Wildlife Conflicts in Riparian Management: Water[1]

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INTRODUCTION

This paper is a summary of observations of the need for a better understanding of the interactions of stream-riparian-vegetation-energy-nutrients-water production-aquatic life and terrestrial life. Most of the riparian ecosystem interactions have had very little attention in Arizona and New Mexico.

WHAT IS WATER

In its pure form water is a colorless, clear liquid compound of hydrogen and oxygen. Water in the riparian zone is never just H_2O. It is a building block for photosynthesis by riparian and aquatic vegetation. It carries assorted dissolved salts (many of which are nutrients). Water carries dissolved organic matter, fine and coarse particulate organic matter, and supports numerous aquatic life forms, vertebrate and invertebrate, large and small (fish plankton, bacteria, etc.) Water, through the riparian vegetation, supports a wide assortment of interesting and valuable terrestrial wildlife species. Water is an energy source in itself as it forms natural, meandering channels and transports particles, large and small.

ENERGY-RIPARIAN ECOSYSTEM

A number of studies have shown that fish production is much lower where grazing occurs in the riparian zone. For example, in the Rock Creek Floodplain Investigation (Marcuson 1970) there were 63 pounds per acre of brown trout in the heavily grazed area as compared to 213 pounds per acre in the ungrazed area.

Bob Phillips (USFS) and others demonstrated the presence of 31 steelhead in a 100-foot heavily grazed section and 75 steelhead present in a nearby lightly grazed section (personal communication).

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(Fisher 1970) demonstrated that 99% of the annual energy budget for Bear Brook comes from the surrounding forested watershed or from upstream areas. Even in large streams, such as the Missouri River, fifty-four percent of the organic matter ingested by fish is of terrestrial origin (Berner 1951).

(Cummins 1974) diagrammed the fate of heterotrophic stream organic materials (dissolved and particulate) and showed a conceptual model of stream ecosystem structure and function.

(Ensign 1957) found that in Mt. Vernon Creek, southern Wisconsin, where cattle were free to graze the streambanks, terrestrial insects made up only 4% of the annual food of brown trout. In Black Earth Creek (a few kilometers from Mt. Vernon Creek) where streambanks were protected from grazing, terrestrial insects comprised 15% of the annual diet of brown trout.

Thus, we find in the literature that streams are often energy dependent upon the riparian vegetation and the watershed. (Likens and Bormann 1974) have demonstrated the nutrient linkages between streams and watersheds. They state clearly that the key to wise management of aquatic ecosystems is wise management of the watershed.

We can extrapolate these works and assume that many streams in Arizona and New Mexico will also be dependent upon the riparian zone and their associated watersheds for their primary energy sources. But in this area, we have streams which can begin at elevations up to 11,000 feet on Mt. Baldy on the Apache National Forest (where they are comparable to streams in Northern United States or Canada) descend to intermediate elevation where they support warm water species comparable to southern and Midwestern United States streams. Others, purely desert streams, are unique in the United States. Just as Arizona and New Mexico are rich in the number of wildlife species produced in the wide diversity of habitats, Arizona and New Mexico streams are also rich in diversity running the gamet from high altitude, cold, clear, mountain streams, through warm, algae rich mid-elevation reaches, finally to low elevation pure desert reaches. For instance, we have grayling, an arctic fish, in a lake above the Mogollon River; while only 50 miles away there are channel catfish, a warm water species, in the Verde River.

Energy interdependence will follow a similar gradation. The high streams are most likely to be dependent on outside sources of energy for the aquatic organism food base. The mid-elevation streams may have somewhat more ability to capture energy in the stream through algae, diatoms, and rooted vegetation. The low desert streams with riparian vegetation and with tributaries supporting riparian vegetation may fix substantial energies in the aquatic environment, but will also receive substantial inflows of plant detritus during storm flows. (Burns 1977)

We need to develop a stream classification system which incorporates these energy sources as a significant criteria, and we need to study stream energy budgets on typical reaches of several stream types, i.e. cold water, intermediate, and warm water to document the stream-energy system sources and gradations of dependence upon terrestrial sources.

No doubt we will find streams which are largely dependent upon the riparian vegetation for a substantial portion of their organic-energy and partially dependent upon the watershed for dissolved organic matter.

As I said earlier, fish weigh less and are less abundant in grazed portions of streams. Putting this fact with the dependence upon energy from the riparian zone, we can understand that plant material eaten by cattle in the streamside strip will not be available for food for aquatic organisms in the stream. Fish will have less food. I used the term "streamside strip" here because on many miles of our streams in the southwest free choice grazing by cattle has brought about complete type conversions in those immediate areas alongside streams.

After many years (50 to 100 or more) of grazing in this "most palatable area" the old riparian trees have died, seedlings are eaten and killed until only the most "grazing resistent" unpalatable grasses and/or trees remain. This type conversion at higher altitude has eliminated alders and willows, leaving only associated grasses. In the middle elevations the sycamore cottonwood and others are often entirely missing to be replaced by bermuda grass-desert willow-seep willow and at some elevations, tamarisk. Thus, grazing is a significant force in altering streamside composition - just as it is throughout the watersheds.

Actual streamside composition varies from those areas where all of the natural species are gone with no seed sources remaining, to other streams that have a few decadent widely scattered specimens with most species present. Fencing alone will start the stream toward recovery, but plantings of seedlings will be needed on many.

In figure 1 we see only a few remnants of willow and narrowleaf cottonwood. The stream is appropriately called the Rio de las Vacas and is on the Cuba District of the Santa Fe National Forest, at elevations from 7000 to 9000 feet. The loss of shade for the stream, the loss of bird habitat and the premption by cattle of often the only source of green feed is obvious. The loss of energy to the stream is not so obvious. In fact, all too many times little thought has been directed towards learning how energy used by the stream flows through the ecosystem.

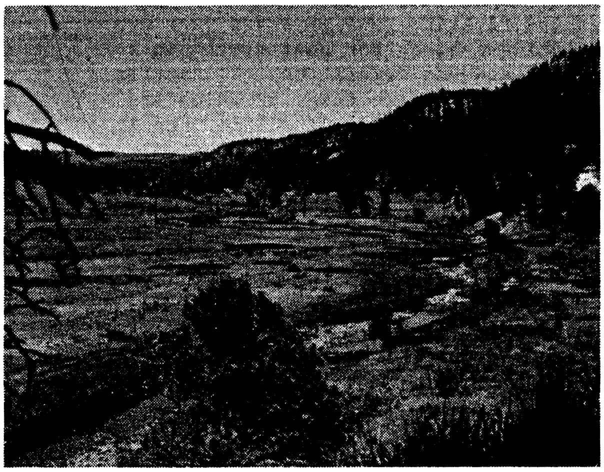


Figure 1

STREAM MORPHOLOGY

Another, more subtle, impact on the fishery occurs when riparian trees are eliminated by continual grazing. The stream is less confined to its banks and will have a more constant sediment load, especially from unvegetated stream banks. Overgrazing in associated watersheds creates higher peak storm flows. Overgrazing combined with hydraulic force of these peak storm flows plus the grazing by cattle on young seedlings keeps many streams in a young, undeveloped and raw condition.

Region 3 of the Forest Service (Arizona and New Mexico) has in National Forest streams approximately 4000 fish habitat improvement structures to make more pools in the miles and miles of flat, shallow streams.

An alternative to these structures and their maintenance is to fence cattle out of the narrow riparian zone so that the streams can progress through successional stages toward more stable conditions. As vegetation and trees become established in the immediate water edge area, the stream will, over time, become more narrow and deeper provided the associated watershed is properly grazed. Grazing levels must provide for suitable vegetative cover to insure soil protection and retard rapid runoff. The number of pools and their suitability for fish habitat will improve. Figures 2 and 3 show an area along a one mile reach of the Rio de las Vacas that has cattle fenced out. Stream profiles, photos, etc., are being established to document changes in stream morphology and riparian composition. Water temperatures in June 1977 reached 70°F. in this area. Narrowleaf cottonwood (Populus angustifolia), Arizona alder (Alnus oblongifolia) and willow (several species) comprise the bulk of the remaining riparian tree species. There are only about 50 individual specimens of narrowleaf cottonwood remaining in eight miles of the stream.

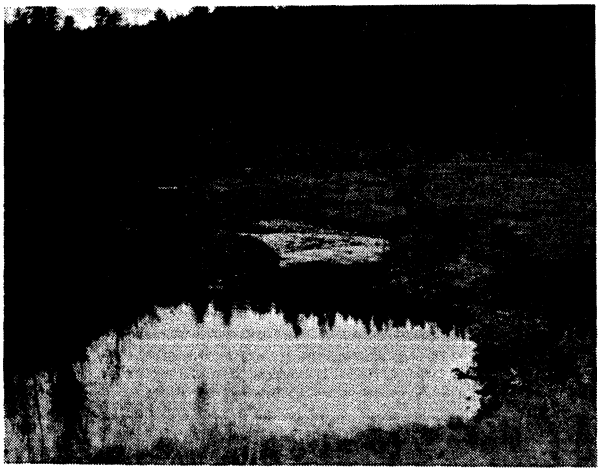


Figure 2

Figure 3 shows the remnants of an old trash catcher type stream improvement structure, entering the water at the arrow. Stones, silt, etc., caught by the fence posts and wire have somewhat constricted the stream making a slightly deeper spot just to the left of the fence. How much better for the fishery, the bird life, the esthetics, and the cattle if the dead trees had survived and reproduced until the roots provided cover, formed a pool and dropped leaves and insects into the stream.

Figure 3

(White and Brynildson 1967) have documented successional stages with drawings which clearly demonstrate the process (see figure 4). Time in these changes will no doubt be faster in Arizona and New Mexico at low elevations with long growing seasons and perhaps slower on the Rio de las Vacas at 8500 feet with a short growing season.

A great deal of research has gone into ways to produce more water on National Forests in Arizona. Much has been written about the evapotranspiration of water by riparian species, native and introduced. There have been no concentrated, integrated efforts to determine which mixture of riparian species might best serve the needs of all resources, the fishery, the bird and wildlife resource, esthetic needs and water production.

As manipulations are applied to watersheds (chapparal and timber) to produce more water, it will become more important to manage the riparian zone (which in one aspect becomes a water "pipeline") to insure all the intrinsic values while producing the maximum amounts of high quality water for downstream users. It is certain that a vigorous stand of well established riparian trees will produce the amenities we are interested in.

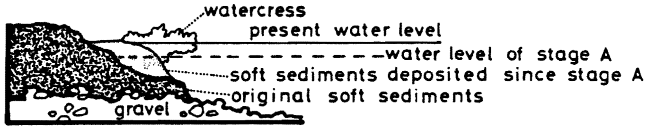
There may be ways to improve tree composition to favor energy flows for the fishery, reduce evapotranspiration for water production, and provide habitat for the bird life and other animal needs for green forage and cover. Perhaps leaves from Arizona walnut transpire less water and are better food for aquatic insects. Maybe the leaves have a higher calorie count - a better mix of nutrients.

Some stages in natural development of a fertile lowland Wisconsin trout stream from overgrazed (A) to very productive (D-E-F) to overforested (G&H) when protected from grazing. A hypothetical 14-foot wide cross-section plus adjacent bank shown.

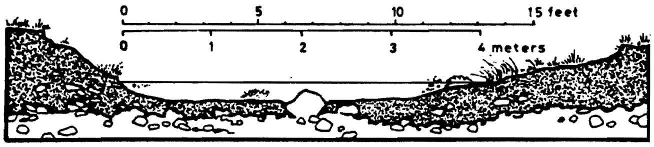
The complete sequence from stage A to stage E-F has been observed on Black Earth and Mt. Vernon Creeks near Madison.

Later succession — stages G and H with many intermediates — is to be seen on other streams. Details of this succession vary from stream to stream, especially after stage E-F, but the passage from predominantly herbaceous to predominantly woody vegetation generally has the same detrimental effects. Good management for trout — and other wildlife — would be control of vegetation to maintain stages D-E-F.

KEY

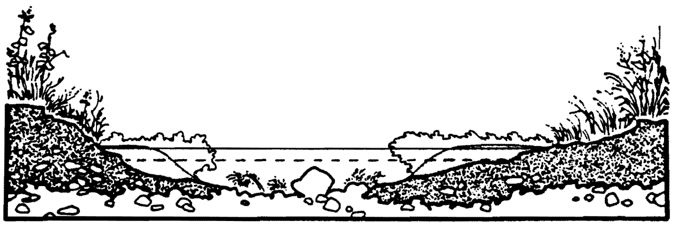


A



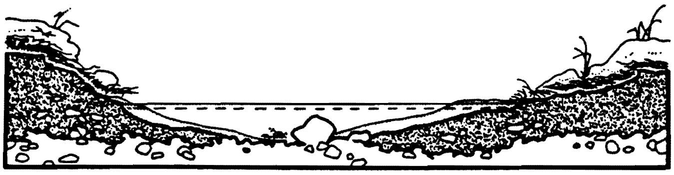
MIDSUMMER CONDITIONS UNDER HEAVY GRAZING BY LIVESTOCK:
Bank vegetation and watercress grazed and trampled. Banks eroding, and stream bed mostly covered by shifting silts. Submergent plants grow poorly. Whole surface of water and stream bed exposed to sun. Greatest depth in cross-section only 9 inches (22 cm). These conditions offer trout no shelter, no place to spawn, little food, and frequently unfavorable temperatures.

B



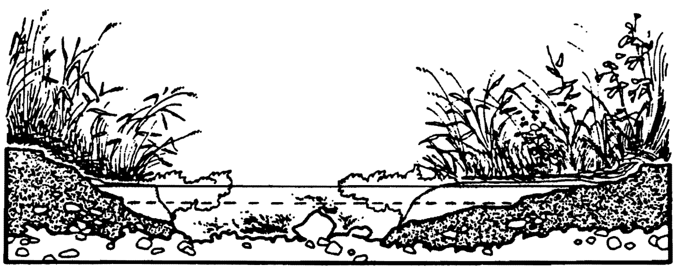
MIDSUMMER CONDITION AFTER 2 TO 4 YEARS OF PROTECTION AGAINST GRAZING:
Bank vegetation forming a turf. Abundant watercress at edges of stream constricts channel, thus deepening and speeding water. Soft sediments scoured from much of stream bed and trapped in cress beds. Submergent plants thriving. Only about half the former stream width exposed to sun. Greatest depth about 20 inches (50 cm). Trout have ample shelter beneath watercress, beside rock, and among submergent plants. Firm stream bed and many plants provide substrate for many animals that trout eat. Newly exposed gravel is a place to spawn.

C



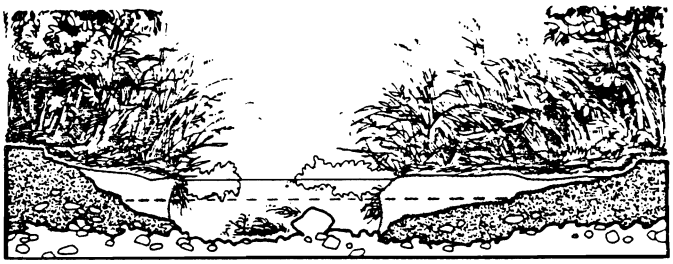
LATE IN THE NEXT WINTER:
Watercress has withered and drifted away. The silts it held slump into the channel, smothering many of the trout eggs buried in gravel and preventing fry from emerging into stream. Food is scarce. Broad surface of water exposed to cold. Shelter for trout almost as poor as at stage A and will not redevelop until May or June.

D



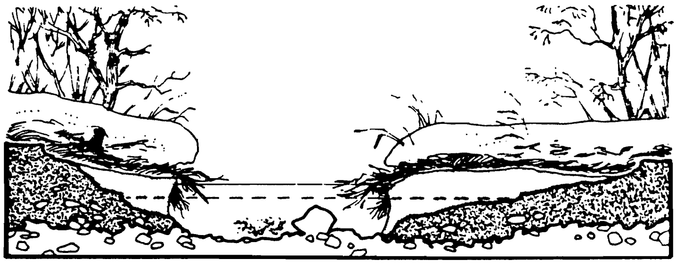
MIDSUMMER CONDITION IN ABOUT 3RD TO 5TH YEAR AFTER GRAZING HALTED:
Further scouring of fine sediments from stream bed. Silt bars at stream edges being tied down by reed canary grass with its tough system of roots and runners. Watercress flourishing, and submergents at peak of development. Only 4 feet of stream width exposed to sky, and this shaded much of day by high grasses. Greatest depth in cross-section about 2 feet (60 cm). For trout, shelter, food, and spawning gravels are ample.

Figure 4



E

MIDSUMMER A FEW YEARS LATER:
Silt bars further stabilized by turf. Channel narrowed by 40% to 50% since stage A. Only 2 feet of stream width exposed; therefore submergents less abundant. Also less volume of watercress due to shade of taller plants. Woody vegetation starting to dominate.

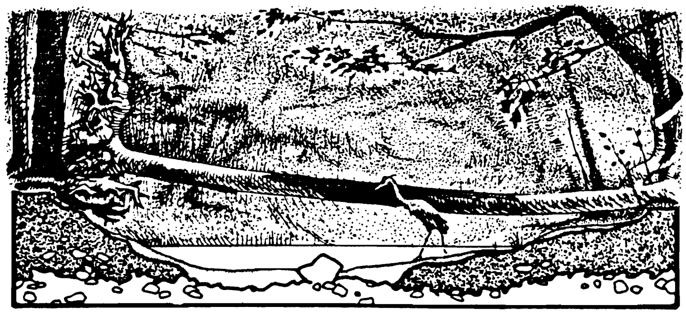


F

LATE WINTER DURING STAGES D AND E:
Turf still holds bank materials firmly. Overhanging fringes of matted grass provide shelter for trout. Gravels remain clean enough to allow normal hatching and emergence of fry.

G

MIDSUMMER 10 TO 20 YEARS LATER:
Alders or other high bushes predominate (saplings of ash, elm or maple at left). Turf completely shaded out. Water level high due to clogging by debris. For trout, food may be scarce, shelter is excellent beneath banks, among roots and fallen branches.
But:
Innermost rows of alders will soon tip into channel, further clogging flow and destroying overhanging bank. The largely vegetational processes of bank-building will not be repeated as long as shade persists.



H

MANY YEARS LATER:
Mature forest . . . Dense shade. Few plants on forest floor. Banks have eroded, channel has spread and silts again cover stream bed. Channel less than 1 foot deep. Little shelter for trout. Even trees undermined by current and toppled across the stream may provide poor hiding cover. Conditions almost as bad as in stage A.

Figure 4

This example reminds us that there are hundreds of plants which regularly grow in the riparian. We know very little about their intrinsic values and how they interact in a normal, managed (not overgrazed) riparian ecosystem. Certainly a shaded stream with a nearly closed canopy over a narrow, deep stream will produce cool, clear, water and less sediment will reach the reservoirs, extending their lifetime. The fate of many species such as the bald eagle may ultimately depend upon the subtle energy flows needed to produce the fish which the eagles are dependent upon. The fate of several fish like the endangered squawfish and others are also dependent upon a properly functioning riparian ecosystem.

This managed "riparian pipeline ecosystem" will hopefully produce ample quality waters for other downstream uses. The evapotranspiration in the pipeline is not wasted, society needs the products produced.

J. Stokley Ligon wrote 50 years ago, "Cold water fish and fishing streams are as seriously affected by overgrazed watersheds as is game. Not only do the extremes of low and high water, caused by floods and erosion, affect the normal flow and temperature of waters, but the destruction of willows, alders, weeds and grasses eliminates both food and shelter for cold water fish. No experienced angler fishes in sun-exposed streams where the water spreads shallow in unprotected flood-ravished watercourses; he seeks the cool shadows where the alders, willows or conifers overhang the banks, where the stream is narrow and banks with matted roots are secure along New Mexico's cold water streams today. Abuse by overgrazing of watersheds and watercourses, as no other cause, has deteriorated New Mexico's fishing."

The creation or perpetuation of the little winding stream jungles everywhere are a national as well as a state need. The space they occupy, whether on the farm, deep in the creek bottom, canyon course or on overflow lands, has no appreciable value from the standpoint of agriculture or stock raising, but as little jungles they have an intrinsic value. As boys how many of us got our greatest thrills and enjoyment from these little jungles - the jungles we resorted to at every opportunity to follow our dog after rabbits, squirrels or coons, or to hunt quail, fish, or to set our traps for furbearers? The intensity of the job and satisfaction thus derived demands that this little institution, the wasteland jungle, be perpetuated for the American boy and man. These little spaces, properly protected, are the only means of conserving the small game in reclaimed canyons and valleys as commercialism agressively overrides every weakling of Nature that does not have the sympathetic support of organized forces to oppose it."

CONCLUSIONS

1. The fishery resource is often energy dependent upon the riparian vegetation and the watershed.

2. Uncontrolled grazing brings about complete type conversions in the riparian zone and prevents streams from progressing to more stable conditions.

3. Trees and other vegetation in the riparian zone control sediments, provide stream stability and tend to narrow and deepen channel morphology, which benefits the fishery resource.

4. Research is vitally needed to document and study the interactive and intrinsic value of the many plant species in the riparian ecosystem.

5. The fishery, wildlife, esthetic resources, and water quality and quantity are dependent upon these interactions and our efforts to integrate the needs of the various resources. Free choice, uncontrolled grazing is incompatible with these resources.

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