riparian vegetative structure and density, which in turn have impacted wildlife populations (Fleischner 1994). Grazed riparian areas typically have less ground cover, a poorly developed understory and midstory, and decreased vegetative biomass when compared to similar ungrazed riparian areas. These conditions result in a paucity of available niches which a great number of wildlife species depend upon for feeding, resting and cover.

Horning (1994) estimated that livestock grazing played a significant role in the listing of 76 species of fish and wildlife, and that livestock grazing is a factor in the decline of another 270 candidate and listed fish and wildlife species. Of this total, the two most arid western states (Arizona and Ne-

vada) have the most number of species harmed by grazing (86 and 75 respectively). Eighty percent of the 346 fish and wildlife species found to be seriously impacted are riparian dependent, and unmanaged grazing has severely compromised the quality of habitat upon which they depend for survival. Based on a critical literature review and advice from wildlife experts, Horning (1994) added that "there is irrefutable evidence that abusive grazing practices have severely compromised native biological diversity by damaging ecologically vital riparian areas and fragile arid and semi-arid grassland ecosystems, in some cases irreparably."

Determining the true impacts of unmanaged livestock grazing on Southwestern riparian wildlife populations is difficult to assess because there were virtually no extensive vertebrate studies conducted before the Twentieth Century. Intensive grazing has been present in the Southwest for over 300 years. Scientists have no baseline information from which to draw significant conclusions. However, we can document historical changes within the past 100 years, and then based on the evidence, infer "what might have been" from studying recovering riparian habitats that have been excluded from livestock grazing. Integral to these studies are measurements of the resultant changes in vegetation and wildlife communities through time in the absence of domestic livestock.

Carothers and Johnson (1975) mentioned that although direct economic measures of riparian alteration are possible (economic cost and benefit ratios measured in dollars earned or lost), the "intangible" values of riparian ecosystem health are much harder to define and quantify. How can an economist measure the value of a spring morning walk within the splendor of the riparian habitat surrounding the Verde or the San Pedro Rivers? What is the value of seeing a Green Kingfisher (*Ceryle americana*) amongst the root masses and overhanging streambanks of a healthy riparian system, or the diagnostic ripples in a pond as a beaver forages near a remote mountain meadow? These are the intangible values of a healthy and functioning Southwestern riparian ecosystem, and although they are nearly impossible to measure, they must be taken into account in regard to riparian habitat management. To many public land users, loss of wildlife and associated recreational opportunities due to riparian habitat destruction or alteration is an increasingly unacceptable consequence of traditional land management practices.

Invertebrates

While very little research has been conducted on the response of aquatic invertebrates to livestock grazing, much of the available evidence shows that many invertebrate species decrease as habitat is degraded (Horning 1994). Fleischner (1994) compiled data from studies which show that domestic livestock grazing has had negative impacts to terrestrial invertebrate populations in several western states, including Arizona where grasshopper densities were 3.7 times greater on protected sites than on grazed sites. Ryder (1980) also stated that insect production can be altered under heavy grazing practices. Most studies of grazing impacts on invertebrate populations have been conducted in grasslands and not within riparian habitats, but it is obvious that with vegetative disturbance and removal of plant biomass which sustains invertebrate populations, certain taxa will be negatively affected.

Fish

Platts (1991) found that in 20 of 21 studies he reviewed, riparian habitats and fish populations were negatively impacted by livestock grazing. Unmanaged livestock practices compact soils and low-growing riparian vegetation, denude marshes and meadows, trample stream banks, and remove protective riparian vegetation from the banks of watercourses. This results in increased siltation and sedimentation, increased water temperatures, and decreased habitat quality for native fish species. Behnke and Zarn (1976) concluded that livestock grazing within Western riparian ecosystems was the major threat to improving or stabilizing degraded trout habitat.

Destruction of riparian vegetation and streambank stability results in unstable water temperatures which most fish species depend upon for egg development. Increased siltation can cover gravel spawning beds which cuts off oxygen required for proper development of eggs. In many streams where livestock grazing has been limited or eliminated, native fish species are able to more effec-

tively compete with non-native fish species. In riparian livestock exclosure studies, native fish species have been shown to increase populations by nearly 600 percent (Crispin 1981, Platts and Nelson 1985).

Fish, especially colder water species such as trout, have been shown to be good indicators of ecosystem health. However, species such as the Lahontan cutthroat trout (*Salmo clarki henshawi*), the Bonneville cutthroat trout (*Oncorhynchus clarki utah*), the Apache trout (*Oncorhynchus apache*) and the Gila trout (*Oncorhynchus gilae*) are federally listed or Candidate species. These and many other species are at risk because of habitat loss and degradation associated with livestock utilization within sensitive riparian habitats. The destruction of spawning and natal rearing habitat due to logging and livestock production in sensitive riparian areas of the upper Gila River in New Mexico and in the White Mountains of Arizona have been responsible for the declines in the latter two trout species (Rinne and Minckley 1991). Fleischner (1994) stated that fish production and standing crop biomass of salmonids increased significantly when cattle were excluded from riparian ecosystems in the Great Basin and in Colorado. To determine whether these fish species would benefit from livestock exclusion from riparian areas, measurements of biomass change and overall population response need be implemented. Costs of fencing riparian areas from livestock may be less expensive than other expensive recovery efforts.

Economic costs to recover high elevation fish species to stable levels can be staggering. For instance, recovery of the Lahontan cutthroat trout is expected to top $14 million. To enhance riparian areas for the benefit of Apache trout in Arizona will cost the USFWS up to $2 million over the next 10 years. Even while these enhancement projects are being conducted, adjacent riparian areas continue to be grazed and degraded (Homing 1994).

Mid-elevation streams from 900 to 1900 m. elevation flow through low coniferous forests, oak woodlands and portions of high elevation grasslands. These habitats support most of the remaining native fish populations in the Southwest (Rinne and Minckley 1991). However, due to the extreme riparian degradation of the 1870s and 1880s as a direct result of overstocking the range in Arizona, many native fish species were extirpated from historic habitat and have not since been able to return naturally (Rinne and Minckley 1991). These systems have not had the tremendous grazing pressures that lower elevation riparian systems have sustained, but continual degradation which accompanies livestock grazing has impacted these fish populations as well.

Low elevation riparian systems below 900 m. elevation have been heavily impacted because these systems typically are-in areas with extreme temperatures and low rainfall. This creates conditions which concentrate cattle into small areas, which increases soil compaction, streambank erosion and decreases vegetative cover.

Of 41 species of freshwater fishes native to the Southwest, 10 occur only in Mexico, 9 occur only in the United States, and the remaining 22 species are shared by the two countries (Rinne and Minckley 1991). By 1989, 28 of the 41 species were officially listed as threatened, endangered or of special concern by the American Fisheries Society. Three other species not considered in the above total are now officially extinct. Ninety percent of Arizona's native fish species are now extinct, extirpated; or Federally or state listed.

As a result of diversions, mineral activity, unmanaged domestic livestock practices, and other impacts ". ..native fishes are being exterminated. Destruction of aquatic habitats, changes from natural to artificial conditions, and predation and competition by alien species enhanced by artificial conditions, all combine to destroy them. Many are nearing extinction, some are already gone, and neither legislation, nor determined attempts at conservation by agency, academic, or other managers have succeeded in reversing the trend. The only chance seems to lie in an emergence of public opinion that recognizes native fishes as valuable resources and demands their conservation." (Rinne and Minckley 1991). Recovery of the hundreds of species and subspecies of threatened or endangered western fish will depend upon restoration of severely degraded riparian ecosystems. One of the most effective methods is livestock exclusion or more effective livestock management which will result in the stabilization of sensitive riparian soils and vegetation.

Amphibians and Reptiles

Amphibians have also been shown to decline in population size and overall distribution as riparian habitat has been degraded. In particular, species which are candidates for listing such as the yellow and red-legged frogs, the Yavapai leopard frog, as well as numerous toad species, are known to be harmed by grazing (Jennings 1988, Toone 1991, Jennings and Hayes 1993, Martin 1993). Many Western amphibian species which are dependent on functioning riparian habitats for breeding or shelter requirements are negatively impacted by unmanaged livestock grazing as riparian streambanks break down, sedimentation increases, and erosion accelerates.

Certain reptile species, including various grassland lizards and snakes, are less abundant due to livestock caused alteration of riparian habitat (Fleischner 1994, Horning 1994). The wandering garter snake, an atypical riparian-associated reptile, is much less abundant in grazed habitats relative to adjacent ungrazed habitats (Szaro et al. 1985). Fleischner (1994) reported that in two studies in California and Arizona, lizard abundance was two times and biomass 3.7 times higher on ungrazed sites relative to grazed sites, and that abundance and diversity was higher on ungrazed sites rather than on grazed sites in 80% of the study sites measured. It is clear that, similar to impacts imposed on fish populations, continued degradation of riparian habitat will not only hinder the recovery of many listed species, but will also accelerate the decline of dozens of candidate amphibian and reptile species.

Birds

Although consisting of less than 1% of the land mass of the western United States, western riparian habitats are extremely important to neotropical migratory landbirds as well as resident species (Szaro 1980, Bock et al. 1993, Krueper 1993, Ohmart 1994). In the Southwest, riparian areas support a higher breeding diversity of birds than all other western habitats combined (Anderson and Ohmart 1977, Johnson et al. 1977, Johnson and Haight 1985). Over 60% of all neotropical migratory birds use riparian habitat in the Southwest as stopover areas during migration, and these habitats have recorded up to 10 times the number of migrants per hectare than adjacent non-riparian habitats (Stephens et al. 1977, Krueper unpub. data). Because of high rates of metabolism, birds are extremely dependent on the habitats in which they find themselves during the migratory period, and must utilize seasonally abundant resources when available (Sprunt 1975). Southwestern riparian systems provide migratory bird species rich food resources during the critical migratory period because plant growth rates and resultant vegetative biomass are very high, which allows for greater insect production (Gori 1992).

The highest non-colonial avian breeding densities in North America have been reported from southwestern riparian habitats (Johnson 1970, Carothers and Johnson 1975, Anderson and Ohmart 1984, Krueper 1993). Within the San Pedro Riparian National Conservation Area in southeastern Arizona, migration and breeding densities of 3000 individuals per 40 ha have been documented (Krueper, unpublished data). Johnson et al. (1977) reported that more than 75% (127 of 166) of southwestern bird species nest primarily in riparian habitats, and 60% (59 of 98) are neotropical migratory birds.

Bird species are differentially affected by cattle grazing in riparian areas. Bird species have been shown to respond to alterations in vegetative structure and species richness within riparian habitats (Bull and Slovlin 1982, Szaro and Jakle 1985). Other avian studies have shown a higher density and diversity of birds in ungrazed riparian habitats compared to adjacent grazed habitats (Crouch 1981, Mosconi and Hutto 1981, Taylor 1986).

Neotropical migratory bird species have been found to be very sensitive to habitat change (Sedgwick and Knopf 1987, Knopf et al. 1988, Krueper 1993). Buttery and Shields (1975) stated that if riparian conditions are not suitable due to changes in key vegetative components, the stimulus to breed in one area may not be elicited. Once riparian habitat has been compromised through land use practices such as unmanaged livestock utilization, birds may simply vacate traditionally used riparian breeding habitats in search of suitable habitat elsewhere. Grazing pressure on vegetation has been shown to alter growth form, plant vigor and plant species composition, resulting in

increases or decreases in populations of bird species (Glinski 1977, Townsend and Smith 1977, Ryder 1980). Rucks (1978) stated that livestock grazing causes the replacement of shrub-nesting bird species with species showing no preference for vertical vegetative structure. Vegetative structural components such as foliage height diversity, total percent foliage cover, foliage volume, and plant species diversity are key factors determining the density and diversity of breeding birds (Balda 1975, Anderson and Ohmart 1984). Birds were found in lower numbers in habitats lacking high structural diversity and suitable number of mature trees. All of these key structural components of the vegetative community are directly impacted by unmanaged livestock practices to the detriment of avian populations. Especially impacted are ground nesting riparian obligate species such as Common Yellowthroat (*Geothlypis trichas*), Yellow-breasted Chat (*Icteria virens*), Abert's Towhee (*Pipilo aberti*), and Song Sparrow (*Melospiza melodia)*, which have been shown to respond with significant if not spectacular population increases when livestock have been removed from riparian ecosystems such as within the San Pedro NCA (Krueper 1993).

Excessive livestock grazing can also affect types and abundance of food items for birds (Ryder 1980). Cattle and sheep have been shown to eat selected species of range and forest plants. These shelter mammal and insect populations which species of birds utilize as food. Small mammal populations are affected by high levels of grazing which benefit open habitat specialists such as deer mice, whereas various species of pocket mice and western harvest mice which prefer heavier cover are selected against. Raptors which utilize small mammals as prey may not choose to frequent submarginal riparian habitats for feeding due to lack of preferred prey items. Additionally, insect biomass may be decreased in riparian habitats which are heavily grazed due to lack of understory vegetation (Krueper pers. obs., R.D. Ohmart pers. comm. 1995). Insectivorous birds using riparian habitats for breeding and migratory habitat depend heavily on the annual insect biomass which is found in undisturbed riparian zones for feeding of young and for replenishing energy resources before continuing migratory movements. Annual and perennial grasses in riparian habitats are heavily utilized during the summer breeding season by many species of birds. During the late summer and fall migration period within the San Pedro Riparian National Conservation Area (NCA), avian species such as Black-headed Grosbeak (*Pheucticus ludovicianus*), Lazuli Bunting (*Passerina amoena*), Indigo Bunting (*Passerina cyanea*), Lincoln's Sparrow (*Melospiza lincolnii*) and Green-tailed towhee (*Pipilo chlorurus*) feed primarily on the seeds produced from grasses which are produced within the riparian zone during the summer growing season (Krueper pers. obs.). When cattle were present in the riparian habitat prior to a domestic livestock moratorium in 1988, little vegetation and seed production for granivorous bird species were noted. However, since the moratorium has taken effect, annual and perennial grasses in and adjacent to the riparian zone have greatly increased, and the resultant seed production currently attracts more granivorous bird species by a factor of ten over population densities before the livestock moratorium took effect (BLM files).

Bock et al. (1993) summarized results of previous studies of the avifauna of riparian woodlands of the West. Of the 43 avian species studied, 8 responded positively to grazing while 17 were negatively affected and the remaining 18 were unresponsive or showed mixed response. Neotropica1 migratory bird species which were most heavily impacted by livestock grazing were those which require dense understory vegetation for feeding or for nesting cover. Bock et al. (1993) noted that those species most critically impacted were Common Yellowthroat and Lincoln's Sparrow. Based upon known habitat requirements, they predicted that many of the other 18 species which showed mixed results actually would be negatively impacted from riparian grazing practices. In one of the largest studies in the Southwest monitoring avian response to a grazing moratorium, populations of Song Sparrow, Common Yellowthroat and Yellow-breasted Chat increased from five to ten-fold within 5 years after cessation of livestock grazing pressure (Krueper 1993).

Although Schultz and Leininger (1991) found that while American Robin (*Turdus migratorius*) benefitted from heavy grazing and the resultant open habitat, species such as Wilson's Warbler (*Wilsonia pusilla*) and Lincoln's Sparrow which require densely vegetated understory and

midstory for feeding and breeding requirements were much more common in ungrazed areas with abundant willows. Greater shrub cover in ungrazed habitats allowed much higher breeding densities of these avian species than in the grazed habitats.

While riparian neotropical migratory bird species use fragmented habitats in high densities, due to the limited extent of western riparian ecosystems, these species may actually have smaller overall populations than the neotropical migratory bird species which breed in more expansive eastern forests (Bock et al. 1993). This is cause for concern because even species which currently have high densities in southwestern riparian habitats are at risk of extirpation if the remaining quality and quantity of riparian ecosystems are compromised. DeSante and George (1994) documented 58 species of migratory landbirds which have decreased in the western United States during the past 26 years. Of this total, 16 species have declined as a direct result of riparian habitat destruction, and one of the primary factors attributed to these declines was overgrazing. Over forty percent of Arizona's state-listed bird species are considered to be riparian obligate species (Corman, Arizona Game and Fish Department, per. comm.). It becomes obvious why such a high percentage of the state total has been designated as such when one considers that historically less than 5% of the total land mass of Arizona was classified as riparian habitat. Of that total, over 95% has been destroyed or altered in a negative manner (Lofgren 1990). While many avian species teeter on the brink of becoming listed or extirpated, we must recognize that avian species declines are but the result of a much larger problem. Hunter et al. (1987) succinctly summarized the dilemma in saying:

> "the greatest problem afflicting effective riparian management throughout the Southwest, especially at lower elevations, is the attention given to single species at the expense of an entire community of species that is in trouble....Listing of any one species will not protect all other declining species...in the Southwest. A radical change in orientation is needed, from the piecemeal approach of protecting single species (which is still essential) to protecting habitats. Native riparian systems must be protected for what they are - endangered ecosystems. Only by river system management can we effectively stem the decline of our riparian avifauna...."

Conservation of neotropical migratory bird populations in the Southwest will continue to require protection and restoration efforts within riparian ecosystems.

Mammals

One of the least understood and least studied group of vertebrate animals using riparian habitats are small mammals. Livestock grazing impacts on avian populations have been fairly well documented. For the same reasons that understory bird species are affected by grazing in riparian habitats, small mammals have been shown to be similarly impacted. Shrews, voles and mice species which require thick understory vegetation and available water resources have been shown to decline under a riparian grazing regime (Johnson 1982, Medin and Clary 1990, Schulz and Leininger 1991, Clary and Medin 1992). Mammal species richness and diversity are significantly lower in many grazed riparian areas compared to ungrazed areas. Alternately, Johnson (1982) found that grazing increases the density of certain small mammal species which prefer low levels of vegetative cover. In these heavily utilized areas, small mammal species which require high levels of vegetative cover decreased significantly. Although this conclusion would seem to be obvious to the trained biologist, few studies have been conducted for the duration needed to generate hard data on impacts of livestock on small mammal populations.

It appears that quality of vegetation and vegetative composition within the community is more important in determining suitable habitat for small mammal communities than the availability of water (Cranford 1983, Schultz and Leininger 1990, 1991). When unmanaged livestock grazing removes vegetative cover from riparian habitats, small mammals will vacate the area regardless if available water is present. Thus, livestock grazing changes vegetative habitat structure which results in a shift in small mammal species composition in riparian habitats.

CONCLUSION

Preservation, protection and restoration of riparian habitats in the Southwest is of critical

importance because of their limited geographic extent and their extraordinary abundance and diversity of native wildlife. Domestic livestock grazing is the most widespread economic land use in the western United States. Livestock utilize public lands in all western states, from sea level to alpine habitats. Because of this situation, domestic livestock have now become the key element in the regulatory processes of nearly every Southwestern ecosystem. This situation has existed in the lowland Southwest for nearly 300 years despite the fact that large ungulates such as domestic cattle were not historically present in these habitats. Southwestern lowland riparian ecosystems evolved in the absence of the tremendous grazing pressures which now exist. Due to historic stocking levels and unmanaged grazing systems, many Southwestern riparian habitats have been permanently altered in their structural and functional integrity, resulting in loss of species diversity, richness and abundance.

Very little ecological management has occurred in Southwestern riparian habitats. Historic and current management of these sensitive ecosystems has traditionally centered around a concept of single-purpose consumptive utilization such as mining, timber harvest, water management, livestock production or hydroelectrical power. In the American Southwest, the predominant land use based upon total acreage under utilization, continues to be domestic livestock management. Numerous studies have shown that unmanaged livestock grazing results in serious deleterious impacts on native flora and fauna.

Riparian habitats are critical for wildlife and fish species in arid ecosystems. The Public Land Law Review Commission (1970) wrote "(t)he Federal Government has a responsibility to make provision for protecting, maintaining, and enhancing fish and wildlife values on its lands generally because of the importance of those values as part of the natural environment over and above their value for hunting, fishing and other recreational purposes." The health of these ecosystems is the best indicator of whether livestock management is in accordance with the multiple use mandate of the Federal Land and Policy Management Act of 1976. Sadly, these requirements are not being met in many riparian areas of the Southwest. Although the BLM and the USFS have been directed by the Public Rangelands Improvement Act of 1978 to improve declining range conditions, the agencies have been unable to meet the Congressional mandates of the Act. The BLM and the USFS have not been able to effectively administer an intensive livestock management program because these agencies do not have the capability in terms of staffing and funding. State land departments have an even worse track record for management of the lands they are entrusted with (Robert Ohmart 1995, pers. comm.)

Many vertebrate species have declined in recent years due to alteration of riparian habitats, and these species may soon be considered for Federal listing. To prevent future listings and to reverse population declines of sensitive wildlife species, land management agencies need to implement appropriate practices within riparian ecosystems. Recent riparian ecosystem recovery efforts have been shown to benefit many wildlife species and can be used as examples of balanced riparian ecosystem management.

A major hurdle which continues to impede riparian area management is mixed ownership patterns which fragment local communities and polarize "consumptive" and "non-consumptive" users alike. Private landowners may see riparian ecosystems as an opportunity for monetary gain, while others may choose to manage these systems in a natural, "hands-off" approach. Land management agencies such as the USFS and the BLM are mandated to administer public lands in a multiple-use manner provided that the impacts do not jeopardize the continued sustainable use of those lands. Herein lies the crux of the problem. Humans will always agree to disagree on management of "their" public lands, and why shouldn't they? Afterall, it is their public lands, to be enjoyed now and for future generations. The challenge is to strike a balance between consumptive needs and the needs of the general public. The only way this can be accomplished is using a consensus problem-solving process where management techniques and implementation are agreed upon by all affected parties. This has been shown to work, but it can be a lengthy process. Communication, understanding and acceptance of change for the integrity of the ecosystem and for the benefit of the greatest number of people are the answers. But how to get there...?

MANAGEMENT CONFLICT AND RESOLUTION

Aldo Leopold, as early as 1924 said that "grazing is the prime factor in destroying watershed values" in Arizona. Over seventy years later, grazing management practices are still impacting the rangeland and riparian ecosystems of the arid Southwest. Why has this continued to occur when so many dedicated public and private land owners have recognized the problem for so long? As with many new ideas, change is associated with unfamiliarity and a reticence to accept even the most basic truth in light of past mismanagement. We have known for decades that unmanaged livestock use in riparian habitats has caused great destruction, yet political pressures and institutional paradigms have made riparian habitat rehabilitation move at a snail's pace. Land managers must accept this reality, and yet continue to move forward in a progressive manner that addresses issues of riparian degradation in both a humane and biological context. We cannot simply force all cattle off of the public lands with a sweep of the pen, and we cannot expect ranchers to anonymously accept the inevitable changes which are on the horizon. Human acceptance of change will take time, but land managers must continue to work with their allottees to determine the best management practices possible for the health of riparian ecosystems and sustainability of their fragile resources.

Management Recommendations

1. Recognize that a problem does exist. Riparian ecosystems are uniquely sensitive habitats, and should not be managed as part of adjacent upland sites. Most management activities do not address riparian condition or recovery as their main objective. Riparian habitat should be managed as the most sensitive and most productive North American habitat.

2. Manage riparian systems for biological integrity rather than for domestic livestock utilization until desired ecological condition is restored.

   - The grazing management system designed for an area should be tailored to the conditions, problems, potential, objectives, and livestock management considerations on a site specific basis using the best information and science possible that will best meet the needs of the resources (Kinch 1989).
   - Whenever possible, exclude all grazing from riparian habitats to protect vegetation, wildlife and watershed values. Livestock should be permitted in riparian areas only if grazing contributes to the improvement of riparian health.
   - If riparian habitats are to be grazed, light to moderate use during the late fall and winter period are preferred.
   - Degraded riparian habitats may need complete rest for several years to initiate recovery. In most cases, only complete exclusion from the riparian zone can recover these habitats. While a system of rest-rotation can increase forage production, there is no conclusive evidence that it can completely recover a badly degraded riparian ecosystem. Desired Future Condition will **never** be achieved in an unmanaged livestock scenario.
   - Monitor results of vegetative and wildlife response regularly to determine if goals are being met. Change management as needed to achieve Desired Future Condition.
   - Allow extended non-use of grazing permits to protect sensitive or recovering riparian ecosystems and the wildlife these systems support.

Kinch (1989) correctly states that western riparian systems can be resilient under continued heavy livestock utilization and that these systems typically respond more quickly to management change than drier upland habitats. He further states that there is currently no single grazing management system that has conclusively proven to result in consistent improvement of degraded riparian areas in the western United States. It is widely accepted that historically less than 1% of the arid Southwest was composed of riparian habitat and that of that total an estimated 95% has been severely altered or destroyed. I would argue that because of the importance,

fragility and limited total riparian acreage that remains, all riparian habitats should be excluded from domestic livestock use until they recover their integrity and functionality within an ecosystem-based context. It is at this point that grazing be considered within western riparian systems, but only after wildlife, recreational and watershed values are adequately addressed.

Grazing allotment decisions are made at the national, resource area/forest, and allotment level. The public is entitled and encouraged to contribute input at all levels in the decision making process. The public must get involved in the formulation of land use plans. By actively influencing land management agency decisions, the public can bring a measure of balance and environmental concern to the management of the public lands. As responsible land managers, we need to insure that future generations don't inherit the same problems that the current generation has inherited (Wald et al. 1991). Local consensus and support are critical to successful riparian area management.

3. Monitor rates of recovery and potential impacts of adjacent land management practices. Domestic livestock grazing is but one of many management activities which impact riparian ecosystems. Other impacts which need to be monitored are recreation, mining, logging, mechanical manipulation of riparian habitats and urbanization.

4. Address the issue of "burden of proof." Do not assume that the Federal Land and Policy Management Act with it's multiple-use mandate automatically reads "all uses in all habitats unless you can prove it will have an adverse impact."

   - Consumptive users should bear the burden of proof to show that their activities will not impact sensitive riparian resources.
   - Adopt the concept of "appropriate use in appropriate habitats under appropriate circumstances." Management efforts should promote the biological integrity of the riparian ecosystem rather than political or economic gain. The use of one dominant resource activity should not be pursued to the exclusion of other equally important (although possibly not as financially lucrative) activities. Riparian ecosystems cannot be managed to achieve optimal production for all competing uses, and must be balanced among a great variety of uses.

5. Hold managers and permittees "accountable" for the health of the ecosystem.

   - Managers need to show riparian improvements in yearly appraisals. Protecting scenic, ecosystem, wildlife, recreation, cultural and hydrologic values are within the realm of mandated legal duties of the USFS and the BLM.
   - Permittees should receive incentives to rest pastures with riparian habitat. Grazing fees should be restructured to reward the rancher who is improving the health of riparian areas, and to avoid rewarding the rancher who continues to degrade these systems. Permittees who are achieving desired riparian objectives may pay less per animal unit month than permittees who are not achieving riparian objectives.
   - Land management agencies need to re-evaluate grazing systems within the context of sound biological principles and recognize that all riparian systems are unique. One management prescription will not apply to all systems. Each system requires thorough investigation, monitoring and management techniques which are tailored to that specific system. When change is required, land managers must have the biological and professional integrity to admit that change is needed, and then implement the change.
   - The preservation of functioning ecosystems and native floral and fauna1 species should be the primary goal of public land management.

The BLM and the USFS are mandated by the following laws to administer lands in a manner which does not compromise the integrity of the ecosystem health: the Taylor Grazing Act (1934); the National Environmen-

tal Policy Act (1970); the Endangered Species Act (1973); the Federal Land Policy and Management Act (1976); the Public Rangelands Improvement Act (1978); the Clean Water Act (1977 and 1987 amended); and BLM and USFS riparian area policies and mandates (various dates). The Endangered Species Act of 1973 was clearly intended to protect and recover all listed plant and wildlife species. The Act states that recovery of these species will be the highest priority for all land management agencies, and that this mandate would supersede the multiple-use mandates of the USFS and the BLM. Even with this guidance, public land management agencies have not been able to operate their range programs without meeting their mandates as directed by the Act.

6. Encourage research and monitoring using sound science to gather, synthesize and dispense information which will restore degraded riparian ecosystems and associated biotic resources.

7. Manage riparian ecosystems and associated nongame wildlife resources with established programs which utilize game species as a focal point for wildlife management. As Gottschalk (1975) stated: "(w)e have not yet reached the point in our public attitudes toward wildlife where we can assume support for fish and wildlife resources that have no obvious utility. Therefore the best approach will be to attempt to tie programs for nongame species into an overall ecological orientation. To do so will require changes in public policy dealing with our renewable wildlife resources, and in the system of training land and wildlife managers. Meanwhile such managers must do their best to become practical ecologists."

Domestic livestock grazing is undoubtedly the most ubiquitous land use within the western United States, and has been documented to have greatly influenced all aspects of the western landscape. Cooperrider (1990) stated that "since livestock grazing remains one of the most common and widespread uses of western rangelands, and since impacts of such grazing on biological diversity are so poorly understood, livestock grazing must be considered as one of the primary threats to biological diversity." Conservation of biological diversity within Western ecosystems is essential because the accumulated loss of populations and ecosystem fragments could result in the permanent disappearance of many plant and wildlife species as well as entire biological communities (Ehrlich 1987). Riparian habitats are an integral component of western biological ecosystems, and their loss could permanently impact the integrity of the land as well as all of the inhabitants which depend on the land, including plant, animal and human populations.

Aldo Leopold wrote that "to keep every cog and wheel is the first precaution of intelligent tinkering". One of the most integral "cogs" that must be preserved are the endangered riparian ecosystems of the Southwest. Riparian ecosystems are fragile corridors of life in the otherwise arid Southwest, and these systems link all other habitats together. Losing riparian habitats creates dysfunctional ecosystems. Unmanaged livestock utilization has resulted greatly in the dysfunctioning and destruction of riparian ecosystems in the Southwest.

I would warn land managers that if we do not address Southwestern riparian issues, and in particular continued unmanaged livestock utilization, then plant and wildlife species that are dependent on Southwestern riparian habitats will create issues which could bury the issues facing wildlife managers in the Pacific Northwest. While a Western Yellow-billed Cuckoo (Coccyzus *americanus* occident&), Southwestern Willow Flycatcher (*Empidonax traillii extimus*) or Mexican Garter Snake (*Thamnophis eques*) may not have the economic impact or political sensitivity of a Northern Spotted Owl (*Strix occidentalis),* they are a few among the scores of wildlife species which are now "teetering on the brink" in Southwestern riparian ecosystems. This issue has only recently been addressed, but it will eventually affect all future land use decisions and management of Southwestern riparian ecosystems.

We have thus far been using a piecemeal approach to riparian management, but with little success. We must determine the carrying capacity of a watershed before we compromise the quality of life and the ecosystem which sustains that quality of life. We have a choice as land managers. Continue to be reactive in our management techniques at the expense of many species, or be proactive to prevent extinctions and future listings of many wildlife species. It is our choice, but we no longer have the luxury of time.

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