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# LIVESTOCK GRAZING AND RIPARIAN/STREAM ECOSYSTEMS— AN OVERVIEW

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Streams have been subjected to damaging events since the day they were formed, initially by such natural events as glaciation, floods, climatic temperature changes, and droughts, and, more recently, by man colonizing along the stream banks and using the stream and its surroundings for mining, lumbering, livestock grazing, road construction, and sewage and waste disposal. These land

uses, including livestock grazing, are of widespread concern to the public and land-management agencies. This forum and other seminars, symposiums, and workshops have been called to place grazing problems in perspective and to find solutions for the land manager.

The meetings held to date have determined (1) solutions to grazing problems are not easily found; (2) no single

discipline possesses the skills and knowledge for all problem-solving; (3) past studies have identified many problems and offer some guidance; (4) more studies are needed to develop better understanding; (5) agencies responsible for the management of the streamside environment have not adequately considered the influence of livestock grazing; and (6) not all answers will be found in the near future.

It will take many small steps in the advancement of awareness and knowledge to get land managers to recognize and implement management practices that protect streams and their riparian environments.

Land managers have often failed to recognize that streamside environments are different from other terrestrial systems, and so need specialized management. The stream, the riparian environment, and the adjacent upland environments require different land-management strategies. For example, even among riparian systems a broad riparian zone in a wet meadow has a different influence on a stream than a narrow riparian zone in a sagebrush ecosystem.

Today's range-management guidelines do not call for different management strategies for the different habitat types; these guidelines cover only broad combinations of lands that mix riparian zones with the upland zones. A complication to the better balance of resource management is that scientists still differ on their interpretations of the effects of grazing strategies on stream and riparian habitats.

Authors express both sides of the livestock-fishery interaction subject. Behnke (1977) feels the best opportunity for increasing fish populations in the West is to improve fish habitats degraded by improper livestock grazing. This thinking may have merit, for 83 percent of the area of the 11 western states is in forest and range, and 70 percent of the 1.2 billion acres of forest and range in the United States is being grazed by livestock.

Heady *et al.* (1974), however, state that livestock grazing is being managed and integrated with other uses of federal lands and that there is no evidence that well-managed grazing of domestic livestock is incompatible with a high-quality environment. Leopold (1974) felt the opposite. He said that fish and wildlife habitat in western rangeland has experienced and is experiencing steady deterioration under existing multiple-use patterns. Furthermore, he said that livestock grazing may be having cumulative and unfortunate effects on land and water productivity.

These disagreements must be resolved because more and more pressure is being brought on land managers to increase the output of all resources. Grazing land is continually being reduced, which conflicts with the projected needs for an additional 70 million acres of range within the next 25 years to meet the demand for red meat (Heady *et al.* 1974). The increasing demand for energy development, recreation, and high-quality water will conflict with the demand for more red meat unless better management can be obtained.

The purpose of this forum is to allow cattlemen and fisheries biologists to exchange information and to reach a certain accord in regard to grazing practices beneficial to both. My charge is to present an overview of livestock-

fishery interactions, setting the stage for papers identifying specific problems and/or presenting solutions.

## HISTORY

Before the influx of European man into the western United States, natural ecosystems existed in which wild ungulates usually grazed compatibly with the range's carrying capacity. If for some reason the forage produced by a given range suddenly became scarce or non-existent, wild grazing animals either migrated to more favorable ranges or sustained a mortality, which brought the herds into balance with the range capacity.

Upon settling this country, European man soon recognized the possibility of using the vast rangelands for livestock production. As a result, the number of cattle on the western ranges and pastures has increased continually since 1875 (Wagner, in press). As a result of increased forage use and changes in or eradication of natural vegetation, much rangeland has been altered (Alderfer and Robinson 1974; Lusby *et al.* 1971; Sartz and Tolstead 1974). Since livestock are attracted to streambanks, overuse of the riparian zone has often resulted in widespread stream degradation.

Where the ranges were heavily stocked with livestock and confined within man-made barriers, changes in vegetation took place. Livestock trampled and compacted the soil, and the high-quality, fibrous-rooted plants gradually gave way to shallow-rooted annual species or taprooted forbs or shrubs that could exist on areas with lowered water tables. Generally, these invader species are less palatable than plants with fibrous roots and provide less nutrition and, often, only seasonal benefits for livestock. As soil compacted, infiltration of water into deep soils lessened and surface runoff increased. The accelerated rate of erosion had major effects on terrestrial and aquatic productivity. Rich topsoil was lost by the erosive action of wind and water, and the quality of streams receiving the eroded material was reduced. In addition, fine sediment smothered spawning and rearing areas, altering the habitat of fish.

As the livestock industry grew during the 19th Century and into the mid-1930's, the number of animals occupying the available range increased far beyond its carrying capacity. Overuse resulted in deteriorating ranges. The situation became so critical by the mid-1930's that the Taylor Grazing Act was enacted by Congress in 1934 to reverse the trend on the remaining rangeland in the public domain and to stabilize the livestock industry using these lands. Little attempt was made, however, to regulate grazing to conform to the ability of rangelands to sustain it, since there was little public interest in rangeland conditions at that time.

By the mid-1960's, management by allotment had become an accepted practice, and this is essentially the present situation. Public awareness of environmental quality, including rangelands, brought into clearer focus the original goals of the Taylor Act. The Resources Planning Act Assessment of 1975 projects increased demands on rangeland for the production of domestic livestock through the year 2020. With an expanding human popula-

tion, it is inevitable that red meat production will have to be increased and more pressure will be placed on public ranges. Similar demands will be placed on production of white meat (fish).

In evaluating, through time, the effects of livestock grazing on the aquatic environment it must be recognized that different classes of livestock have different preferences of use in regard to streamside environments. Sheep prefer slopes and upland areas, but cattle prefer riparian habitats. Much former sheep range has been converted to what is primarily cattle range. Because cattle prefer streamside environments, deterioration of riparian habitat has been significant and much of the deterioration continues.

Because riparian environments are lumped into broad terrestrial environmental classifications, they become unidentifiable for land-management purposes. Often what is good for timber or range management is not good for riparian or stream management.

The importance of riparian vegetation to wildlife has become apparent for the first time in this decade (Patton 1977). The importance of riparian vegetation to fish has been apparent for much longer. Fishery biologists were informed of problems and their input to land managers over the past two decades was inconsequential. Also, the leadership of the land-management agencies was paying little heed to those few scientists who had the foresight to alert them to ongoing habitat destruction. Land managers were devoting their attention to species management and to hatcheries rather than to habitat requirements.

Today, decisionmakers see the need for better management of streamside zones. Scientists who a few years ago would not undertake livestock-fishery interaction studies are now developing good data banks. These trends are encouraging and will lead to better livestock management.

## FISHERY NEEDS

The habitat requirements of fish are a complex mixture that fishery biologists don't fully understand. However, biologists have completed some excellent biological work that makes possible a description of this habitat. Armour (1977) presents an excellent discussion of habitat needs of fish; this is reflected here.

**Riparian Vegetation.** Riparian zones are identified as those areas associated with surface water that reveal, through the vegetative complex, the influence of that water (Franklin and Dyrness 1973; Minore and Smith 1971). Riparian zones are the interface between terrestrial and aquatic environments. Riparian zones serve as a filter or a trap to stop pollutants moving from the terrestrial to the aquatic environment.

Riparian areas are the productive part of western grazing lands, usually containing the most productive timber and forage sites. Cattle forage on such areas more frequently than in adjacent, drier areas. Road builders often use riparian areas because of the gentle topography, and recreationists flock to such places for the scenic values associated with water.

Although most streamside zones are riparian, some are not. Examples of non-riparian sites are those areas

where the sagebrush ecosystem reaches the water's edge, where the streamside zone is composed of bedrock, where streams are bordered by steep-sided canyon lands, or where streamside environments are composed of boulders or rubble. Non-riparian streamside zones can also be affected by livestock grazing, but usually to a lesser degree.

The streamside vegetation, in combination with undercut banks and streamside debris, provides fish cover. Binns (1976)<sup>1</sup> found cover highly significant in determining fish biomass in Wyoming streams. Boussu (1954) increased trout biomass over 200 percent by simulating cover in a South Dakota stream. Upon eliminating cover, trout biomass decreased. Streamside vegetation also provides a habitat for terrestrial insects that are in the fishes' diet, providing the organic material for about 50 percent of the stream's food energy (Cummins 1974).

Streamside vegetation shades the stream and decreases water temperature. Stream temperature for trout should not exceed 65° F and should be even lower for the critical spawning and incubation periods. Streams in the West, where riparian vegetation has been removed, are often too warm in the summer and too low in the winter. Streamside vegetation protects streambanks by reducing erosive energy, by helping deposits build the streambank, and by keeping the streambank from being damaged by ice, log debris, or animal trampling. Lack of vegetation exposes soils to erosion from rain or running surface water.

**Stream Channels.** Sedimentation in stream channels reduces instream cover for fish and depresses their food supply by filling channel interstices and reducing the substrate's potential to produce food. Large amounts of fine sediment kill fish embryos incubating in the stream-channel materials (Phillips *et al.* 1975). Large concentrations of fine sediment in spawning areas impede the intragravel subsurface waterflow, causing embryos to receive less oxygen and allowing toxic metabolic wastes to accumulate. Also, fish need instream cover, especially during their early years of development and during winter. Fine sediments filling the interstices reduce the amount of protective cover and force young salmonids to live in surface waters where they are more exposed to severe winter conditions.

Salmonids are dependent on aquatic and terrestrial invertebrates for their food. Fine sediments can cover the food-producing rubble and gravel channel areas, reducing the quality of the aquatic insect's habitat; this, in turn, impairs the quantity of food available for salmonids.

**Streambanks.** Streambanks bordering smaller streams (of stream order less than 6) provide the habitat edge needed to maintain high fish population densities. Fish often adapt their survival to this habitat edge because streambanks provide cover, control water velocities, and supply incoming terrestrial foods. The condition of the streambank often governs the water depths and velocities the fish must live in. Stable streambanks are an important part of the environmental quality needed by fish in small streams.

<sup>1</sup>Binns, N. Allen. 1976. Evaluation of habitat quality in Wyoming trout streams. Unpublished, on file at Wyoming Game and Fish Department, 260 Buena Vista, Lander, Wyoming.

**Water Quality.** Fish need high-quality water because this is their living medium. Water cannot be too warm or too cold, too fertile or too infertile, too fast or too slow, or too high or too low in dissolved gasses. Water of acceptable quality must first be present before the stream channel and streambank can form and contain it in a manner that fits the fish's habitat needs. Water that enters streams from the earth usually is of excellent quality to sustain fish. This new water needs only to be charged with certain gasses and nutrients to sustain fish. Most streams begin with high-quality water that deteriorates in the downstream areas because of land uses.

As water quality decreases and the water becomes more turbid, fish must survive in a medium in which they have difficulty seeing or moving. Often a less turbid area is not available to them. Migrating fish may avoid turbid streams, but fish forced to remain in turbid waters may have trouble feeding, using oxygen, and reproducing.

## LIVESTOCK EFFECTS

Authors have already listed the effects of livestock grazing on fish and the aquatic environment (Platts, in press; Menke, in press; Armour 1977). This section summarizes these papers and discusses additional grazing effects.

**Riparian Vegetation.** Streamside vegetation is directly affected by grazing because riparian zones are usually grazed more heavily than are upland zones (Holscher and Woolfold 1953; Armour 1977). Duff (in press) found that when cattle were introduced into an area that had not been grazed for 4 years, the riparian vegetation declined 35 percent to pretest conditions in 6 weeks. Lorz (1974) found no difference in fish populations in ungrazed vs. grazed sections of the Deschutes River, Oregon when dense willow cover was on one or both banks.

Claire and Storch (in press) found the willow canopy in an enclosed area provided 75 percent more shade on the stream than areas outside the enclosure receiving year-round grazing. Gunderson (1968) found streamside cover was 77 percent more abundant in an ungrazed section of Rock Creek, Montana than in a grazed section.

Livestock grazing can affect the riparian environment by changing, reducing, or eliminating vegetation and by the actual elimination of riparian areas by channel widening, channel aggradation, or lowering of the water table. The most apparent effects on fish habitat are the reduction of shade and cover and resultant increases in stream temperature, changes in stream morphology, and the addition of sediment through bank degradation and off-site soil erosion. Stream temperatures increase in small headwater streams when riparian vegetation is removed and changes occur in the composition of fish communities in receiving streams downstream (Vannote, in press).

Detritus formed from terrestrial plants is a principal source of food for aquatic invertebrates and eventually for fish (Minshall 1976). A change in the quantity and quality of the detritus reaching the stream can severely interfere

with natural conditions. This may result in a decline in the organisms fish eat and in a disruption of the stream's ability to process organic matter (Cummins 1974; Vannote, in press). Riparian vegetation is needed for the cycling of organic energy and for control of water temperatures.

**Stream Channels.** Stream-channel sedimentation caused by soil erosion on millions of acres of rangeland has long been recognized as a major problem. Lusby (1970), studying the effects of grazing on watershed hydrology in Colorado, found that ungrazed watersheds produced only 71-76 percent as much sediment as did grazed watersheds. Moore (1976)<sup>2</sup> estimated that rangelands in Environmental Protection Agency Region X (excluding Alaska) were second only to cropland in total sediment production. Duff (in press) found stream-channel widths were 173 percent greater in grazed stream reaches of Big Creek, Utah than in ungrazed stream reaches.

**Streambanks.** The sloughing-off and collapse of streambanks caused by improper livestock grazing probably affects fish populations most importantly. Streambanks erode because livestock congregate along streams for shade, more succulent vegetation, and drinking water. Livestock grazing off the vegetative cover and caving in over-hanging streambanks is one of the principal factors contributing to the decline of native trout in the West (Behnke and Zarn 1976). Winget and Reichert (1976) found that livestock grazing on selected Utah streams reduced bank stability 59 percent. In other Utah studies where livestock exclosures were used, streambank stability increased 100-740 percent (Berry and Goebel, in press; Duff, in press).

Marcuson (1977) found an ungrazed portion of Rock Creek, Montana had 2.5 times less channel erosion than an adjacent stream section that was grazed. Duff (in press) states that introduction of livestock into an ungrazed area for 4 years resulted in a 14-percent decline in streambank stability within 6 weeks. Hayes (1978), however, concluded that during spring runoff streambank degradation occurs more often and to a greater extent along an ungrazed streambank than along a grazed streambank. Seminar proceedings (Townsend and Smith, eds. 1977) and a symposium (Menke, in press) addressed interactions with wildlife and fish and their environments. Both publications concluded that livestock grazing degrades aquatic and riparian communities. Seminar members concluded that livestock grazing is the single most important factor limiting wildlife (including fisheries) production in the West. The symposium participants concluded that livestock grazing has severely reduced riparian vegetation and altered stream geomorphology, changes that adversely affect fish.

**Water Quality.** Claire and Storch (in press), studying the Deschutes River, Oregon alongside an exclosure that was ungrazed for 10 years, noted that the average stream temperature had dropped 12°. Busby and Gifford (in

<sup>2</sup>Moore, Elbert. 1976. Livestock grazing and protection of water quality. Environ. Prot. Agency, draft working paper. 123 p.

press) also found that grazing may be damaging water quality by affecting the hydrologic conditions within a given watershed. Skinner *et al.* (1974), Darling and Coltharp (1973), and Kunkle (1970) attribute the high coli count in streams to livestock grazing. Bacteria, along with sediment or chemicals, will degrade water quality.

Range practices can affect the condition of water in the runoff from a watershed, especially by increasing sediment. Photosynthesis is decreased by stream turbidity, and primary productivity is reduced. With primary productivity reduced, productivity of the entire ecosystem is decreased.

**Fish Populations.** The literature shows that streams modified by livestock grazing are wider and shallower. Generally, they have channels that contain more fine sediment, streambanks that are more unstable, banks that are less undercut, and higher summer water temperatures than natural streams. Behnke and Zarn (1976) identify livestock grazing as the greatest threat to the integrity of trout-stream habitat in the western United States. Behnke (in press) believes that rehabilitation of streams damaged by livestock grazing offers the best possibility of increasing wild, self-sustaining trout populations in the western United States.

Van Velson (Armour 1977) found, in Otter Creek, Nebraska, in an area fenced to exclude livestock, that within 3 years after fencing the stream improved from a non-producer to a major producer of trout. The stream width decreased, streambanks quickly stabilized, and summer water temperatures were reduced 2-5°. Clair and Storch (in press) found within an enclosure on the Deschutes River, Oregon that over a 10-year period of non-grazing the fish population shifted from predominantly dace (*Rhinichthys* sp.) to rainbow trout (*Salmo gairdneri* Richardson).

Marcuson (1977) found in Rock Creek, Montana that brown trout (*Salmo trutta* Linn.) biomass per unit area in a stream within a nongrazed section was 340 percent higher than in an adjacent stream section that was heavily grazed. In the same stream, Gunderson (1968) found trout were 27-400 percent more abundant in ungrazed sections than in grazed. Kennedy (1977) reported that trout were 240 percent higher in ungrazed sections of an Oregon stream than in grazed sections. Duff (in press) found trout populations 360 percent higher in ungrazed stream reaches of Big Creek, Utah than in grazed stream reaches. These studies strongly suggest that improper livestock grazing decreases both the quality and quantity of fish populations.

#### WHERE SHOULD THIS SYMPOSIUM TAKE US?

Hormay (1970) studied the effects of livestock grazing for many years and created some of the most widely used grazing strategies. Armour (1977) quotes Hormay as stating in personal communication that:

Vegetation in meadows and drainageways is closely utilized under any stocking rate or system of grazing. Where this is the case, about the only way to preserve recreational values is to fence the area off from grazing. Reducing the livestock or adjusting grazing seasons usually will not solve the problem.

Under present financial limitations, it is impossible to fence all the streams in livestock grazing allotments. Currently, there is not enough money to maintain existing fences or to fence the most critical areas, let alone fence all streams. So, the problem is much larger than Hormay indicates; however, fencing should not be counted out as a management tool, for in many areas it may be the only way to protect streambanks and their vegetation.

The challenge is to use forums such as this to stride ahead by tackling problems and judging their solutions. Some of the situations this symposium should address are:

1. Which of the existing grazing systems are most compatible with the fishery resource?
2. What new innovations are needed to make livestock grazing more compatible with fishery needs?
3. Is there an ideal livestock grazing strategy for riparian areas?
4. What is required and how long does it take a stream altered by livestock grazing to return to near-natural condition?
5. What techniques are available or should be developed to reduce the recovery time for degraded streams?
6. How much, if any, of the fish population is lost because of livestock grazing streamside areas?
7. If streams need to be protected by fences, how much of each stream and what type of stream should be fenced?
8. How much vegetative canopy is needed on streambanks to prevent unacceptable stream temperatures?
9. How do different classes of livestock affect the riparian environment?
10. What are the first indicators that a stream is beginning to disintegrate or to improve from management of livestock?
11. How much forage use can the different vegetative types and streambanks support without unacceptable changes?
12. Are there times of the year when livestock grazing is less damaging than others?

These are avenues that some scientists have begun to explore. Claire and Storch (in press) rested a streamside area for 4 years and then grazed it annually each year after August 1, with no apparent damage to the fish population. Lorz (1974) concluded that dense willow stands would protect streambanks from being overgrazed.

This symposium will give us better insight into the effects of livestock grazing on riparian vegetation, water quality, stream-channel morphology, streambed condition, and streambank stability. In turn, better guidelines will be available to the resource manager for predicting the effects of the different grazing strategies on the condition and the productivity of stream and riparian systems. We must remember, however, that such meetings alone will not solve our problems. More facts will lead to greater understanding and to implementation of corrective actions for better land management. Corrective action has not been the case for stream and streamside management over the past 50 years. And, as a result, it is my belief that most stream environments are worse now than they were 10, 20, 40, or 80 years ago.

## DISCUSSION

Livestock grazing can affect all four components of the aquatic system—streamside vegetation, stream-channel morphology, shape and quality of the water column, and the structure of the soil portion of the stream-bank. Livestock grazing can affect the streamside environment by changing, reducing, or eliminating vegetation bordering the stream. Channel morphology can be changed by sediment accrual, altered channel substrate composition, disrupted pool-riffle relationships, and channel widening. The water column can be altered by increasing water temperature, nutrients, suspended sediment, and bacterial counts, and by altering the timing and volume of water flow. Livestock can trample stream-banks, causing banks to slough off, creating false setback banks, and exposing banks to accelerated soil erosion.

Documenting and evaluating effects of these alterations are difficult because nature causes similar alterations and effects. Fishery biologists are confronted with the problem of determining how different types of grazing systems affect the various aquatic components and how changes in these components affect fish health and survival.

Livestock grazing can cause annual microchanges in the environment that accumulate over many decades. These subtle changes are difficult to detect, whereas environmental changes from such sudden catastrophes as flood damage are usually readily observed and measured. Whether a stream has suffered a catastrophic degrading event or a long period of annual small events, the end point for fish can be the same. In either case, the stream and its fisheries have been damaged and, once stress is relieved, recovery may take years.

Streams and streamside zones are the most critical zones for multiple-use planning and offer the most challenge for proper management; therefore, stream habitats should be identified as separate management units to receive concentrated effort. Land-management agencies responsible for managing livestock grazing have not adequately considered the influence of grazing on streams and on their banks. Land managers often fail to recognize stream ecosystems and their importance as separate systems in their management programs. This oversight occurs even though studies have demonstrated that practices which protect streambanks from damage also enhance the potential of riparian vegetation to support other resources (Gunderson 1968; Marcuson 1977; Duff, in press).

The problem is that past management, or lack of it, has allowed streamside environments to deteriorate, and land managers do not have the information needed to correct the problems. Fishery biologists and range managers must concentrate on finding solutions to problems and on providing these solutions to the land managers, so that each riparian resource can be managed without infringing on other uses.

We must not continue to argue about whether livestock grazing degrades streams and their fisheries, but to use forums such as this to determine how to best manage streamside so forage can be utilized and the fishery protected. The process will work only when forum participants take new knowledge back with them and apply it

toward better range management. Better fisheries will be the result.

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