Management Alternatives for the Riparian Habitat in the Southwest[1]

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Abstract -- Exploitation, by man, has significantly altered the riparian habitat in the Southwest. For decades, the primary or dominant use of riparian habitat has been water management; other values were not considered. Management alternatives and objectives are evaluated for environmental consequences.

Diversity and numbers of plant and animal species are continually changing through geologic time. Disappearance of some plant and animal species and the emergence of others results from evolutionary processes of natural selection. Plant and animal species are constantly adapting to changing environmental pressures. Fossil records indicate that extinction is the inevitable fate of all species. Continual variation in the physical and biological environment initiate extinction in nature. When an individual species is unable to adapt to changing environmental stresses, it is replaced by others.

Prior to the appearance of Homo sapiens on this planet, extinction occurred as a consequence of natural phenomena. With the advent of humans, an additional stress was exerted on the physical environment. Some data imply that the rate of extinction increased as a result of human stress (Martin, 1967). Human stress on the environment has many forms -- agricultural practices, timber harvesting, domestic animal grazing, industry, hunting, predator control, and pollution. Often it is the interaction of numerous types of stress which results in the extinction of a species.

The primary causal factors of animal extinction include, but are not limited to: ecosystem alteration, introduction of exotic species, predator and pest control, pollution, poaching, and the capture of wild animals for legitimate and illegal purposes. Ecosystem alteration is one of the more significant causes of extinction. When wildlife niches are altered, animals must move to other areas, adapt to a new environment, or die. Even though some habitats are not totally destroyed, there may not be enough suitable area remaining to maintain a viable population. Habitat destruction is responsible for approximately 30 percent (%) of the presently endangered species (Uetz & Johnson).

Riparian habitat in the Southwest is a classic example of the effect man can exert on a particular habitat. Records of early explorers (Emory, 1948) reveal that riparian communities have been altered significantly from the original type. Significant man-caused impact on the riparian type began approximately 450 years ago, when European man first journeyed into the Southwest from Mexico. Early day grazing undoubtedly had an effect on riparian areas. In the last 100 years, the rate of alteration has increased significantly. This is due largely to ever-increasing human pressures, land clearing for agriculture, dam construction, grazing, pumping of ground and surface water for irrigation, and increased recreational pressures. For decades the primary or dominant use of riparian habitat in the Southwest has been water management; other values were not considered. The dominant use was to supply metropolitan areas with water.

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Wildlife populations have adapted to survive in these alterations of the riparian type.

The importance of the riparian type for wildlife has been well documented, particularly for avian species. MacArthur (1964) established a correlation between bird species diversity (BSD) and floral height diversity (FHD). He also reported that habitats with permanent water had higher avian populations than those without. Johnson & Carothers (1975) recorded the highest population of non-colonial nesting birds ever reported in North America in a homogenous cottonwood stand along the Verde River in Arizona. Of the 70 breeding species investigated in the riparian type, 50% were obligate nesting species, 20% indicated a decided preference for the riparian type and 30% nested in either the riparian type or non-riparian without a significant preference for either type (Carothers & Johnson, 1975).

Gavin & Sowls (1975) found 476 pairs of nesting birds per 40 hectares in a mesquite (Prosopis juliflora) bosque in Southern Arizona. The adjacent habitat type was temperate and desert grassland. Balda (1967) found 31 and 46 pairs per 40 hectares (ha.) in the mixed grass and yucca-grassland types in Southern Arizona. Carothers (1974) found 332 pairs/40 hectares (ha.) in the mixed broadleaf type in the Verde Valley in Arizona. Beidleman (1960) and Hering (1957) reported 30 pairs per 40 hectares in the adjacent pinyon-juniper type. Obviously, bird densities are significantly higher in the riparian type than in adjacent communities.

Riparian vegetation enhances aquatic habitats through reduction of solar radiation, reduced erosion, decreased sedimentation, and energy input in the form of vegetational debris and terrestrial insects. Most of the food for important aquatic insects comes from land vegetation. Several studies show that these sources contribute a 50-70% of the energy responsible for producing fish in a stream. (Fisher & Likens, 1973).

Riparian habitats have three basic prerequisites for wildlife: food, water, and cover. The cover component has proportionately more ecotones than any other type. Ecotonal areas are a result of horizontal and vertical stratification of deciduous and evergreen trees, water and hydrophilic plants, and the undulating configuration of the type. Vertebrates that either live or reproduce in water are confined to these zones. Riparian habitats receive proportionately more use per unit area than any other type. A large percentage of terrestrial species known to occur in a given area are either directly dependent on riparian zones or utilize them proportionately more than any other habitat type. In short, the riparian type is the most important habitat type in the Southwest for wildlife.

A substantial volume of literature documenting the importance of the riparian type has been published but some key questions need to be answered prior to initiating a realistic attempt to manage this type.

1. What floristically is a riparian community?

2. Where is it located and what is its ecological condition?

3. What are the ecological factors limiting perpetuation of the community?

4. Is the community maintaining itself through natural reproduction? If not, what are the factors preventing perpetuation?

5. What should our management objectives be for riparian habitat? Water production, habitat for wildlife, water quality, recreation, fuelwood, aesthetics, fisheries, grazing, and agriculture are all potential uses of the riparian type.

6. What is the species composition and age class of a healthy riparian community?

Verbose definitions of what constitutes a riparian type abound in the literature, but, simply stated, it is an aggregation of floral species which depend on a flow of water on or near the surface for subsistence. Riparian habitat occurs in every life zone in Arizona with the possible exception of the Hudsonian. Species composition changes with elevation. Often the climatological conditions prevalent in drainageways allow the downward extension of a higher elevation species such as ponderosa pine (Pinus ponderosa) fingering down a canyon into the Upper Sonoran Life Zone. These inclusions are ecologically important as they provide an additional ecotone within the arid Upper Sonoran Life Zone and should properly be classified as a riparian community.

These riparian communities should be mapped and classified as to type and condition rating. Until we know where they are and what their ecological condition is, we cannot manage them. This should be an integral component of our planning process.

Prior to implementation of any type of management, the most critical need is knowledge of the ecological requirements of individual plant and animal species for self propagation. It is not realistic to believe that we can artifically maintain a vegetative type through perpetuity. Classification of riparian communities and documentation of their condition class will reveal whether or not these communities are maintaining themselves. If not, the next logical step is to carefully determine what are the causal factors. Generally speaking, failure of the riparian type to regenerate itself in Arizona can be related to several factors either operating independently or in conjunction with one another.

1. Loss of water flow as a result of diversions for irrigation, impoundments for metropolitan usage, and lowering of water tables by pumping for sundry uses.

2. Loss of significant portions of entire communities as a result of devestating floods. These periodic floods are significant because they remove substantial numbers of older mature trees which serve as seed sources. Many of the riparian species are adapted to periodic flooding and an occasional flood is necessary for germination and survival of the seedlings, but floods of a significant magnitude are detrimental.

3. In areas of high recreational use, soil compaction, trampling, and inability of the soil to retain moisture prevent seedling establishment. Also, loss of ground vegetation (herbaceous) dries out the site and prevents regeneration of some species.

4. Phreatophyte control essentially eliminates the vegetation, removes the seed source, and changes the micro-site relationships.

5. Overgrazing by domestic livestock, in my opinion, is probably the major factor contributing to the failure of riparian communities to propagate themselves. Continued overuse of riparian bottoms eliminates essentially all reproduction as soon as it becomes established. Overstocking and the consequent loss of vegetative cover on the adjacent watersheds is probably the main reason for the frequency of high intensity floods resulting in drastic changes in the density and composition of riparian bottoms.

An evaluation of a riparian community necessitates making a judgment of whether the type is in good, fair, or poor condition. In the Southwest we are talking about many different species aggregations within the riparian type. Significant research data is needed to answer some of these questions:

a. Should a certain percentage of the vegetation be comprised of a particular species?

b. What should the age class distribution be in a healthy stand?

c. What is an ideal canopy coverage in percent?

d. What should the composition and density of herbaceous vegetation be?

e. Does a particular site have potential to develop a riparian community under proper management?

Research has been initiated here in the Southwest in an attempt to answer some of these questions. During the interim we have developed the following scorecard to use in our evaluations.

RIPARIAN STAND ANALYSIS

This rating of the riparian habitat will be based principally on its attraction to associated wildlife and ecological stability of the type.

The 100-point transect described for browse and the aspen stand analysis will be used. Certain modifications in the technique and score card will make it adaptable for the riparian type. A description of this technique follows:

A. Mapping

Riparian types will be delineated on aerial photographs.

B. Establishing Transects

1. Riparian types to be analyzed will be sampled with paced condition transects.

2. Transect locations will be carefully selected to fall within representative portions of the type.

3. Additional transects will be run in the same stand whenever a change in condition is recognized.

4. Within the stand to be sampled, select a route and pace interval that will

provide a good cross section of the stand. The starting point should be identified and pin pricked on an aerial photo.

5. Pace along the chosen route, walking as straight as practically possible. Along a meandering stream course, cross back and forth across the channel but do not take sample points in the channel.

6. At each sample point, record whatever is found with a 3/4 inch loop immediately in front of a mark on the boot toe. This may be bare ground or erosion pavement, rock, litter, grass, or forb. Grasses and forbs will be identified and tallied by individual species when all or part of the live root crown falls inside the loop. Record as litter if more than one-half of the loop covers dead plant material older than that resulting from current growth. Record hits on rock only for rock in place. Small, loose moving rock should be tallied as erosion pavement.

7. At each sampling point, the examiner will record, by species, the nearest woody riparian plant to the boot toe that occurs within a 180 degree arc in front of the sample point ("hit"). If the species involved can be described in timber terminology as a sprout (less than 4½ feet tall), a sapling (4½ feet tall to 4.9 inches diameter breast height d.b.h.), a pole (5 inches to 8.9 inches dbh), or mature (over 9 inches dbh), it should be tallied as such. If, however, the species involved is mature (at 4 inches dbh), the observer should use his best judgment on where the specimen of that species fits into the above described sale (i.e., if a species is mature at 4 inches dbh and one is "hit" that is 3 inches dbh., it should be tallied as a pole, not as a sapling.) If a dead riparian species is "hit", tally it and then record the size class for the nearest live riparian species. This will result in a transect sample of 100 live riparian species. If a riparian species is a sprout, determine if the sprout has been browsed or not. Dot tally this information on the appropriate column.

8. At each tenth sampling point, obtain the basal area and crown density of all woody species. Crown density will be taken with a spherical densiometer. Count each corner which intersects an opening in the canopy. Each corner represents approximately 6% of the total canopy. Multiply the number of corners which intersect openings by 6 and subtract this figure from 100 for crown density percentage. Basal area will be computed in the following manner: using a 1/100th acre plot (11'9" radius) record the dbh of all woody species at breast height and dot tally into the following size classes. All specimens greater than 12" dbh will be recorded individually by species. Basal area in sq. ft/ acre will be computed by using standard basal area tables.

9. At each tenth sampling point, a 1/100-acre pellet group plot will be run. Include all countable groups for deer, elk, cattle or horses.

C. Composition

"A species" (must be 4 or more) making up 75% or more of the composition. = H

"A species" (must be 2 or more) making up 35% or more of the composition. = M

"A species" comprise less than 35% of the composition or only one "A species" represented. = L

Species Rating - A

Cottonwood	Ash	Mulberry
Sycamore	Willow	
Walnut	Alder	
Hackberry	Elm	
Grape	Box Elder	
Rhus	Oak	

D. Crown Density

Crown density, as utilized in this particular scorecard, serves as a criterion of relative dominance, of potential productivity, of the influence of plants on precipitation interception and soil temperature, and of the value of vegetation to animals. It is applicable to almost all ecosystems, owing to the universal importance of light coming from above.

Crown density will be taken with a spherical densiometer. Count each corner on the grid which intersects an opening in the canopy. Each intersection represents approximately 6% of the total canopy. Multiply the number of intersections which occur in openings in the canopy by 6 and subtract the result from 100 for crown density percentage.

Crown Density Rating Guide

80%-100% = High (H)
50%-80% = Medium (M)
0-50% = Low (L)

E. Basal Area

Basal area refers to a comparison of species as to the aggregate cross-sectional area of the individual plants taken at or near ground level, per unit of land area. Basal area gives a relative indication of dominance and biomass (by species) for the riparian community.

Basal area will be computed utilizing a 1/100th acre plot (11'9" radius) at each tenth sampling point. Record the d.b.h. of all woody species at breast height and dot tally into size classes. All specimens greater than 12" d.b.h. will be measured and recorded individually by species. Conversion factors for all d.b.h. size classes from 0"-12" are included on the scorecard. For those species greater than the 12" d.b.h. use the standard basal area tables included in the handbook.

Basal Area Rating Guide

60 sq. ft/acre or greater = High (H)
30 sq. ft/acre - 60 sq. ft/acre = Medium (M)
0-30 ft. sq/acre = Low (L)

F. Vigor

Vigor is determined by utilizing three (3) criteria: (1) the percentage of "A species" which are sprouts, (2) the percent of "A species" sprouts which have been browsed, (3) the number of "hits" on dead "A species." Summarize data for each measurement, apply to Riparian Vigor Rating Guide and indicate appropriate vigor rating (L-M-H) on the riparian scorecard. (See example below)

Riparian Vigor Rating Guide

Riparian type has at least 10% sprouts/seedlings of "A species"	and	No more than 25% of the sprouts/seedlings are browsed	and	No more than 10 "hits" on dead riparian species
Riparian type has over 5% sprouts/seedlings of "A species"	and	No more than 75% of sprouts/seedlings are browsed	and	No more than 30 "hits" on dead riparian species
Riparian type has less than 5% sprouts/seedlings of "A species"	or	More than of sprouts/seedlings are browsed	or	"Hits" on dead riparian species exceed 30

G. Stand Structure

The age class distribution of "A species" determines the stand structure rating which will be applied to a riparian stand. This rating is based on the percentage of sprouts and saplings in relation to poles and mature "A species". Summarize this percentage and apply to the Riparian Stand Structure Rating Guide and indicate score on Form.

Riparian Stand Structure Rating Guide

All age classes represented with sprouts/seedlings and saplings of "A species" making up 30% or more of the stand. = H

At least 3 age classes represented with sprouts/seedlings and/or saplings of "A species" making up 10% or more of the stand. = M

Less than 3 age classes of "A species" represented with sprouts/seedlings and/or saplings of "A species" making up less than 10% of the stand. = L

The key question that needs to be answered is what should our management objectives be for the riparian habitat? Should the management objective be identical for all the riparian type, or should they be tailored to fit different species aggregations?

The riparian type has many potential uses but our primary objective should be to maintain the type in a healthy ecological condition, a condition which enables natural perpetuation of the community. It should be managed as the most sensitive habitat in the Southwest. This is particularly important because it is an area of maximum potential conflict between resources such as timber, wildlife, grazing, recreation, and water production. Past management has tended to overlook or disregard the intangible or non-economic uses of the community. Public land management agencies, partially as a consequence of public pressures, have had difficulty recognizing uses that are superficially lacking in tangible economic benefits. The dominant use of riparian type has been grazing and water production with little thought given to its value for wildlife and recreation or preservation as a unique community.

In order to evaluate management alternatives, an investigation of potential benefits versus ecological consequences is needed. Multiple use management should not assume that all uses should necessarily occur on the same acre of ground. Typically, management objectives are complicated by a variety of environmental situations and conflicting demands on resources.

If our management objective is to maximize the net gain in usable water, we should treat the upper watersheds and eliminate the riparian vegetation along the stream channel. Heindle (1965) estimated that we were harvesting approximately 5 million acre feet of surface water annually in Arizona, New Mexico and western Texas and predicted this amount could be doubled by treating upper watersheds, eradicating all riparian vegetation, suppressing evaporation from reservoirs, salvaging excessive surface water, diversions, and capturing uncontrolled streamflow.

Predictable amounts of water salvaged as a result of the complete removal of riparian vegetation have not been thoroughly documented. Estimates vary with different studies: Culler (1970) estimated an approximate savings of 0.8 acre/ft. per acre when dense tamarix (Tamarix Pentandra) and mesquite were completely cleared. Bowie and Kam (1968) estimated that complete removal of 22 acres of cottonwood (Populus fremontii), willow (Salix. spp), and seepwillow (Baccharis spp.) would salvage approximately 1.7 acre ft./acre or a savings of 6 percent of the inflow. Converting 15 acres of riparian shrubs and trees to grass in Southern California increased water yield 17 acre feet (1.1 acre ft./acre) in eight months (Rowe, 1963). Average water savings in certain habitat types is approximately 1 to 2 acre ft./acre (Horton & Campbell, 1974).

Control of riparian vegetation for water *production appears to be most feasible on flood* plains where the water table is between 8 to 20 feet in depth and on upper watersheds above 7,000 feet in moist coniferous sites. Removal of riparian vegetation along perennial streams is probably not economically feasible because evaporation exceeds transpiration (Horton & Campbell, 1974).

Several logical assumptions can be postulated from the aforementioned studies: (1) removal of riparian vegetation increases surface flow but to what degree depends on the species, composition, and density; (2) increases in surface flow are modest because of the attendant increased surface evaporation; (3) re-treatment of the site is necessary as a result of reinvasion. (Campbell, 1970)

Evaluating the data brings to mind an interesting hypothesis. If we assume that water is a natural resource and the demand for water in large metropolitan areas for municipal and industrial uses will increase significantly, the price of water will also increase. If the demand is such that we need to increase our water yields we can accomplish this task and also improve the condition of our riparian habitat if we concentrate our efforts on the upper forested watersheds and the floodplains below 3500 feet with dense stands of mesquite or tamarix.

Dortignac (1965) reported maximum water yields emanate from forested high-elevation watersheds. He estimated that, in the Rio Grande Basin in New Mexico, 32 percent of the total water yield comes from the spruce-fir-aspen forest above 8,000 feet, while 40 percent is derived from the ponderosa pine forest. Horton & Campbell (1974) suggested that phreatophyte control is most effective on floodplains in lower elevations which support a dense stand of phreatophytes.

Riparian habitat that occurs between 7000-3500 feet in elevation has the highest ecological diversity, the greatest value to wildlife, and is the most abused by overgrazing. Increased streamflow through this elevational zone as a result of treatment in the upper watersheds would, if accompanied by reductions in domestic livestock, change some ephemeral streams to perennial, enhance regeneration potential as a result of increased moisture conditions, enhance density and vigor, improve aquatic habitat, and reduce stream temperatures as a result of more shading. Riparian vegetation in this zone, in most cases, is relatively sparse. Increasing the streamflow would increase the density of vegetation with an attendant increase in the amount of water lost through evapotranspiration. However, if this anticipated increase flows *into perennial streams with* a dense stand of riparian vegetation, no significant increase in evapotranspiration is predicted. (Campbell, 1970)

What would be the consequences of maximizing water yields without mitigating for other resources? The answer must be speculative, but the following results can be visualized:

1) All riparian plants will be temporarily suppressed.

2) Erosion and sedimentation will increase significantly because stream banks will lack vegetation for stabilization.

3) Transpiration losses will be negligible, but evaporation from the soil will increase as a result of higher soil temperatures and shallower water tables.

4) Rate of siltation of downstream reservoirs will increase.

5) Degradation of aquatic habitat will occur as a result of:

a. increased water temperatures

b. loss of energy from vegetational debris

c. loss of niches for aquatic insects

d. increased algae growth

6) Riparian habitat for wildlife will be lost; many species would be completely extirpated.

7) Aesthetic quality would be significantly diminished.

8) Potential recreational opportunities would be eliminated.

9) Potential for torrential type floods will increase.

10) Forage and cover for domestic livestock would be reduced.

What management strategies and alternatives are available if the stated objective is to manage the riparian type for production of domestic livestock? Obviously, the riparian type consists of many different aggregations of species, occurs within many habitat types, and is subjected to numerous management situations. Management strategies must, because of the diversity of the type, be referred to in a general sense. There is no panacea which is applicable to all situations.

Logically, prior to proposing a management strategy we need to know: What are the problems and what are the desired consequences? The problem is that the riparian areas are in poor condition, particularly when their potential productivity is considered. In order to correct a problem, one needs to determine what was/is the cause. Overgrazing by domestic livestock, in my opinion, is the obvious answer. The desired consequence is to create a situation within the riparian type which will support an optimum number of domestic livestock on a sustained basis. This implies maintaining a suitable forage base through perpetuity to support livestock numbers for future generations.

The effect overgrazing has had on the riparian type is twofold: 1) increased potential for devastating floods due to elimination of vegetative cover on adjacent watersheds; 2) removal of herbaceous material and seedlings and/or sprouts of woody riparian in the bottoms. Consequently, the following situation exists:

1) failure of the type to reproduce itself;

2) poor representation of age classes;

3) low vigor;

4) lack of sufficient vegetative cover to prevent erosion;

5) elimination due to channel-scouring floods of older mature trees which constitute critical seed sources;

6) elimination of moist microsites required for reproduction of such species as sycamore (Platanus wrightii);

Proper stocking on adjacent watersheds is needed to reduce both the volume and frequency of flooding. If this cannot be accomplished, efforts to obtain reproduction in the riparian type will not be as effective.

An expedient procedure to rejuvenate riparian stands is to exclude livestock by fencing until reproduction is out of reach. In steep canyons this can be accomplished easily because of restricted accessibility, but in other areas many miles of fence would be required. Riparian species are prolific growers. If conditions are amenable to growth, cotton (Populus spp.), alder (Alnus spp.) and sycamore can grow 10 to 15 feet in several years if protected from grazing.

Once re-establishment has occurred, grazing under a rest-rotation management program accompanied by proper utilization factors, salting and riding can be utilized to maintain the optimum species composition for a sustained yield of domestic livestock.

Anticipated environmental and social consequences of managing the riparian habitat for domestic livestock are:

1) a significant reduction in stocking rates would temporarily have an adverse economic effect on many livestock operators;

2) decreased flooding potential;

3) improvement of terrestrial and aquatic habitats;

4) reduced erosion and sedimentation;

5) improvement in water quality;

6) reduction in water yield;

7) retention of long term site productivity;

8) improved forage production for domestic livestock;

9) enhanced recreational opportunities;

10) increased esthetic quality;

Management of the riparian habitat for wildlife could best be accomplished by the total exclusion of domestic livestock with the exception of water gaps for watering purposes. A theoretical exception whereby periodic grazing would be beneficial would be a marsh area occupied by nesting waterfowl. Dense vegetation along the periphery should be eliminated periodically by grazing to retain a terrestrial herbaceous food source. A logical question as regards a recommendation to exclude livestock would be: Can livestock be prudently utilized to maintain a desirable understory composition? Realistically, the time necessary to restore the riparian habitat to a healthy condition is decades. The potential use of livestock to manipulate vegetation in the riparian habitat may be worthy of consideration in 30 years. Horizontal and vertical stratification, diversity of floral species, and floral volume is needed for optimization of wildlife habitat -- regardless of what is done, this will not be realized for many years.

Environmental consequences of managing riparian habitat for wildlife are essentially the same as listed for managing for livestock with the following exceptions:

1. Adverse economic effect would be permanent, i.e., production of domestic livestock from the riparian type.

2. Forage production for livestock would not improve because they would be excluded.

3. Reduction in water yield would increase.

Management for recreation would utilize the procedures mentioned for wildlife, but access should be provided by trails, campgrounds, etc. Environmental consequences are the same.

Riparian habitat in the Southwest is rapidly dwindling. Land managers need to initiate management to stop the rate of loss and insure the perpetuation of the community.

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