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WILDLIFE HABITATS IN MANAGED RANGELANDS-- THE GREAT BASIN OF SOUTHEASTERN OREGON

NATIVE TROUT

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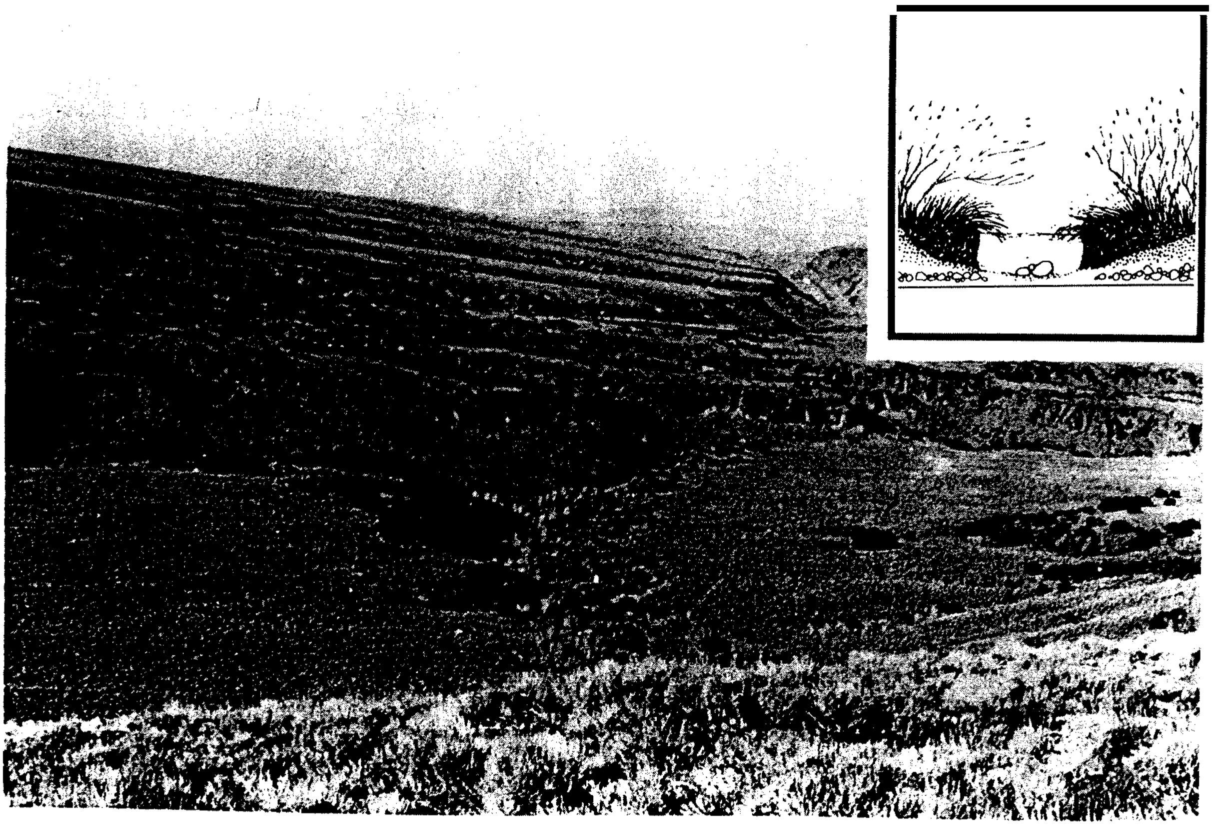


PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION
FOREST SERVICE U. S. DEPARTMENT OF AGRICULTURE

This publication is part of the series **Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon.** The purpose of the series is to provide a range manager with the necessary information on wildlife and its relationship to habitat conditions in managed rangelands in order that the manager may make fully informed decisions.

The information in this series is specific to the Great Basin of Southeastern Oregon and is generally applicable to the shrub-steppe areas of the Western United States. The principles and processes described, however, are generally applicable to all managed rangelands. The purpose of the series is to provide specific information for a particular area but in doing so to develop a process for considering the welfare of wildlife when range management decisions are made.

The series is composed of 14 separate publications designed to form a comprehensive whole. Although each part will be an independent treatment of a specific subject, when combined in sequence, the individual parts will be as chapters in a book.

Individual parts will be printed as they become available. In this way the information will be more quickly available to potential users. This means, however, that the sequence of printing will not be in the same order as the final organization of the separates into a comprehensive whole.

A list of the publications in the series, their current availability, and their final organization is shown on the inside back cover of this publication.

Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon is a cooperative effort of the USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, and United States Department of the Interior, Bureau of Land Management.

Introduction

Southeastern Oregon has a variety of fish habitats which include major rivers, tributary streams, large and small reservoirs, lakes, and springs. These habitats are directly related to and highly dependent on the conditions of the surrounding rangeland watersheds. Satterlund (1975, p. 22) put it this way: “Rangelands may yield little water, but they are second only to cultivated lands as a source of water quality problems.“ It may be fairly stated, therefore, that man’s agricultural activities in rangelands of southeastern Oregon have altered aquatic habitats more than any other land use. And of all the agriculturally oriented activities in southeastern Oregon rangelands, livestock grazing has exerted greater influence on more aquatic habitats than any other land use (Gunderson 1968, Marcuson 1977). Gebhards (1970, p. 3) summed it up:

> Man has gained the knowledge and technical skill that makes him capable of completely altering, or nullifying natures handiwork-but he rarely ponders his inability to duplicate it.
>
> . ..Today. through the science of hydrology we know that a stream is in reality the end product of a watershed. Water originating as precipitation flows across and through the surface of the watershed to form the stream. Changes brought about in the watershed by...road construction, overgrazing by livestock, or other disturbances of the land, can greatly alter the pattern of water movement and even water quality within the watershed.

Thirty-eight species of fish are known to occur in southeastern Oregon (Bond 1973) (table 1). Some of these species, including trout (*Salmo* spp.), were once native to most streams. If habitat conditions are or become suitable for good trout production, populations of other indigenous cold-water fish, such as sculpins (*Cottus* spp.), mountain whitefish *(Prosopium williamsoni),* and some suckers (*Catostomus* spp.), will also thrive because their basic habitat requirements are similar (table 2).

Some species, such as bass (*Micropterus* spp.), crappie *(Pomoxis* spp.), and catfish (*Ictalurus* spp.), have been introduced and provide good fisheries. Introduced fish either have occupied habitats which have been altered in a way that favors their living requirements or have occupied natural habitats that are suitable to them but unsuitable or marginal for trout. Introduced species may also partially displace native non-game species, and may pose a threat to sensitive species.

Annual stocking programs have also developed important fisheries in some reservoirs and specific sections of streams. Although such stocking programs will continue to be important, the production of native trout in hundreds of kilometers of streams is considered to be the highest priority and is emphasized in this chapter.

Table l-Fishes that are known to **occur in southeastern Oregon'**

Trout and Salmon:	
Redband trout	*Salmo* species
Brown trout	*Salmo trutta*
Rainbow trout	*Salmo gairdneri*
Alvord cutthroat	*Salmo clarki* subspecies
Kokanee	*Oncorhynchus nerka*
Coho salmon	*Oncorhynchus kisutch*
Brook trout	*Salvelinus fontinalis*
Dolly Varden trout	*Salvelinus malma*
Mountain whitefish	*Prosopium williamsoni*
Sturgeons:	
White sturgeon	*Acipenser transmontanus*
Sunfishes:	
Smallmouth bass	*Micropterus dolomieui*
Largemouth bass	*Micropterus salmoides*
Warmouth bass	*Lepomis gulosus*
Bluegill	*Lepomis macrochirus*
White crappie	*Pomonis annularis*
Black crappie	*Pomoxis nigromaculatus*
Perches:	
Yellow perch	*Perca flavescens*
Catfishes:	
Channel catfish	*Ictalurus punctatus*
Black bullhead	*Ictalurus melas*
Brown bullhead	*Ictalurus nebulosus*
Flathead catfish	*Pylodictus olivaris*
Tadpole madtom	*Noturus gyrinus*
Sculpins:	
Mottled sculpin	*Cottus bairdi semiscaber*
Torrent sculpin	*Cottus rhotheus*
Piute sculpin	*Cottus beldingi*
Shorthead sculpin	*Cottus confusus*
Minnows and Carp:	
Carp	*Cyprinus carpio*
Tui chub	*Gila bicolor*
Lahontan redside	*Richardsonius egregius*
Redside shiner	*Richardsonius balteatus balteatus* also *R. b. hydrophlox*
Long-nose dace	*Rhinichthys cataractae dulcis*
Leopard dace	*Rhinichthys falcatus*
Speckled dace	*Rhinichthys osculus*
Chiselmouth	*Acrocheilus alutaceus*
Northern squawfish	*Ptychocheilus oregonensis*
Suckers:	
Largescale sucker	*Catostomus macrocheilus*
Bridgelip sucker	*Catostomus columbianus*
Lahontan sucker	*Catostomus tahoensis*
Mountain sucker	*Catostomus platyrhynchus*

'Bond. Carl E., 1974. Endangered plants and animals of Oregon. I. Freshwater fishes. Spec. Rep. 205 (revised). 9 p. Agric. Exp. Stn.. Oreg. State Univ.. Corvallis.

Table 2-Habitat requirements for fishes of southeastern Oregon. X = habitat(s) where species normally occurs, 0 = habitat(s) where species can be found

Species	Stream[1] Small Cold[2]	Stream Small Warm	Stream Medium Cold	Stream Medium Warm	Stream Large Cold	Stream Large Warm	Large reservoir[3]	Small reservoir or Pond[4]	Lake	Spring
Trout & Salmon										
Redband trout	X	O	X	O	X	O	0	0	0	0
Brown trout			X	O	X	O				
Rainbow trout	X	O	X	O	X	0	X	X	0	0
Alvord cutthroat	X	O	X	O						
Brook trout	X		X							X
Dolly Varden trout	X	O	X	O	X	O	O			
Kokanee						O	X			
Coho						O	X			
Mountain whitefish	X	0	X	0	X	O	O			
Sturgeons										
White sturgeon					X	0	0			
Sunfishes										
Smallmouth bass				X		X	X	0		
Largemouth bass				O		X	X	X	X	
Warmouth bass					O	X	X	X		
Bluegill				O		X	X	X	O	
White crappie				O		X	X	X	O	
Black crappie				O		X	X	X	0	
Perches										
Yellow perch				0		X	X	X	X	
Catfishes										
Channel catfish				0		X	X			
Black bullhead				O		X	X		O	
Brown bullhead				O		X	X		X	
Flathead catfish						X	X			
Tadpole madtom						X	0			
Sculpins										
Mottled sculpin	X	O	X	O	X	0			0	
Torrent sculpin	X	O	X	O						
Piute sculpin	O	O	X	O	O	0				
Shorthead sculpin	X	O	X	O						
Minnows										
Carp	0	0	0	X	0	X	X	O	O	
Tui chub		0		X		0	X	X	O	
Lahontan redside	X		X	O						
Redside shiner		X		X		X	X	O	O	
Longnose dace	0	O	X	O	X	O	O	O	O	
Leopard dace			X	X	O	0				
Speckled dace	X	X	X	X	X	X	O	O	O	X
Chiselmouth				X		X	X	O	O	
Northern squawfish				X		X	X	O	O	
Suckers										
Largescale sucker	O		O	X	O	X	X	O	O	
Bridgelip sucker	X	0	X	O	X	O	X	X	O	
Lahontan sucker			X	0						
Mountain sucker	X		X		0					

[1]Stream size is based on average width of water (wetted perimeter of streambed or channel) during the summer low-flow period.

Small = Less than 3.04 m (10 feet)
Medium = 3.4 to 7.6 m (11 to 25 feet)
Large = Greater than 7.6 m (25 feet). including main rivers, such as the Snake, Owyhee, and Malheur (lower parts of North and South forks) Rivers.

[2]Cold — Refers to streams with maximal summer water temperatures usually less than 21°C (70°F).
Warm — Refers to streams with maximal summer water temperatures commonly over 21 °C (70°F).

[3]Reservoirs over 10.1 surface hectares (25 surface acres) in size and 4.5 m (15 feet) in depth at usual minimum level.

[4]Bodies of water less than 10.1 surface hectares (25 surface acres) in size and 3.04 m (10 feet) in depth at usual minimum level. Includes many small farm ponds.

Objectives

No long-term research has been specifically aimed at the factors affecting trout production in southeastern Oregon, but studies are available that define the habitat components necessary for good trout production, identify limiting factors, and describe land-use conflicts. Data specific to southeastern Oregon and applicable data from other areas are, therefore, synthesized to provide rangeland managers with the information necessary to make the best possible decisions with respect to fish habitat management. Our objectives are to present these data in a way that will assist managers in evaluating trade-offs while achieving short-term management goals, and to present a tool that can be used simultaneously in long-range land-use planning.

Assumptions

In order to fulfill the charge of this chapter it was necessary to recognize the following assumptions:

1. All land management activities will have some impact(s) on fish habitat. Those activities that affect the riparian zone will have the greatest impact.

2. Water quality and habitat conditions in downstream areas are directly affected by land management activities in upstream tributary systems.

3. Trout populations have predictable responses to changes in habitat conditions.

4. If trout habitat is optimal, life requirements of other cold-water species will generally be fulfilled.

5. Because of the increasing public interest in "wild trout," more intensive management of native trout and their habitats will be required in future years. Management will, therefore, be concentrated primarily in the medium- and small-sized tributary streams where most of these fish are found.

6. Because of increasing public concern for certain non-game fishes, land managers will also have to consider management activities that affect those species.

Stream Zones in Southeastern Oregon

Streams in southeastern Oregon generally originate in mountains ranging in elevation from 2 134 to 2 734 m (7,000 to 9,000 ft). As streams descend from the mountains, they pass through three distinctive zones-boulder, floodway, pastoral-and may terminate in a desert sump (fig. 1).

The upper reach of a stream, the boulder zone or headwaters, normally has a steep gradient, falling at a rate of 7.6 m per kilometer (25 ft/mi) or more (fig. 2). This zone is characterized by high velocity water with coarse bedload material and a narrow channel that goes through a steep-walled, bedrock gorge, Vertical erosion of the channel maintains a V-shaped valley.

The gradient gradually decreases as a stream flows into the floodway zone, and there is a corresponding reduction in water velocity (fig. 3). A floodway zone is characterized by a coarse, sand to baseball-sized, sediment load which is constantly shifting, forming gravel bars, islands, and new channels (Palmer 1976). This zone forms floodplains along large streams which are extensively used for agriculture.

In the pastoral zone, which includes the lower reach of a stream, the fine bedload material, silt and sand, forms compacted banks with a deeper meandering channel (fig. 4). Stream banks are often steep and tree-lined. Water velocity is much reduced, and some of the small streams disappear into the ground in what is called a "desert sump" (fig. 5).

Undisturbed stream courses with dense streamside vegetation, stable soils, and moderate gradients-l to 2 percent-keep water from rapidly descending a stream system. Streamside vegetation is important since it stabilizes streambanks and the movement of sediments; this, in turn, gradually reduces the width of a stream and increases the

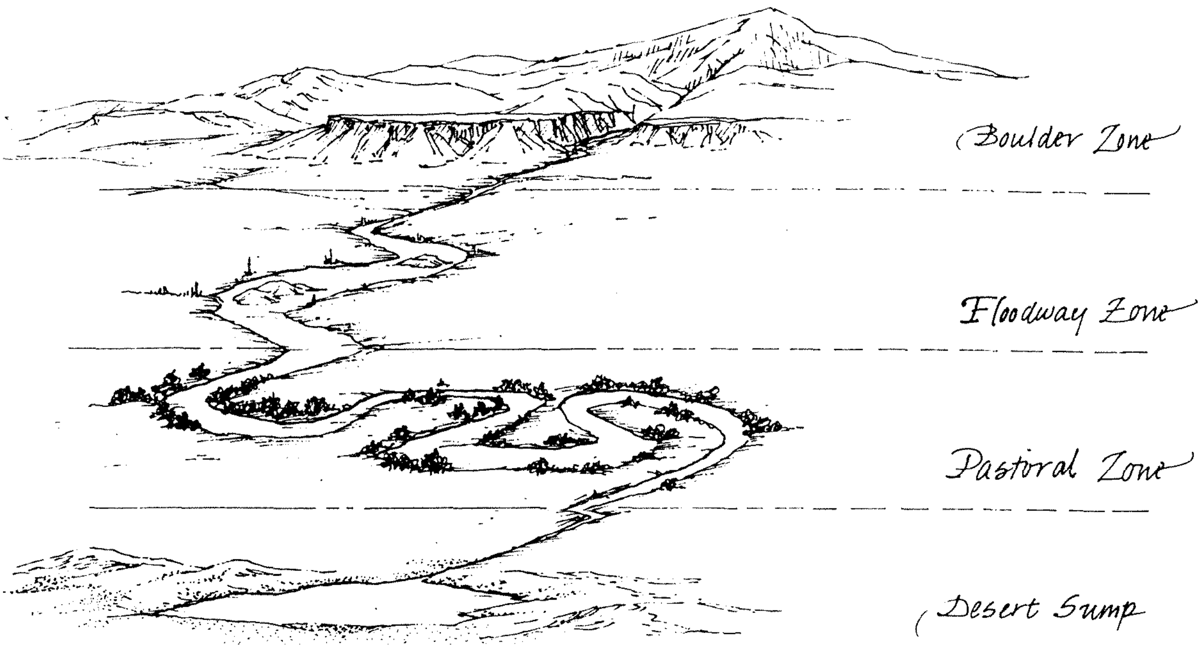
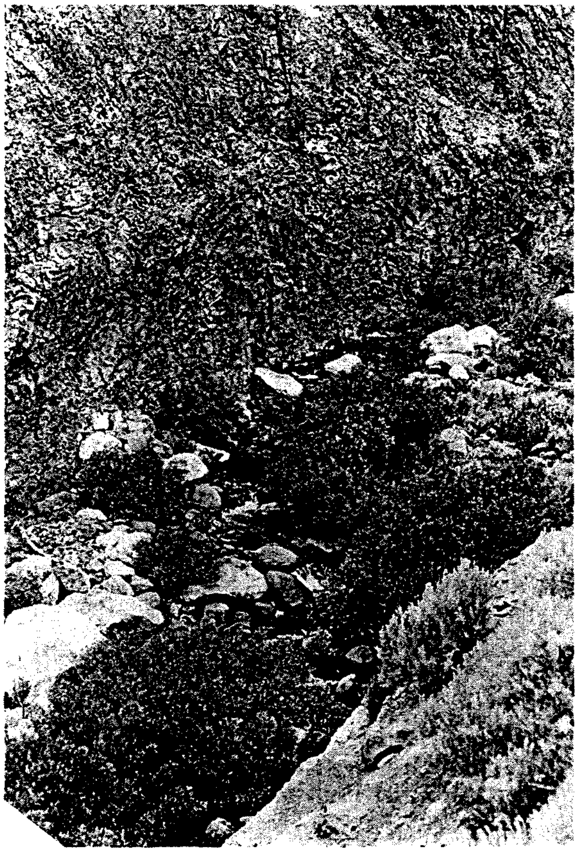


Figure l.-Graphic summary of stream channels of southeastern Oregon streams.



channel depth which creates better habitat conditions for trout (White and Brynildson 1967). Aquatic communities experience a minimum of disturbance where these conditions occur.

Where streamside vegetation is lacking, however, water temperatures rise because of increased exposure to solar radiation. An exposed rock formation, such as canyon walls or especially a bedrock stream bottom, acts as a heat sink that retains heat longer than does the surrounding habitat. Consequently, water temperatures, that would normally decrease rather rapidly after sundown, remain warm for a longer time, particularly on a hot day. Native desert trout can withstand a few hours of high water temperatures, but only if they can find relief in water of cooler temperatures sometime during the day. Where this is not possible,

Figure P.-The boulder zone is the upper reach or headwaters of a stream which normally has a steep gradient and falls at a rate of 7.6 m per kilometer (25 ft/mi) or more. (Oregon Department of Fish and Wildlife photograph by Bill Hosford)

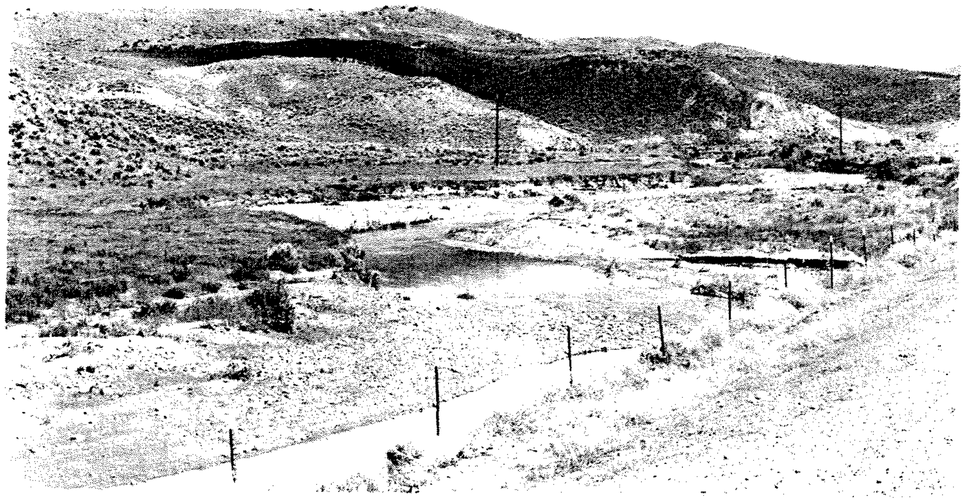


Figure 3.—In the floodway zone there is a gradual decrease in stream gradient and a corresponding reduction in water velocity. (Oregon Department of Fish and Wildlife photograph by Bill Hosford)

Figure 4.—In the pastoral zone the lower reach of a stream often has banks that are steep and tree-lined. (Oregon Department of Fish and Wildlife photograph by Bill Hosford)

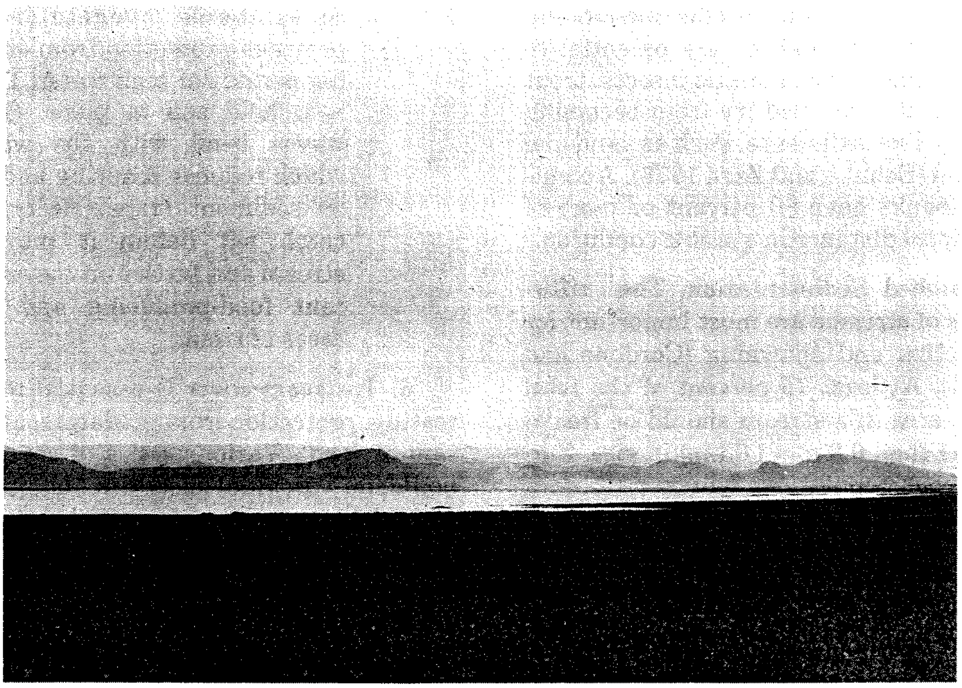


Figure 5.-A desert sump is an area in the desert where a stream terminates and disappears into the ground. (Oregon Department of Fish and Wildlife photograph by Bill Hosford)

their available habitat may be severely restricted or they may be eliminated from a stream.

The best habitat conditions for trout production are generally in the lower boulder and upper floodway zones where water temperatures are cool and riffle-pool ratios are adequate (Elser 1968). As a stream approaches equilibrium in the lower floodway and pastoral zones, new meanders and channels are created. Water temperatures become high, siltation increases, and riffle-pool ratios decrease or are non-existent. Such habitat conditions are more suitable for production of warm-water species of fish than for trout.

Optimum Stream Conditions for Trout Habitat

Native species of trout, adapted to desert environments, have a remarkable ability to survive adverse conditions of high water temperatures, high alkalinities, unusually low streamflows, and marginal spawning areas. These conditions are not ideal and, consequently, trout populations are usually depressed.

If optimal habitat conditions for trout pro duction are considered as management objectives, it should be recognized that not all of them can be achieved in every stream. Some streams, for example, may be too wide for streamside vegetation to provide canopy cover that adequately shades the surface of the water, and alternative management strategies will have to be considered.

The following habitat conditions are optimal for trout production in desert environments:

1. Water Temperature. Summer temperatures should not exceed 21°C (70°F). Certain strains of native trout can successfully survive water temperatures of 27°C (80.6°F) for short periods during the day and can also tolerate a 16” to 20°C (30” to 35°F) diurnal temperature fluctuation. Such extremes are not desirable.

2. **Stable Streambanks.** Stable non-eroding streambanks and watersheds are essential to protect spawning gravel, aquatic insects, trout eggs, and recently hatched fry from becoming suffocated by fine sediments, such as sand and silty material (Behnke and Zarn 1976). Acceptable streambanks have 80 percent or more of their total lineal distance in a stable condition.

3. **Streambed Sedimentation.** The riffle-rubble areas of streams are most important for food production and spawning (Cordone and Kelley 1961). At least 75 percent of the total riffle-rubble area in a stream should be free of siltation less than 0.8 mm (.03 in) in size. Furthermore, trout populations will be reduced if pools become filled with sediments which eliminate rearing or hiding areas.

4. **pH** Range. Most good desert trout waters have a pH between 6.5 and 9.0. Although some species of fish can tolerate a higher pH (10 to 10.5), this is not a desirable condition.

5. **Streamside Vegetation.** Streamside vegetation is the most important key in maintaining good trout habitat for several reasons:

a. Streamside vegetation is essential in providing shade which keeps water temperatures from becoming lethal during hot weather (Brown 1976). Such vegetation may consist of trees, shrubs, grasses, sedges or other plants. Streamside vegetation should shade at least 75 percent of the stream surface during the hours of 11 am to 4 pm from June to September, because solar radiation is highest during this time of day and season.

Topography, rocks, and canyon walls can provide some of this needed shade in some situations.

Streambank vegetation also acts as habitat for terrestrial insects which, when they fall into a stream, are an important food source for fish (Butler and Hawthorne 1968, Chapman 1966, Ellis and Gowing 1957, Meehan et al. 1977).

b. Streambank vegetative cover provides protection from erosion during periods of high water. Plant roots help hold soil in place. Stems and leaves bend with the water flow, which reduces scouring and also acts as sediment traps. Sediment traps catch silt before it moves down stream and settles on the more important food-producing and spawning areas of trout.

6. Instream cover is essential to trout for resting, protection from predators, and production of food'. Various types of cover, such as boulders, provide instream habitat niches which act as a base for continual fish occupancy. The trout carrying-capacity of a stream, in otherwise good condition, is greatly reduced without adequate instream habitat niches.

Optimal instream cover should be available over at least 50 percent of the total stream area. Such cover may include rocks, turbulent water in pools or riffles, debris, tree roots, overhanging banks, or aquatic vegetation (Boussu 1954).

Overhanging streamside vegetation may augment or replace instream cover provided such vegetation is not more than 60.8 centimeters (2 ft) above the water. Overhanging vegetation should cover at least 50 percent of the streambanks and is particularly crucial on the outside bends of streams.

Effects of Livestock on Fish Habitat

Rangelands of southeastern Oregon have been historically grazed by cattle (*Bos* sp.), horses (*Equus* sp.), and sheep (*Ovis* sp.). Much of this activity was unrestricted and livestock exceeded the carrying capacity of ranges causing severe range deterioration by 1900 (Heady and Bartolome 1977, Foss 1960). Many of the

[1] Binns, Allen N.. 1976. Evaluation of habitat quality in Wyoming trout streams. Unpublished paper presented at the Am. Fish Soc., Annu. Meet.. Dearborn, Mich. 33 p.

uplands were denuded of soil-stabilizing plants which resulted in extensive sheet, rill, and gully erosion. Extensive down-cutting of stream channels on valley floors was also caused by heavy grazing[2] (Winegar 1977).

In many areas, especially during summer and early fall, riparian zones were extensively overused by livestock because of the lush plant growth and the proximity to water. Continued heavy livestock use of riparian zones produced the following results:

1. Compaction of soils due to livestock trampling caused a reduction of water infiltration, increased water runoff, and made successful reproduction difficult for many species of plants. This, along with a loss of ground cover, caused soil erosion throughout many watersheds.

2. Riparian vegetation needed to provide shade to streams was eliminated, and overhanging streambanks were broken down which resulted in loss of escape cover and accelerated bank erosion.

3. Some highly productive wet meadows have been lost because stream channels have eroded their way down, lowering the water table. This process has resulted in the encroachment of dry-site plant species, such as sagebrush (*Artemisia* spp.). Consequently, small streams that once had adequate flows during summer months are now intermittent or dry, creating a substantial loss of trout habitat.

4. Some streambottoms have been historically burned to eliminate dense vegetation and facilitate the gathering of livestock. This practice has been devastating to the entire riparian zone and associated fish habitat.

5. Coliform bacteria counts are extremely high in some streams due to livestock faces and carcasses. These materials not only impair water quality but also pose potential health problems for recreationists.

[2]McKinley, Charles. 1965. The management of land and related water resources in Oregon-A case study in administrative federalism. p. 21-31. A manuscript partially supported by a grant to Reed College from the Resources for the Future Inc., Washington, D.C., on fife at Dep. of Interior Library, Bonneville Power Administration, Portland, Oregon.

Studies have shown that in stream sections where livestock use is light or is eliminated by fencing, production of trout increases substantially. The average increase in fish production was 184 percent for five study areas[3,4] (Gunderson 1968, Marcuson 1970, Lorz 1974) (fig. 6). These data indicate that trout production in streams currently being heavily grazed

[3]Claire, Errol W.. 1977. Fish populations and habitat studies on Camp Creek. Unpublished data on file at Oreg. Dep. Fish and Wildl., John Day.

[4]Duff. Donald A., 1977. Big Creek aquatic habitat management and impacts from livestock grazing. Unpublished paper presented at the Bonneville Chapter of the Am. Fish Soc., Annu. Meet., Ramada Inn, Salt Lake City. Utah. 13 p.

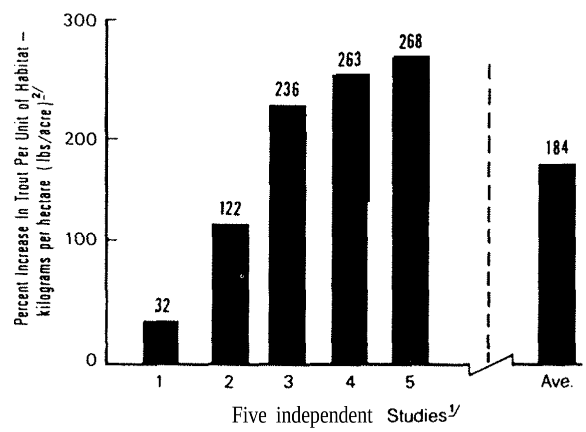


Figure 6.—Percent increase in trout production in areas of controlled or light cattle grazing as compared with heavily grazed areas of the same streams.

[1]Source:

1. Gunderson (1968): Rock Creek, Montana-brown trout (*Salmo trutta*) (exclosure).
2. Claire (1977): Camp Creek, Oregon-rainbow trout (*Salmo gairdneri*) (exclosure with controlled grazing).
3. Marcuson (1970): Rock Creek, Montana-brown trout (exclosure).
4. Duff (1977): Big Creek, Utah-rainbow and cutthroat trout (*Salmo clarki*) (exclosure).
5. Lorz (1974): Little Deschutes River, Oregon-brown trout (light grazing).

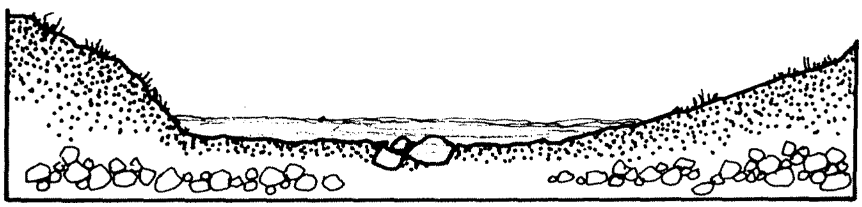
[2]Percent increase of trout in kilograms per hectare (lbs/acre) for all studies except Camp Creek; Claire (1977) reported increase in number of fish per linear distance of stream studies.

could be increased about 200 percent if management decisions were made to optimize habitat conditions for trout.

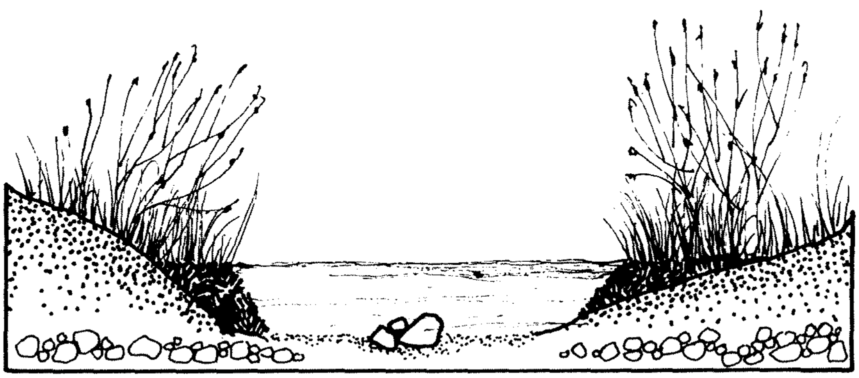
Water temperatures in areas adjacent to exclosures were found to be high; and as a result, such fishes as suckers, dace (*Rhinichthys* spp.), and shiners (*Richardsonius* spp.) were prevalent. In one stream, for example, dace were 4.5 times ***more*** numerous in a stream section with season-long grazing use than within a 13-year-old exclosure with controlled grazing (no grazing within the first 6 years and light grazing thereafter). Water temperatures from 26 August to 11 September downstream from the exclosure were 6.7°C (12°F) higher 25.6°C (78°F) than within the exclosure 139°C (66°F) (Claire 1977).

Streambank erosion has also been common outside exclosures. Heavily grazed sections generally cause the stream channel to be widened, resulting in decreased water depth and increased water temperature (White and Brynildson 1967, Van Velson n.d.) (fig. 7a). Figure 7b and 7c illustrate the natural stream

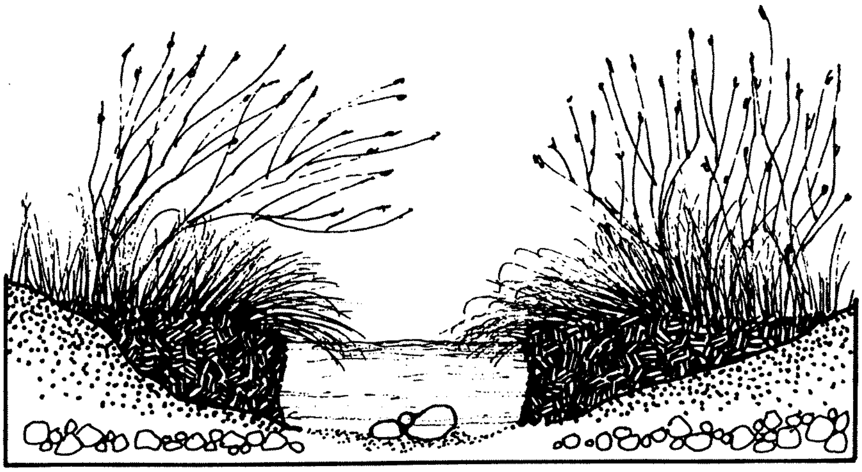
Figure 7.-Stream habitat conditions with heavy grazing (A) and subsequent improvement over a lo-year period-providing livestock gizing is discontinued (B and C). Adapted from White and Bryniidson (1967).



A. Late summer stream conditions with heavy livestock use: Bank vegetation and aquatic vegetation grazed and trampled. Banks eroded and streambed mostly covered by shiftin sediment. Water and streambed exposed to sun. These con 8itions offer trout no cover, no place to spawn, little food, unfavorable temperatures, and turbid water.



B. Late summer conditions after 2 to 3 years without grazing: Streambank vegetation includes grasses, young willows, wild rose and aider-vegetation binding soils, sediment being deposited, and stream receiving some shade. Trout habitat improved with increased cover, more food, and better spawning conditions.



C. Late summer stream conditions after 5 to 10 years of non-use by livestock: Streambanks are well vegetated with 2.4- to 4.6-m. (8- to 15-foot-) high willow, wild rose, alder, cottonwood, red osier dogwood, grasses, shrubs, and sedges. Stream has numerous overhanging banks with little sediment movement. Excellent trout habitat providing cover, cold water, food, and spawning area.

processes that restore degraded habitats to productive conditions when grazing use is eliminated for a number of years (fig. 8).

Although no documentation was found, it seems to be obvious that any wild herbivore using the riparian zone is going to have an effect on the condition, species composition, and growth of the plant community.

Figure I.-Natural processes can restore degraded habitat to a productive condition for native trout when livestock grazing is eliminated. (Photograph by Robert R. Kindschy)

Management Tips

Livestock grazing is the dominant land management program on public lands in southeastern Oregon. Most of the tips concern this land use, and are designed to assist a manager in making decisions that are beneficial for trout production.

The previously discussed optimal habitat requirements for trout are repeated here as generalized objectives, the achievement of which will lead to good trout habitat:

1. Where possible, streams should be 75 percent or more shaded with a vegetative canopy cover to maintain summer water temperatures below 21.1% (70°F).

2. Streambanks should be well vegetated to prevent active erosion from occurring on at least 80 percent of their total lineal distance.

3. Instream cover for trout should be about 50 percent of the total stream area, including overhanging bank vegetation on 50 percent or more of the streambanks.

4. At least 75 percent of riffle-rubble areas of streams should be free of siltation or fine sediments.

Attainment of all of these goals on all streams may not be possible because of various site-specific limitations on particular streams. Specific actions that may be taken to maintain or improve native trout habitat are as follows:

1. Implement grazing systems that will create and/or maintain the requirements for good condition trout habitat. Livestock management alternatives that should be considered to improve degraded stream habitats and riparian zones include: (a) deferred grazing on streamside areas until fall months, and (b) on high priority streams, schedule exclusion of riparian areas from livestock grazing until substantial habitat improvement has occurred-this may require from 5 to 10 years, depending on the existing conditions of the habitat. Permanent elimination of livestock grazing in most areas is neither desirable ‘nor feasible, but grazing should be closely controlled to improve habitats in poor condition and to maintain healthy riparian vegetation and productive fish habitat.

2. Fencing may be necessary on the most important trout streams to protect the easily damaged habitat. The entire riparian zone should be excluded from pastures in these areas. Corridor fences are usually considered undesirable but can be used to obtain immediate improvement in small areas where streambank erosion is a serious problem. Gap fences, less expensive to erect, often require annual maintenance.

3. Encourage livestock use away from riparian zones. Management practices, such as salting, water developments, and herding, can relieve pressure on riparian zones and markedly improve upland range conditions.

4. Artificial revegetation of streambanks may produce vegetative recovery more rapidly than natural revegetation. Recovery of critical streamside cover can be accelerated by several years when trees, shrubs, and grasses are planted. Plantings in the riparian zone should include willow (*Salix* sp.), alder (*Alnus* sp.), cottonwood (*Populus* sp.), quaking aspen (*Populus tremuloides*), black locust (*Robinia pseudoacacia*), chokecherry (*Prunus uirginiana),* Russian olive (*Elaeagnus angustifolia),* red-osier dogwood (*Cornus stolonifera),* reed canary grass (*Phalaris arundinacea)* (Rise variety), streambank wheatgrass (*Agropyron dasytachyum),* and yellow-blossom sweet clover (*Melilotus officinalis*). Research is needed, however, to develop varieties of riparian plants that are less palatable to livestock.

5. Stream improvement structures should be installed only after a thorough field evaluation. Recommendations of both hydrologists and fishery biologists should be included in project planning. Recommended structures for streams are trash catchers, gabions, small rock dams, individual boulder placement, rock jetties, and silt-log drops. The type of instream structure recommended will depend on site-specific conditions of each stream. Some structures could serve the dual purpose of increasing the water table in areas of former wet meadows as well as improving trout habitat.

6. Riparian vegetation should be protected during herbicide treatments designed to improve range forage for livestock use. Certain chemicals are toxic to fish and other aquatic organisms. Use of streamside buffer strips and adherence to all other standard procedures for herbicide applications, including close contract supervision, are imperative.

7. Controlled beaver (*Cas tor canadensis)* populations are an asset to small trout streams and their attendant wildlife (Kirby 1975). They help retain water, influence the water table in the streamside zone, and provide some good pools for trout. A regulated trapping harvest is essential to maintain healthy beaver populations compatible with good trout habitat. Regulation of livestock grazing is also essential to perpetuate viable stands of aspen and willow (DeByle 1976, Schier 1976, Smith et al. 1972).

Uncontrolled beaver populations may be destructive to trout habitat on some higher elevation streams. Beaver can completely cut down large aspen groves and willow patches (Hall 1960). After food supplies are eliminated, the beavers either move or die of starvation.

In southeastern Oregon, for example, riparian aspen groves are small, relatively rare, and are easily eliminated by the combination of beaver and livestock use. Consequently, many aspen groves have little or no regeneration or regrowth because young plants are eaten by livestock before they become well-established. Since aspen regeneration is through adventitious shoots, root suckers, or root sprouts, there are ways to rejuvenate a declining grove that is not subject to either beaver or livestock use (Jones 1975, Jones and Trujillo 1975, Schier 1975, 1976). Where beaver or livestock use an aspen grove, however, exclusion of livestock will be necessary for a long enough period of time to allow the young aspen to become established and large enough to withstand livestock use.

Extensive soil erosion may occur within the former aspen-willow areas, and beaver ponds usually become filled with sediment. Old beaver dams may eventually break and discharge heavy sediment loads downstream.

8. Improvements of existing roads or construction of new roads along streams inhabited by native trout could have severely adverse effects upon these fish populations (Whitney and Bailey 1959). Roads along streams destroy the riparian vegetation and thereby remove trout cover and increase water temperatures. Further, sediment movement into streams from roads, particularly road construction, is detrimental to aquatic life. If streamside road construction is unavoidable, however, culverts should be placed so as to minimize erosion and provide easy fish passage.

Improved, well-developed roads usually result in better access and heavier public use. Wild trout, therefore, are generally less abundant in areas where streams are easily accessible.

9. Recreation use will continue to increase in southeastern Oregon. It is suggested, therefore, that developed recreation facilities should not be constructed on any native trout stream because of the tendency to overfish a stream. New recreational facilities should be located in the more accessible areas where fish populations can be maintained either by stocking hatchery trout or with warm-water species.

In addition, if viable trout populations are to be maintained, the construction of trails along native trout streams is not recommended.

10. Water management of large reservoirs occurring on or adjacent to public lands in southeastern Oregon are under the control of the Bureau of Reclamation and/or irrigation districts. Because of this, available options to manage fish habitat must be related to the surrounding lands and upper watersheds. If the surrounding rangelands are in good condition, erosion will be minimized and water flowing into reservoirs will be of sufficient quality to maintain good fish populations.

Small reservoirs, constructed for stock water developments, sometimes have water conditions suitable for fishery development. If water-gap fences are used to keep livestock out of small reservoirs, they may cause maintenance problems. For example, ice breaks such fences; and where reservoirs fluctuate, livestock often get around the ends of the gap fence. Fencing may be necessary, therefore, to exclude livestock from the entire reservoir area. Water can then be piped to a livestock watering trough outside of the fence.

11. Springs that help maintain water quality and quantity in downstream fish habitats, especially during summer low-flow periods, should be protected. Furthermore, isolated springs in the desert environment of southeastern Oregon sometimes contain unique or rare species of fish.

12. Each spring, the Oregon Department of Fish and Wildlife stocks the larger reservoirs, parts of the Malheur River, and many of the smaller water developments with fingerling rainbow trout. Streams that are easily accessible and support heavy angling pressure may receive legal-sized rainbow trout each year. To help maintain strains of wild trout, hatchery trout should not be released in streams where native trout occur.

Habitats not suited for trout production, but with fishery potential, may be stocked with warm-water game fish if there is no adverse impact on native non-game species.

Land managers should contact the local fisheries biologist if they think some of their water developments are suitable for fish production. If a reservoir is found to be suitable habitat, the Department of Fish and Wildlife will stock the desired species and manage the fishery.

Management practices-on any part of a rangeland watershed-ultimately affect the riparian vegetation, water quality and quantity, and fish habitat. Proper resource management, especially livestock grazing, is imperative if we are to insure the welfare of our aquatic habitats and their riparian zones. Streams, rivers, lakes, and their attendant riparian zones are the barometers that reflect the care man takes of his land-support base. Spence (1938, p. 23) summed it up:

> . ..Is it not wiser, under any condition, to suffer now and begin to rebuild on investment than to continue to gamble year after year, and finally end with a total loss...? The problem becomes even more serious when the welfare to future generations is considered.

Fortunately, natural processes not only can help restore streams that are in poor condition but also can help reverse the downward trend of stream habitats. With the existing knowledge of natural processes, management strategies can be tailored to improve stream habitats; but their maintenance and repair will require the cooperative efforts of both public and private rangeland managers because streams ignore political boundaries.

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