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Riparian Zones and Freshwater Wetlands

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Introduction

Riparian zones and freshwater wetlands are among the most heavily used wildlife habitats occurring in forest lands of western Oregon and Washington. Biologists have recognized this for years, but only recently has the significance of riparian and wetland productivity been well quantified by research studies. Of the references cited in this chapter, the majority have been published since 1970. Results of ongoing research are expected to further substantiate and expand our knowledge of wildlife use in these habitats.

Riparian Zones

Webster's New World Dictionary, 2d. college edition defines riparian as: "of, adjacent to, or living on the bank of a river or, sometimes, of a lake, pond, etc." The riparian zones discussed in this chapter occur along rivers, streams, lakes, reservoirs, ponds, springs, and sometimes tidewater (fig. 1). They have high water tables because of their close proximity to aquatic ecosystems, certain soil characteristics, and some vegetation that requires free (unbound) water or conditions that are more moist than normal. These zones are transitional between aquatic and upland zones. As such they contain elements of both aquatic and terrestrial ecosystems (fig. 2).

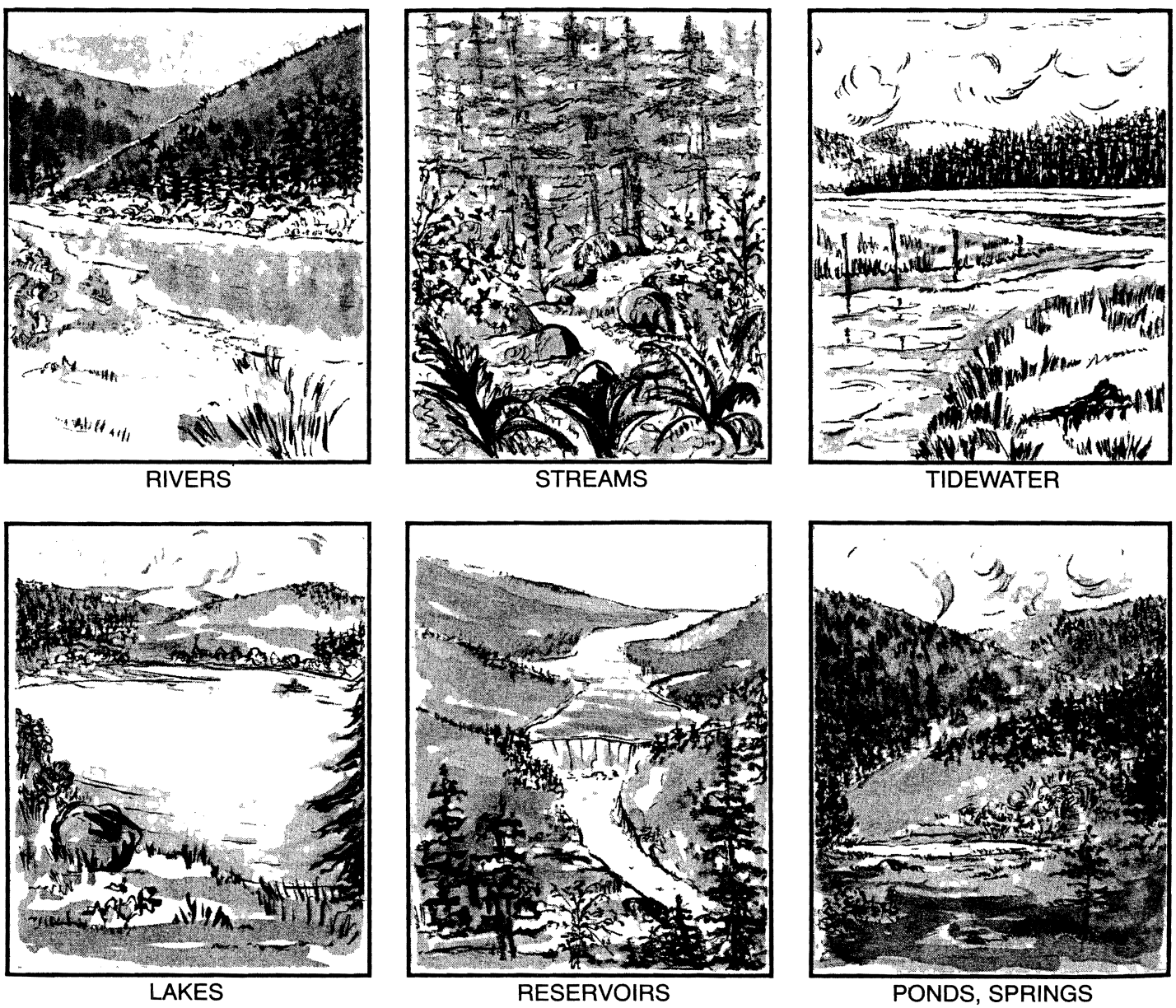


Figure 1.—Aquatic habitats common to western Oregon and Washington that have associated riparian vegetation influenced by the type of water.

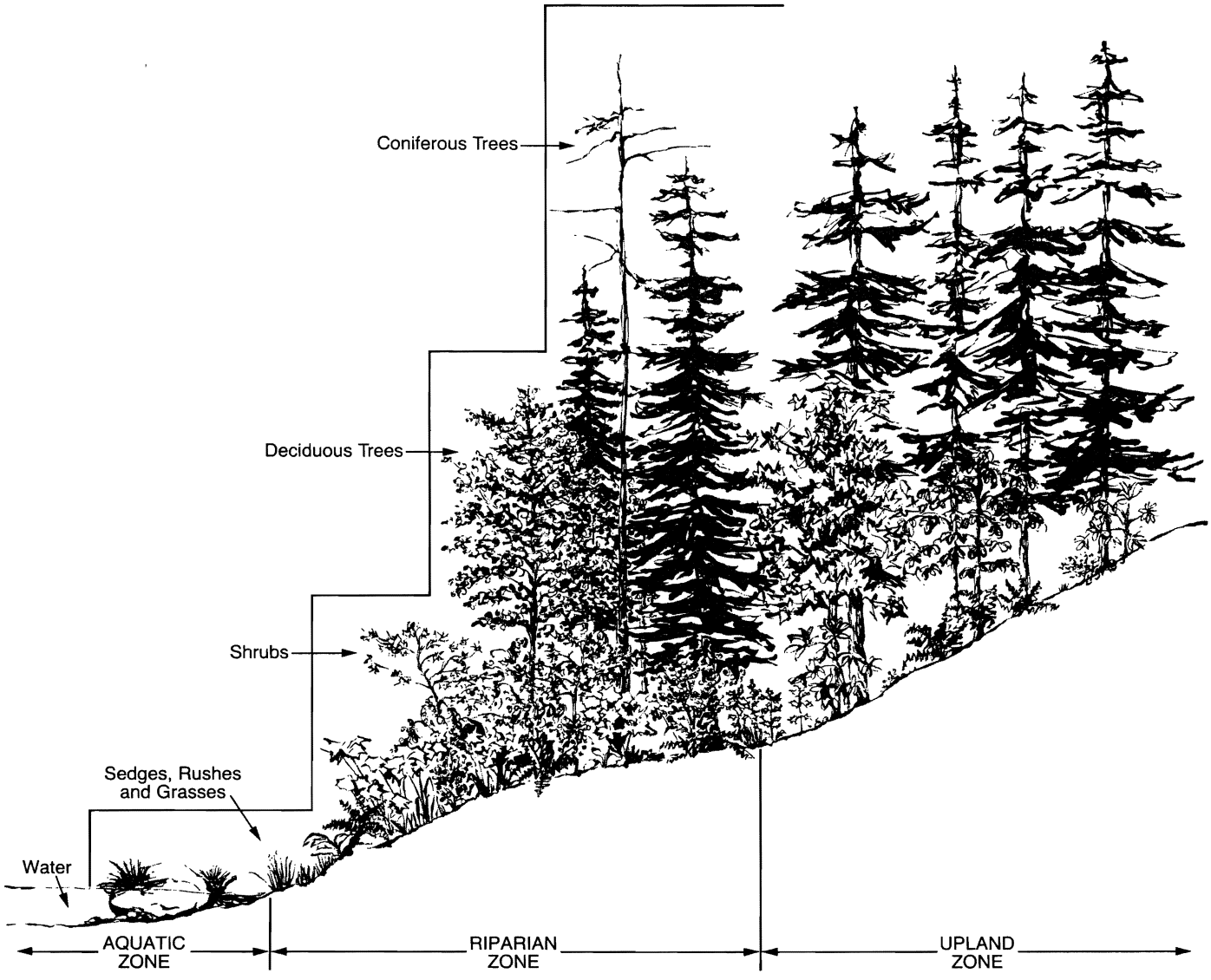


Figure 2.—Riparian zones have vegetation that requires large amounts of free or unbound water and are transitional between aquatic and upland zones.

In the Pacific Northwest, most riparian zones occur along streams and rivers. Such habitats can extend through entire drainage systems from the smallest intermittent headwater streams to the largest rivers (fig. 3). The terms "riparian zones" and "riparian areas"are used interchangeably in this chapter, but by strict ecological definition, they may not be the same in all instances.

Vegetation found in riparian zones usually includes hydrophytes (skunk cabbage, coltsfoot, lady-fern, sedges, devil's club, water-parsley, stink currant, willows, etc.) and species which also occur in drier sites (red alder, salmonberry, vine maple, bigleaf maple, black cottonwood, Sitka spruce, western redcedar, California-laurel, Douglas-fir, etc.) (Brown et al. 1980, Campbell and Franklin 1979, Franklin and Dyrness 1973, Maser et al. 1981, Minore and Smith 1971, Proctor et al. 1980, Walters et al. 1980). Riparian vegetation west of the Cascade Range in Oregon and Washington usually consists of herbaceous ground cover, understory shrubs and overstory trees (Swanson et at. 1981). The edge between riparian and upland zones is usually identified by a change in plant composition, relative plant abundance, and the end of high soil moisture.

Any of the plant communities described in chapter 2 can occur in riparian zones. There is great variability in both the size and vegetative complexity of riparian zones because of the many combinations possible between physical and biological characteristics. These characteristics include stream gradient, elevation, soil, aspect, topography, water quantity and quality, type of stream bottom, and plant community (Campbell and Franklin 1979, Odum 1971, Swanson et al. 1981, Walters et al. 1980). Numerous habitats and niches usually occur within any riparian zone because of these varying conditions.

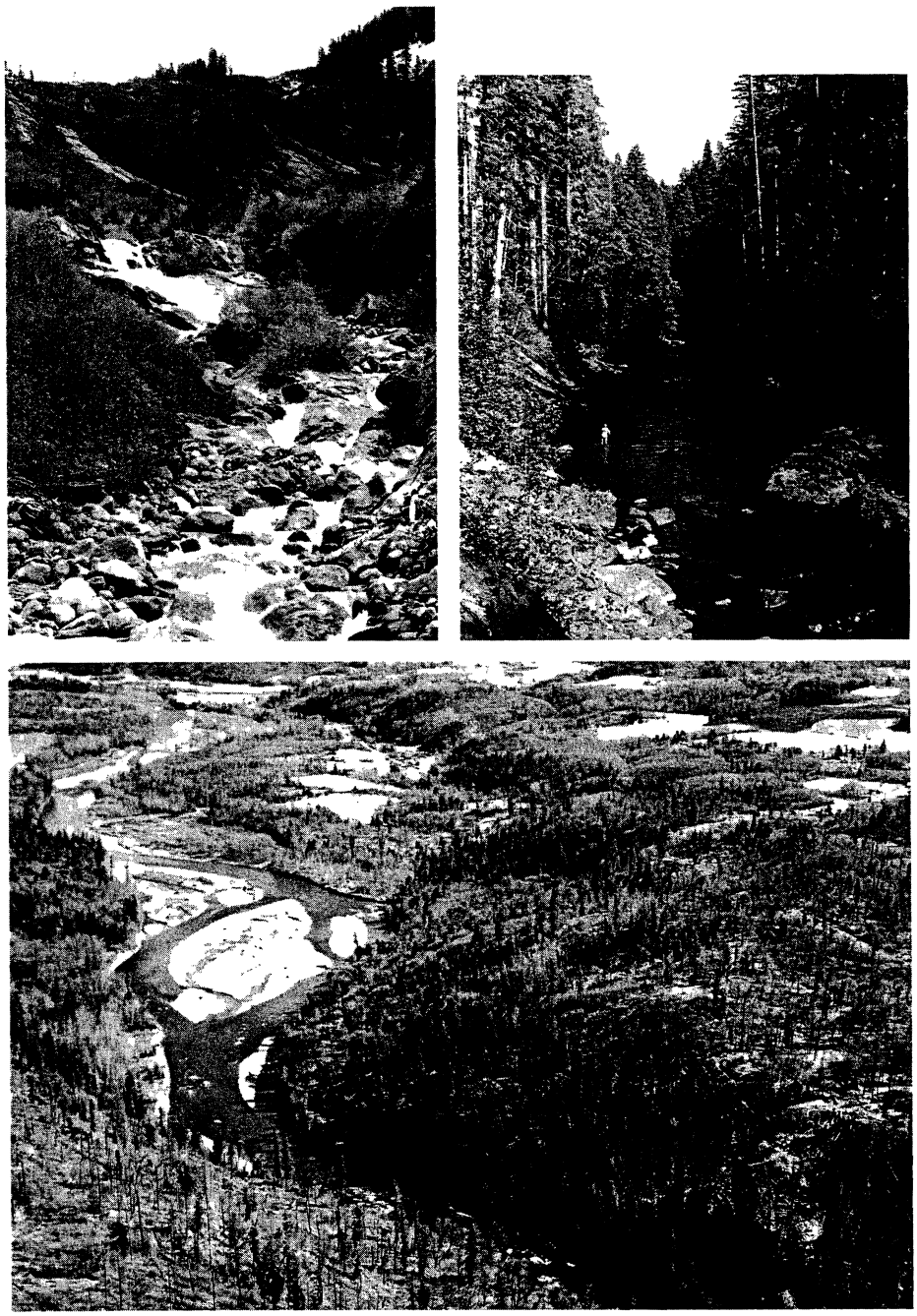


Figure 3.—Riparian habitat conditions vary with the location and size of the stream. There also is considerable difference in their importance to wildlife. Larger, more productive riparian zones are usually found along medium-sized or larger streams.

The natural succession of vegetative types following major disturbances such as floods, fires or logging, determines the kinds of vegetation occurring in a riparian zone at any given time. Pioneer species include willows on gravel bars and red alder on mineral soil (Campbell and Franklin 1979). Stream deposition and erosion influence the topographical features of floodplains and have pronounced effects on the vegetative composition and habitat conditions of riparian zones (Brinson et al. 1981).

Riparian zones of western Oregon and Washington possess the same characteristics as those listed by Thomas et al. (1979a). They occupy only a small part of the overall area but are a critical source of diversity within the forest ecosystem. They create distinct habitat zones within the drier surrounding areas. In addition, riparian zones are elongated in shape with very high edge-to-area ratios (Odum 1979). They therefore possess a high degree of connection with other habitat types and function as effective transport systems for water, soil, plant seeds, and nutrients to downstream areas (Ewel 1979) (fig. 4). They also serve as important travel routes for the movement or dispersal of many wildlife species.

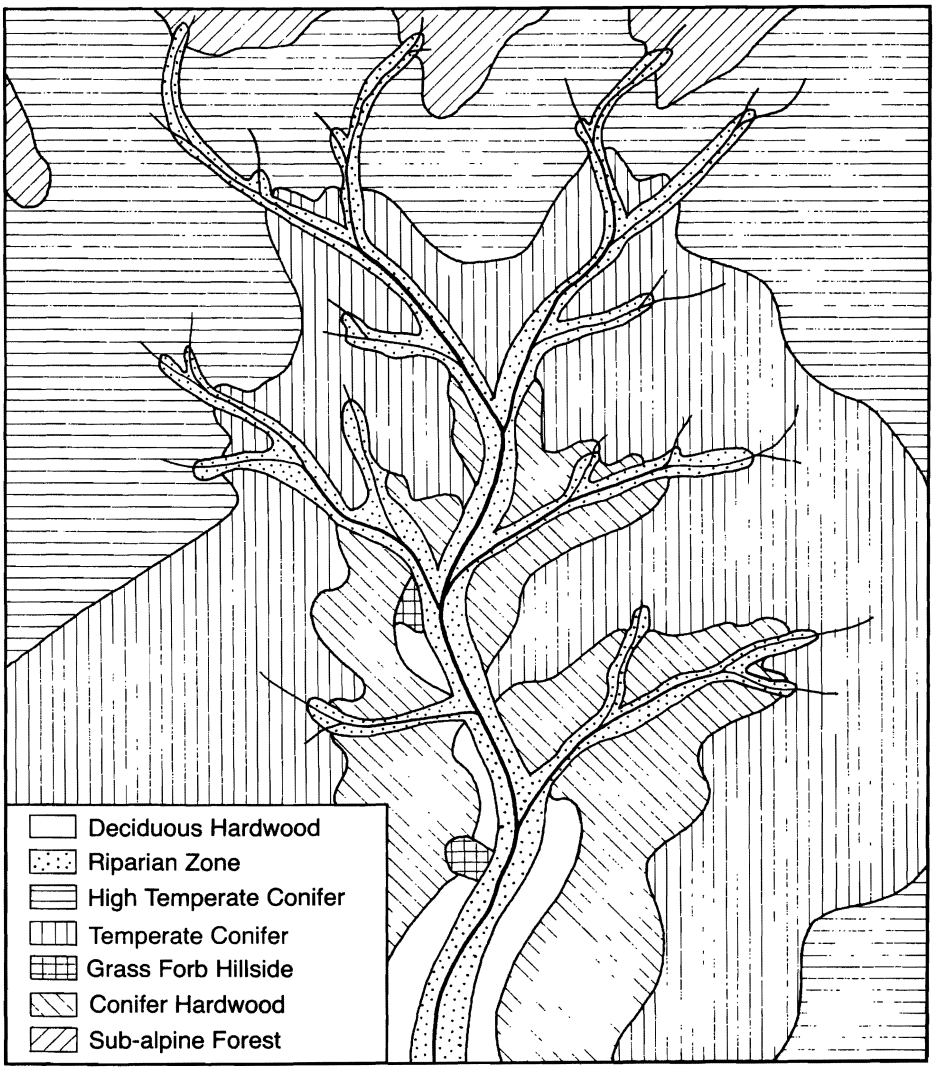
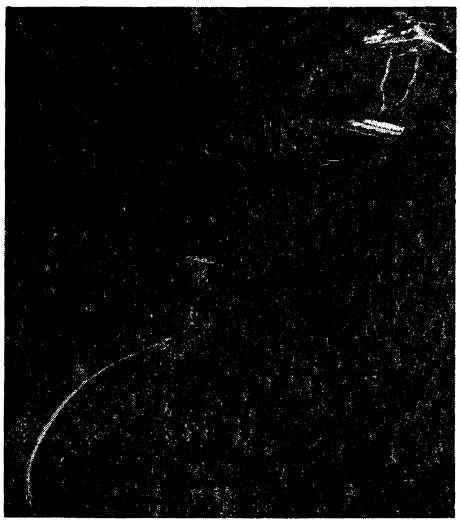
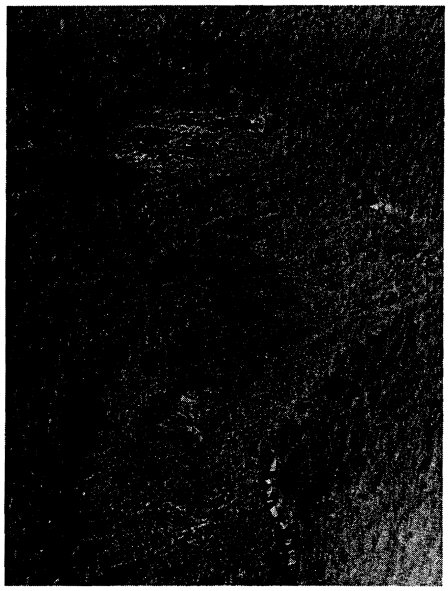


Figure 4.—Riparian zones along streams and rivers function as connectors between habitat types. They are important migration routes for some wildlife species and serve as travel routes for numerous species because of the presence of water, food, and cover.





deeper than 6.6 feet in the deepest part of the basin at low water. These two types of water bodies are considered deep-water habitats, as recently classified by the U.S Fish and Wildlife Service (Cowardin et al. 1979).

In summary, wetland and riparian habitats are characterized by high diversity (numbers of species), density, and productivity of both plant and animal species. There are continuous interactions among the aquatic, riparian and adjacent upland zones through exchanges of energy, nutrients, and species (Cummins 1980, Franklin et al. 1981, Meehan et al. 1977, Odum 1979, Swanson et al. 1981). The direct role of riparian areas in affecting the productivity of aquatic habitats for salmonid fishes is discussed in detail in chapter 10.

Freshwater Wetlands

Wetlands are areas that are permanently or intermittently flooded. The water table is normally at or near the surface, or the land is covered by shallow water not exceeding 6.6 feet in depth at low water. Hydric soils occur and vegetation is composed of floating or submergent aquatics and emergent hydrophytes which require saturated or seasonally saturated soil conditions for growth and reproduction. Examples of wetland plants include yellow water-lily, cat-tail, rushes, skunk cabbage, sedges, cotton-grass, willow, alder, black cottonwood, and western redcedar (Cowardin et al. 1979, Franklin and Dyrness 1973, Proctor et al. 1980). In certain areas, however, vegetation may be completely lacking as on flats where drastic fluctuations in water levels or wave action prevent growth of hydrophytes.

Wetland habitats include freshwater marshes, swamps, bogs, seeps, wet meadows, and shallow ponds (fig. 5). Not included are lakes and reservoirs over 20 acres in surface area with less than 30 percent areal vegetative cover or

Figure 5.—Small ponds, marshes, wet meadows, and bogs are types of freshwater wetlands that add diversity to the forest lands of western Oregon and Washington and provide crucial habitats for aquatic and semi-aquatic species.

Importance of Riparian Zones and Wetlands

Riparian zones and wetlands provide some of the most important wildlife habitat in forestlands of western Oregon and Washington. Wildlife use is generally greater than in other habitats because the major life requirements for many species are present. Aquatic and amphibious species are normally found only in these habitats (fig. 6). Water is the habitat for aquatic life forms, including many species of invertebrates, fish, amphibians, reptiles, birds, and mammals. Vertebrates that either feed or reproduce in water are directly dependent on wetlands or riparian areas and adjacent aquatic areas. Many other species, although not completely dependent on riparian or wetland habitats, tend to use them to a greater degree than upland areas.

Riparian zones are important for many other types of land use. Highly productive timber sites frequently occur along streams and around wetlands or lakes. Livestock utilize vegetation in riparian zones more heavily than in other areas because they concentrate here for water, shade, and succulent forage. Riparian zones are used for road locations, particularly in mountainous, rugged terrain. Rock and gravel for building roads have been taken from streambeds and their banks as well as from floodplains. Mining has direct and indirect impacts on riparian areas. Recreationists concentrate their use in wetland and riparian areas where scenic values are high. Riparian zones are preferred for recreational developments such as campgrounds and summer home sites. Because of these conflicting uses, riparian zones are recognized as critical areas in multiple use planning.

Figure 6.—Many wildlife species require riparian or freshwater wetland habitat to survive. Many others show a preference for these habitats even though their survival may not be dependent on riparian or freshwater wetland habitat.

Riparian zones are more numerous than wetlands in forested areas west of the summit of the Cascade Range and are of much greater significance to forest management. Riparian zones are of paramount concern as wildlife habitat for the following reasons:

1. Most riparian zones contain water, cover, and food—the three critical habitat components.
2. Riparian zones have a greater diversity of plant composition and structure than uplands. There are more internal edges and strata in a short distance due to understory shrubs, deciduous trees, and coniferous trees than in adjacent upslope forest stands (fig. 7). Where riparian zones are dominated by deciduous vegetation, they provide one type of habitat in late fall and winter after leaf fall, and a different type of habitat during late spring and summer when in full leaf.
3. The elongated shape of most riparian zones maximizes edge effect with the surrounding forest as well as with water. This produces high edge-to-area ratios, and creates productive habitats for many species (see chapter 6).
4. Riparian zones have different microclimates from surrounding coniferous forests due to increased humidity, a higher rate of transpiration, and greater air movement. These conditions are preferred by some species during hot weather.
5. Riparian zones are natural migration routes and serve as travel corridors for many wildlife species such as ruffed grouse, bats, deer, beaver, mink, and raccoons, to name just a few. Cover, water, and sometimes food are available for birds and animals when they are dispersing from their original habitats in search of new territories. Strips of old-growth forest left along streams also serve as "connectors" for wildlife to move between otherwise isolated stands of old growth (Franklin et al. 1981) (fig. 4).
6. Productive fish habitats and good water quality depend on well-developed vegetative communities in riparian zones. Self-sustaining riparian forests stabilize streambanks and adjacent slopes and provide food and recruitment of large woody debris to streams (see chapter 10).

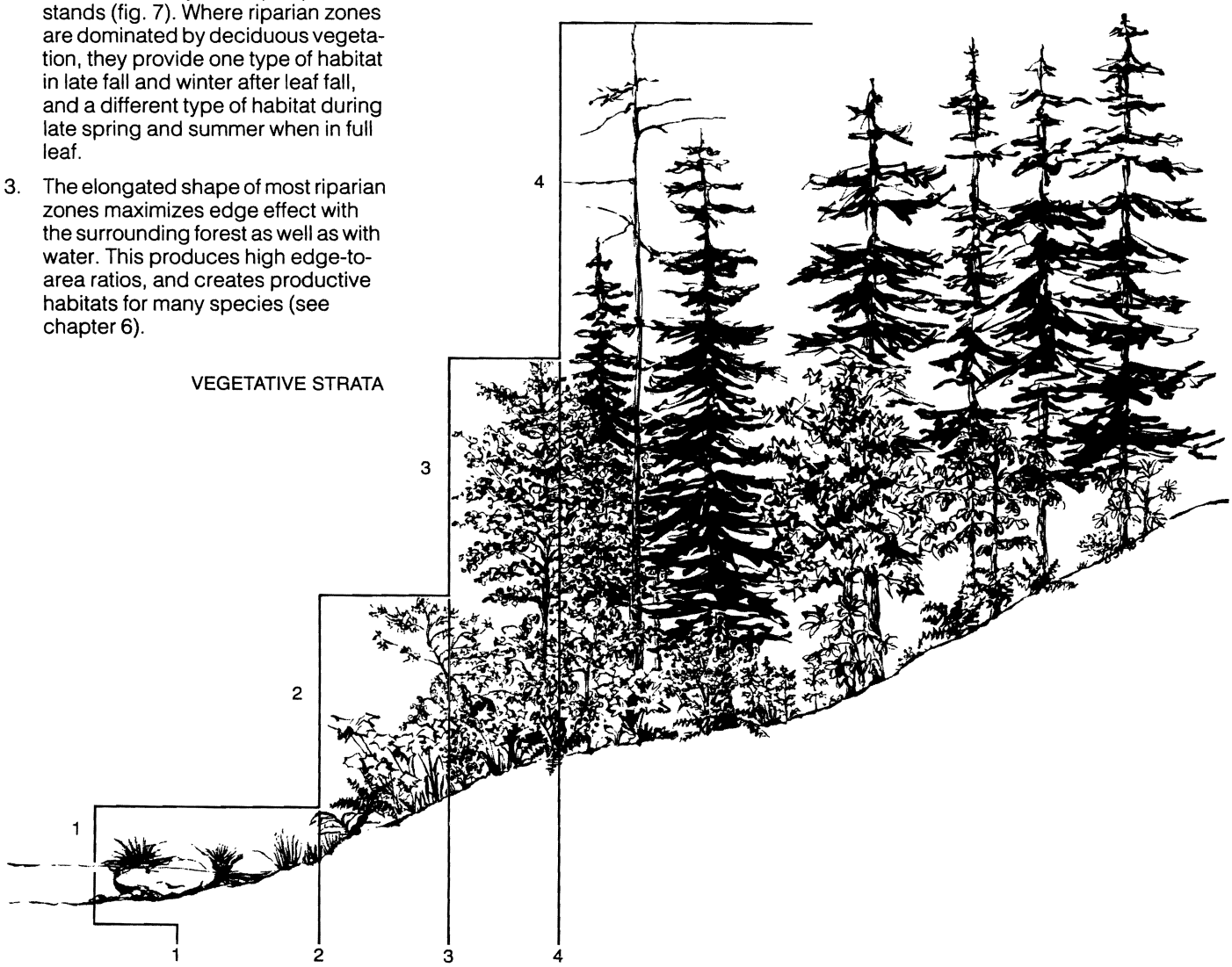


Figure 7.—Riparian zones often have a high number of strata and edges in a relatively small area. This produces habitat for a greater number of species because of the diversity of plants which create numerous "habitat niches."

Major Elements of Riparian Zones and Wetlands

There are many types of riparian zones and wetlands in the Northwest. It is important to be able to identify physical and biological differences in order to properly understand and manage them. It is also necessary to understand the natural processes which cause changes in these habitats. A brief discussion of the major elements of riparian zones and wetlands should facilitate such an understanding. By observing each element, it is possible to draw general conclusions regarding the nature of an area and its management needs. In all cases, field reconnaissance,operational experience, and professional judgment are fundamental to evaluating and managing riparian zones and wetlands.

A wide variety of factors are frequently mentioned to define the character and function of riparian zones and wetlands (Brown et al. 1979; Campbell and Franklin 1979; Collotzi 1978; Cowardin et al. 1979; Odum 1971). The following five important elements are discussed:

1. Topography
2. Vegetation
3. Surface water (including flowing water)
4. Soil
5. Local climate

These elements should provide a basic framework for analyzing and understanding the management needs of riparian zones and wetlands. Additional elements can be added to this list depending on individual needs and the type of planned management activity. Each element is discussed as it relates to defining the quantity, quality, and function of riparian zones and wetlands.

Topography

Topography as used here refers to the "lay of the land" within and adjacent to riparian zones and wetlands. It affects a number of physical (e.g., erosion, deposition, hydroperiod, soil formation) and biological (e.g., plant and animal communities, animal use) characteristics. The topography of the surrounding landscape can be used to stratify riparian zones and wetlands having similar structural and functional characteristics (Brown et al. 1979). Collotzi (1978) and Heller and Maxwell (1980) classified potential riparian resource production based heavily on topographic features including entrenchment floodplain width, and stream gradient.

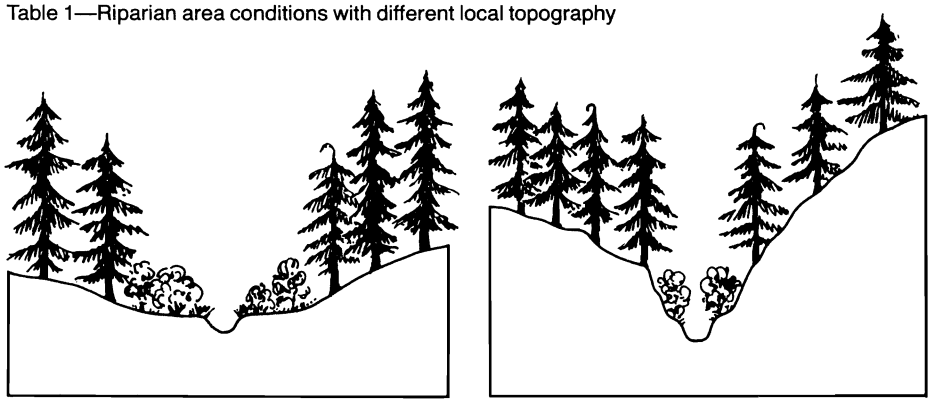
Topography often determines the space available for the development of riparian or wetland plant communities. It is a primary indicator of the type, frequency, and magnitude of erosion/deposition processes occurring in an area. It may have a major influence on local climate, particularly sunlight, temperature, and wind. Topography may strongly influence the occurrence and relative effect of various upslope disturbances (windthrown trees, landsliding, etc.) on riparian zones or wetlands. It determines the capability of the riparian zone for many types of uses.

A comparison of selected characteristics of two riparian zones having substantially different surrounding topography is shown in table 1.

Vegetation

Vegetation has numerous functions in riparian zones and wetlands. It defines the number and type of wildlife habitats present. Vegetation stabilizes soil and streambanks and provides nutrients to the soil. On small to moderate-sized streams, leaves and debris (litter) provide the primary source of energy for the aquatic system (Franklin et al. 1981). Large dead and down trees store nutrients, provide seed beds for various tree species, provide habitat for various wildlife and, when incorporated into streams, control channel structure and stability (Franklin et al. 1981, Swanson et al. 1976). Both the physical and biological structure of riparian vegetation also has a strong influence on the growth, density and biomass of salmonids in adjacent streams (Martin et al. 1981) (chapter 10).

Table 1—Riparian area conditions with different local topography



A. Broad, Open Area

- Local Slopes: 30%
- Location: Well developed floodplains. Also includes lakes, wetlands (marshes, bogs, ponds, wet meadows).
- Dominant process: Deposition.
- Soils: Deep and often fine textured.
- Sunlight: Year-round.
- Winds: Relatively open to disturbance.
- Vegetation and structure: Localized variations in soil type, moisture, and disturbance often create high diversity.

B. Narrow, Entrenched Area

- Local Slopes: 60%, often 80%
- Location: Poorly developed floodplains. Also includes small glacial or landslide lakes, small wetlands around springs or seeps.
- Dominant process: Active erosion and transport.
- Soils: Often shallow and coarse textured.
- Sunlight: Often partially blocked during winter months or long periods of the day.
- Winds: Relatively sheltered.
- Vegetation and structure: Often limited.

The composition of vegetation refers to both the number and abundance of various plant species. Composition is controlled by many factors, including topography, substrate, and stream gradient (Campbell and Franklin 1979, Walters, et al. 1980). Composition also may be influenced by adjacent stands of timber, particularly old growth, through shading and competition (Campbell and Franklin 1979, Franklin et al. 1981).

The structure of vegetation relates to how available space is occupied by different species and sizes of plants. Habitat diversity is controlled by the stratification or structure of vegetation, both vertically and horizontally (Kelly et al. 1975) (fig. 7). In general, it appears that the greatest structural diversity in riparian areas is provided by old-growth stands of timber (Campbell and Franklin 1979, Franklin et al. 1981).

An important aspect of vegetative composition and structure is the potential for both short-term (seasonal) and long-term (successional) change. Seasonal changes, due to the emergence and die-off of annual plants, may cause small scale changes in composition and structure. On a larger scale, the leafing out and subsequent fall of leaves from deciduous vegetation cause major seasonal variations in the habitat conditions of a wetland or riparian zone. Seasonal changes can produce considerable differences in the amount of food and cover available for wildlife use.

Natural succession changes the structure and composition of vegetation over longer periods of time (Meehan et al. 1977). Succession is frequently the result of disturbance such as floods and fires which may involve large areas but occur infrequently. Streambank erosion, channel deposition, and blowdown or mortality of individual trees are small scale disturbances which occur frequently. The patterns of vegetative succession primarily depend on the frequency of disturbance and the substrate of a given area (Campbell and Franklin 1979). These patterns play a dominant role in controlling the diversity of vegetation and, hence, the number and type of niches provided for various wildlife species. Activities of man, like road construction or logging operations, can cause small to large-scale alterations in vegetative communities of riparian zones and wetlands.

Surface Water

The presence of surface water during all or part of the year is a common characteristic of riparian zones and wetlands. The character of the surface water—whether standing (lakes, ponds, marshes, etc.) or running (streams and rivers), and whether perennial or intermittent—plays an important role in the function of these areas. The character of surface water directly controls the type of aquatic habitat, the composition and diversity of vegetation, and its potential use by wildlife, livestock, and man. In wetlands the duration of surface water and its chemistry influence the decomposition process in organic soils (Cowardin et al. 1979).

Hydroperiod (the frequency of flooding in a riparian zone or wetland), is described as the key external factor controlling vegetative composition and productivity (Odum 1979). Hydroperiod may determine the relative resistance of an area to change; a shorter hydroperiod usually means a higher likelihood of change (Ewel 1979). In maintaining or improving riparian zones and wetlands, maintenance of natural flow regimes are important. Extremes (stagnant water, abrasive flooding) or major changes (damming, diversion, fire, logging, etc.) are likely to lower the productivity of an area (Ewel 1979, Odum 1979).

Soils

Soils provide the substrate which supports much of the biological activity of a riparian zone or wetland. They are an expression of the previously mentioned components acting over time. Parent material for riparian soils is usually water-carried sediments whose characteristics depend on the geology and hydrology of the drainage basin. Wetlands, which typically have no flowing water to transport sediments, usually have parent material characteristic of the local geology at a site (Brown et al. 1979).

Important parameters in the classification of wetland soils include soil organic content, drainage, texture, and nutrient content (Brown et al. 1979). Frequently, wetland soils have high percentages (20 + percent) of incompletely decomposed vegetation and are referred to as organic soils (Buckman and Brady 1972). These organic materials are largely provided by overlying or adjacent wetland vegetation.

Texture influences permeability or drainage of soils and their relative susceptibility to erosion. Fine-textured soils found on broad floodplains or wetlands generally are highly productive with good moisture-holding capacities. They are susceptible, however, to compaction as well as surface and/or stream erosion unless streambanks are well vegetated. Coarse-textured soils, often found on narrow floodplains and glacial scour lakes, are characterized by relatively lower productivity and poor moisture-holding capacity. They are less susceptible to erosion and compaction than fine-textured soils.

Combinations of these two divergent types of soil textures may be found in any given riparian zone or wetland. This variability in soil character results in a variety of plant habitats (Odum 1979).

Local Climate

Weather exerts a decided influence on most physical and biological processes of riparian zones and wetlands. It controls the frequency and magnitude of major disturbances such as floods, fires, and wind storms. Climate directly influences the character of soils by controlling physical and chemical reactions and various biological processes (Buol et al. 1973). Regional climatic factors interact with local conditions (topography, elevation, aspect, soil factors, and characteristics of surface water) to determine the types of vegetation in a given wetland or riparian area (Walters et al. 1980).

Wildlife Use of Riparian Zones and Wetlands

Major components of climate are moisture and temperature. These factors interact to determine potential plant and animal populations. Temperature is more limiting where moisture conditions are extreme, while moisture plays a more dominant role where there are extremes in temperature (Odum 1979). Because of abundant water and vegetation, extremes in temperature and/or moisture are ameliorated to a greater degree in riparian zones and wetlands than in nearby upland areas.

In the mountains of the Pacific Northwest, climate is strongly affected by elevation. Although riparian and wetland plant communities show change with elevation, these changes are less pronounced than in drier regions (Walters et al. 1980). Latitude also has an influence on climate between southwestern Oregon and northwestern Washington.

Habitat Functions

Wildlife use riparian zones and wetlands disproportionately more than other areas. Odum (1979) stated that the density and diversity of wildlife are greater in riparian zones and wetlands than in other habitats. Stevens et al. (1977) showed that the effect of riparian zones is not limited to wildlife directly dependent on these zones but that populations in adjacent areas are strongly influenced by the presence and quality of the riparian community. Activities that alter or destroy riparian or wetland habitats will have serious impacts on wildlife because of the large variety of species that use these habitats (Carothers 1977).

Wildlife require food, water, cover, and space which includes areas to feed, breed, rear young, hide, and rest as well as habitats that provide protection from extremes of heat and cold (thermal cover). The density, diversity, and structure of vegetation, combined with the landforms found in riparian zones and wetlands, tends to provide these requirements for a great many wildlife species. More habitat niches are provided in riparian zones and wetlands than in any other type of habitat. Use of these areas is a classic example of the "edge effect" (Odum 1979). Many species not directly dependent on these areas for their basic life functions, utilize them as preferred habitat during certain seasons of the year or as travel corridors in moving from one location to another (Taber 1976, Tabor 1976).

Of the 414 western Oregon and Washington wildlife species covered in appendix 8, 359 use riparian zones or wetlands during some season(s) or part(s) of their life cycles (table 2). Of these, 318 species use one or more of the three plant communitites directly associated with riparian zones and wetlands. Another 41 species use riparian zones or wetlands as special or unique habitats but do not use any of their associated plant communities. These include species such as the shorebirds, gulls, some waterfowl, and harbor seals that use the waters or shorelines of riparian and wetland areas for feeding or resting but do not venture far from the water's edge.

Some species such as the spotted frog, beaver, muskrat, and many waterfowl species are totally dependent upon riparian or wetland areas. Species such as the roughskin newt, ruffed grouse, willow flycatcher, striped skunk, and dusky-footed woodrat may live in other habitats but reach maximum population densities in riparian or wetland areas. Still other species occupy a broad array of habitats including riparian zones and wetlands but at sometime during their life cycle spend a significant amount of time in these areas. Examples of such species are Pacific tree frog, western toad, Cooper's hawk, yellow warbler, bobcat, and Roosevelt elk. Many species with significant economic importance, such as most of the furbearers, are products of riparian zones and wetlands.

Habitat functions that attract wildlife to riparian zones and wetlands are discussed in the following sections.

Table 2—Number of wildlife species using riparian zone or freshwater wetland habitats 1/

Class	Number of westside wildlife species	Number of species using riparian or wetland plant communities	Number of species using riparian zones or wetlands as a specialized habitat but not using plant communities	Total number of species using riparian zones or wetlands
Amphibians & Reptiles	44	35	2	37
Birds	267	192	38	230
Mammals	103	91	1	92
Total	414	318	41	359

1/ Data from appendix 8.

Foraging and Watering

Riparian zones and wetlands provide an abundance and variety of quality food for wildlife. Because of the diversity in vegetation and landforms, many vertical levels (strata) are available for foraging. Seed-eating birds and mammals feed in canopies of tree and shrub layers as well as on seed-producing groundcover. The black-capped chickadee, song sparrow,

and western harvest mouse are examples of seed-eating species found in riparian zones.

Insect eaters such as shrews, bats, flycatchers, swallows, woodpeckers, warblers, salamanders, turtles and snakes find food sources at different levels in riparian communities. Wildlife that feed primarily on vegetation also find an abundant source of quality food in riparian and wetland habitats, e.g. deer, elk, grouse, rabbits, and voles. Beaver and muskrat are species that are totally dependent on food from riparian and wetland vegetation for survival. Other species like the raccoon can survive outside riparian zones and wetlands but reach their maximum densities in this type of habitat.

There are also those wildlife that feed on fish, crayfish and other aquatic or amphibious organisms. Belted kingfisher, American dipper, great blue heron, river otter, mink, Pacific giant salamander, western aquatic garter snake and Pacific water shrew are examples of wildlife that may not survive without food provided by these habitats.

Predators such as hawks, owls, eagles and coyotes are attracted to riparian and wetland habitats by the abundance of prey species. Bald eagles and ospreys are particularly dependent upon riparian and wetland habitats.

Free water is also an extremely important habitat component of riparian zones and wetlands, particularly in summer. Band-tailed pigeons use mineral springs for their water, and young upland game birds need water daily.

Breeding and Rearing

Diverse riparian and wetland areas provide a wide variety of habitats where wildlife can breed and rear young. Fawning and calving areas are usually near water where good quality food and cover are available. Trees, shrubs, and ground cover are used by a great variety of songbirds, shorebirds, wading birds, raptors, and waterfowl for nesting and rearing young. Dippers, for instance, nest on cliffs or banks in moss watered by spray from waterfalls and riffles. Great blue herons nest in large trees of the riparian zones. Wood ducks that require cavities for nesting will use dead or dying trees found in riparian zones and wetlands. Red-winged blackbirds and marsh wrens are examples of species that use marsh vegetation for nesting. Waterfowl nest in a variety of habitats, some on floating nests in the water, some in riparian vegetation, and still others in upland vegetation adjacent to riparian zones and wetlands. All waterfowl species, however, use riparian zones and wetlands for brooding.

Most bald eagles nest in trees or snags along shores of large lakes and streams, perch in snags and trees, and feed on fish, waterfowl, and shorebirds. Ospreys also nest atop trees or snags along waterways and lakes, and feed on fish. The peregrine falcon , a cliff nester, feeds almost exclusively on birds, many of which are associated with riparian zones and wetlands.

Banks, ground cover, hollow logs and trees in the riparian zone provide denning habitat for many small to medium-sized mammals. Beaver, muskrat, raccoon, and Pacific water shrew are examples of mammals that use these habitats in riparian zones or wetlands. Although roughskin newts and western toads frequent forest habitats, they must have ponds, lakes or slow-moving streams for breeding.

Rearing habitat is extremely critical for most species. Rearing areas must be near nesting, fawning, and other areas where young are produced. Species that nest, den or otherwise produce young in riparian zones and wetlands also rear their young there. There must be an abundant supply of food and hiding cover for young, as well as for adults. Feeding areas and hiding cover must be close together to allow ready access between them.

Hiding and Resting

Hiding and resting cover is an essential habitat element for wildlife. Dense vegetation, complex landforms, and abundant water found in riparian zones and wetlands provide this important requirement. Burrows, dens, hollow logs and trees, cavities in logs and trees, and dense foliage are essential for many species of mammals, birds, and other wildlife. Beaver and muskrat rest and take refuge from enemies in dens with underwater entrances. Rabbits and hares hide and rest in burrows, rocks, litter or dense underbrush. Large mammals often hide in thickets of riparian shrubs and trees. Many small mammals burrow or create "runs" under or through this dense vegetation which allows protection from predators. Frogs and turtles rest on emergent vegetation, logs, or floating material in the water and also hide in water and emergent vegetation.

Waterfowl, such as mallard ducks and Canada geese, use sheltered areas along streams for loafing and protection during severe weather. Riparian and wetland vegetation also provides perches for species such as bald eagle, osprey, belted kingfisher, and willow flycatcher. Since riparian zones and wetlands normally support denser vegetation than adjacent upland areas, they provide hiding and resting cover for many wildlife species that are not otherwise dependent on this type of habitat.

Large mammals, furbearers, and predators use riparian zones as travel corridors to and from summer and winter ranges and between feeding, resting, hiding, breeding, brooding, and rearing habitats. Riparian zones and wetlands are also used as stop-over areas by migrating songbirds.

Thermal Cover

The local climate of riparian zones and wetlands is strongly influenced by location, topography, presence of water, and the amount and diversity of vegetation. Extremes in climate are moderated by these factors. Vegetation that ameliorates temperature extremes is referred to as "thermal cover". These areas are often cooler in summer and warmer in winter. In many areas during winter, particularly in severe winters, riparian zones and wetlands may be the only areas where snow does not render the habitat unsuitable to large and medium-sized mammals and to some forest birds. In summer, when humidity is low and temperature very high, these areas provide a cooler, moister climate for wildlife than surrounding upland habitats. Large mammals such as Roosevelt elk and blacktailed deer use riparian zones to migrate seasonally between summer and winter habitats.

Management Considerations

The high value of riparian zones and wetlands must be considered when making management decisions that affect these habitats. The density and diversity of vegetation, combined with a variety of landforms, create edges and microclimates that provide an almost infinite number of habitat niches for wildlife. Heavy use of these habitats by wildlife illustrates their importance.

Riparian zones and wetlands are by nature especially susceptible to natural and man-caused disturbances. Riparian communities in particular, being long and narrow and having extensive interface with both aquatic and terrestrial systems, are highly vulnerable to impact from major upslope events. The cumulative effects of activities in tributary watersheds on riparian zones and wetlands located at lower elevations is an important management consideration.

Human activities are often concentrated in riparian zones and wetlands. Water bodies provide life necessities: hydropower, minerals, diverse and abundant biota, and productive floodplains for forestry and agriculture. In addition, larger rivers are transportation routes where recreation and lifestyle are enhanced by the plant diversity and proximity to water. People are attracted to riparian zones and wetlands for many of the same reasons as are wildlife. Competition between man and wildlife is intense for this limited area.

Forest managers and planners should recognize that riparian zones and wetlands are (1) vulnerable to severe alterations because of their relatively small size and location, and (2) sensitive due to their distinct vegetative communities and microclimates. Because of the interface between aquatic and terrestrial communities, managers should consider the impacts of activities that occur in riparian zones and wetlands to both on-site and downstream communities. For these reasons, riparian zones and wetlands along with their associated water bodies should be managed as one unit within a watershed. Fishery and wildlife biologists, hydrologists, and soil scientists should be consulted when management activities are planned that could affect these important habitats.

Natural Events

Riparian zones are geologically unstable environments, characterized by erosion and deposition (Leopold et al. 1964). Swanson (1980) reviewed the relationships among the ecological time scale, biota, and geomorphic processes. He found that vertical channel erosion lowers the water table, accelerates slope erosion, and may cause adjustment in the profile of the entire drainage network. Horizontal channel erosion (meanders), common on floodplains, undercuts riparian vegetation and erodes soil only to deposit it downstream. Deposition forms meadows, wetlands, and channel bars where plant succession commences again (Morisawa 1968). Smaller wetlands are often ephemeral habitats where a slight amount of either deposition or erosion may change their character. Natural disturbance can be reduced and recovery hastened through careful management (Cairns 1980). Some natural disturbance is desirable, however, and helps to create diversity and may aid in achieving management objectives.

Floods accelerate erosion and deposition, inundate streamside vegetation, and deform, kill, scar, or uproot riparian vegetation. Often, mass soil movements, debris torrents, and organic debris dams are associated with floods (Ketcheson and Froehlich 1978, Swanson and Lienkaemper 1978, Swanson et al. 1976, Swanston 1978 and 1980). These events destroy existing riparian vegetation, but can also form new riparian zones or wetlands as stream profiles are changed. Large organic debris, which develops naturally under old-growth forest conditions, is a major factor in controlling the biological and physical features of smaller forest streams (Bilby and Likens 1980, Bryant 1980, Heede 1972), and in providing an important habitat component in riparian areas (Franklin et al. 1981).

Other catastrophic events such as wildfire (Lyon et al. 1978) (fig. 8), windstorms (Ruth and Yoder 1953), or volcanic eruptions may damage the biota severely (Swanston 1980). The total

Figure 8.—Many riparian areas have been severely impacted by fires and subsequent salvage logging operations as shown by this 1967 photo.

destruction of riparian habitat by massive mud flows resulting from the eruption of Mount St. Helens in May, 1980, is illustrated by figure 9. These large scale natural catastrophies occur infrequently. Over time, affected areas recover as communities become re-established, but time becomes more important as competitive uses intensify the frequency or magnitude of disturbance.

Wildlife populations, if unregulated, can create significant impacts on localized areas of riparian and wetland habitat. High beaver populations increase the frequency of bank burrowing and dams, attendant sediment deposition, and consumption or destruction of riparian vegetation. Raising of the water table and flooding change habitats from lotic to lentic conditions (Gard 1961, Hair et al. 1979). Many of these newly formed lentic habitats are small wetlands. Downslope soil movement along heavily used game trails and overbrowsing by large wild ungulates can have effects in localized areas. Burrowing animals, such as mountain beaver, can alter natural soil-water movement patterns (Swanson 1980). Colony nesting birds sometimes cause excessive damage to vegetation (Carey and Sanderson 1981, Jackman 1974).

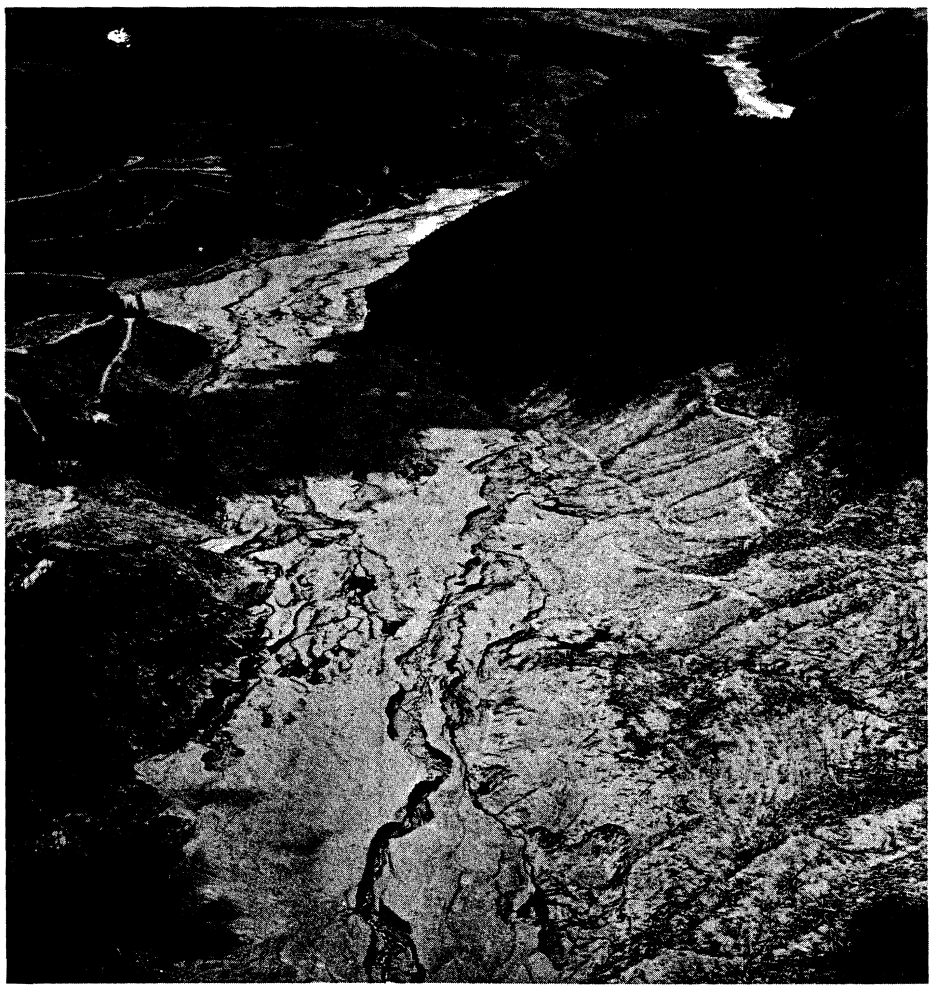


Figure 9.—Aerial view of the South Fork of the Toutle River, June 4, 1980, showing the complete inundation of the floodplain and riparian zone following the eruption of Mount St. Helens.

Timber Management

Complete removal of riparian vegetation (clearcutting to the water's edge) severely impacts not only the habitat of many riparian wildlife species but water quality and fish habitat as well (fig. 10). Oregon and Washington have adopted forest practice rules and regulations concerning the removal of streamside vegetation (State of Oregon 1980a, State of Washington 1982). Federal agencies with forest management responsibilities also have policies and guidelines governing timber harvest in riparian zones and wetlands (see chapter 10). Compliance with these regulations and guidelines, if properly applied, should provide significant protection for wildlife habitats in riparian zones and wetlands.

Maintaining vegetative buffers or leave strips is an important stream riparian management practice designed to protect water quality and fish and wildlife resources during logging operations (Erman et al. 1977, Federal Water Pollution Control Administration 1970, Franklin et al. 1981, Moring 1975, U.S. Environmental Protection Agency 1973 and 1976) (fig. 11). These buffer zones are not a panacea in all instances (Streetby 1971), and windthrow can be a problem (Franklin et al. 1981, Steinblums 1977). Well designed leave strips, however, have generally been successful in achieving management objectives for water quality and fish habitat and should be equally effective in wildlife habitat management. Effective leavestrip width and composition will vary with stream order, topography, vegetation, management objectives, and land use (Lantz 1971b, U.S. Environmental Protection Agency 1976). Lantz (1971a) discussed how leave strips eliminate or minimize three of the four major stream-habitat changes associated with logging, i.e., water temperature, sediments, and dissolved oxygen in surface and subgravel waters. A leave strip not only reduces impact on streams from upslope land use activities, but also maintains the diversity of the long, narrow riparian zone relatively intact.

If harvest of forest products in a riparian zone is planned, careful evaluation must be given to impacts on fish and wildlife habitat. Selective or shelterwood cutting will have less impact than clearcutting on canopy density and solar radiation, which in turn affects stream-water tem-

perature and microhabitat (Brown 1970, and 1974, Thomas et al. 1979a) (fig. 10). After on-site inspection and consultation with wildlife and fishery biologists and the establishment of management objectives, it may be possible to selectively harvest some trees from the riparian zone without creating undesirable changes in habitat conditions. Important factors to consider in this decision are that the narrower the riparian zone or the greater the number of trees harvested, the more susceptible the area becomes to loss of habitat function and productivity. Detailed recommendations, pictures, and guidelines for logging practices that limit direct and indirect impacts on riparian zones are included in several publications (Federal Water Pollution Control Administration, 1970, Lantz 1971b, Moring 1975).

Research concerning the effects of logging on stream flows has demonstrated that changes in annual stream flows are minimal in larger watersheds where timber harvesting is done in small, well-spaced clearcuts. In small headwater watersheds, however, studies have shown that road building, clearcutting, and other activities associated with timber harvesting may result in (1) significant increases in annual water yield and summer low flows, (2) increases in fall peak flows and small winter peak flows, and (3) increases in large, major winter peak flows if more than five percent of the watershed has been compacted (Harr 1976, Harr and Krygier 1972, Harr and McCorison 1979, Harr et al. 1979, Harris

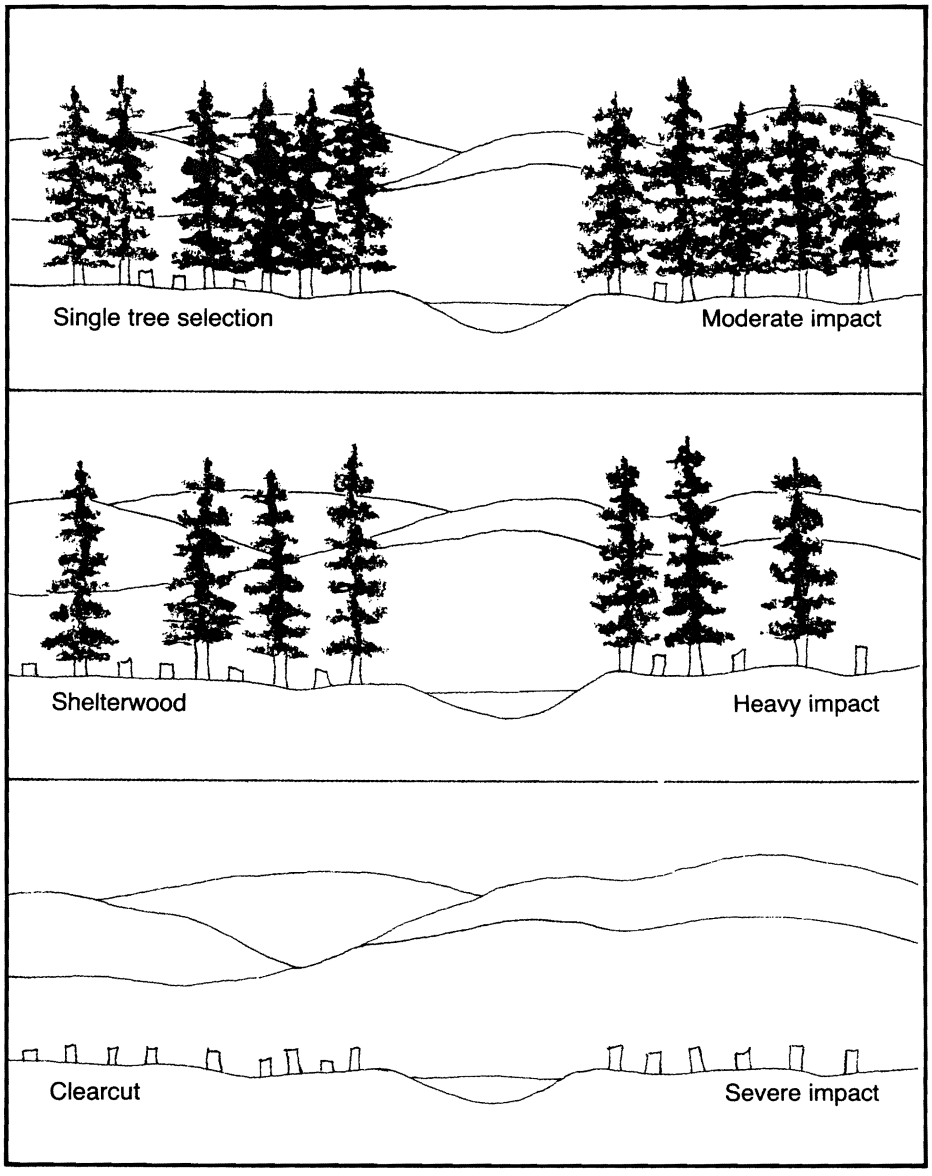


Figure 10.—Environmental impacts should be carefully evaluated when timber is cut in riparian zones.

1973, Rothacher 1970 and 1973). Variations do occur and much depends on the amount of watershed disturbed, the harvest system used and the time since the activities were conducted (Dyrness 1967, Harr 1980).

Figure 11.—Habitat diversity in riparian zones is maintained by leaving conifers as well as hardwoods in vegetative buffers adjacent to streams. These trees, when they die, may become snags providing habitat for cavity users (see chapter 7) or when they fall to the ground they provide habitat for many other species (see chapter 8) as well as providing structure in stream channels (see chapter 10).

Onsite damage to stream channels and adjacent riparian habitats in small watersheds can occur due to increases in peak winter flows after logging. Downstream impacts in streams of larger basins may be lessened by vegetative conditions in uncut areas. Except on highly disturbed and compacted areas, infiltration capacity and erodibility can return to prelogged conditions within three to six years (Johnson and Beschta 1980).

If wildlife habitat is to be protected, timber harvest should be carried out in a manner that will maintain normal water movement and minimize adverse impacts from floods on stream channels and riparian zones. Because clearcuts and road construction can greatly accelerate the natural rate of debris avalanches and debris torrents (Swanson and Lienkaemper 1978, Swanston 1980), practices to minimize these events should be encouraged in order to reduce undesirable alterations of established riparian communities (fig. 12).

Figure 12.—Debris torrents in stream channels carry tons of soil, rocks, boulders, and vegetative material downstream causing longlasting adverse impacts on the productivity of riparian and aquatic habitats.

To maintain desirable habitat conditions, natural, stable organic material in the form of large debris in stream channels and large down logs in riparian areas should be left undisturbed during logging operations (Franklin et al. 1981, Swanson et al. 1976) (fig. 13). It should be recognized, however, that forest residues remaining after timber harvest can exert both favorable and unfavorable influences on animal populations (Dimock 1974). If natural logs are scarce, some large and small down material resulting from logging operations should be left in the riparian zones. Because logging may add significantly to the total amount of debris (Froehlich 1971), the amount and location of logging debris left in riparian areas should be carefully determined to reduce the risk of subsequent large debris dams, debris avalanches or debris torrents. Large conifers retained in riparian zones would ensure a source of dead and down woody material for future habitat needs.

The type of yarding system chosen by forest managers can do much to minimize the impact of tree harvest on

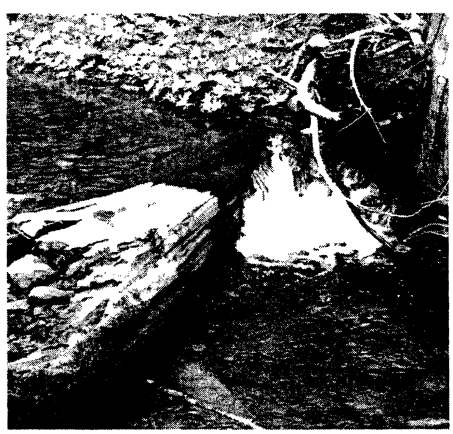


Figure 13.—Trees that fall across streams are used as bridges by many wildlife species until they decay and fall into the stream wnere they add structure to the stream channel.

riparian zones. Use of full cable suspension, ballooon, or helicopter transport removes trees with almost no disturbance of soil or vegetation (U.S. Environmental Protection Agency 1973 and 1976). Uphill felling reduces breakage and keeps felled trees out of the riparian area (Burwell 1971). Parallel felling can also be effective in preventing damage to riparian vegetation where steep side slopes occur. Natural amounts of small organic debris are essential to the aquatic food chain (Cummins 1974 and 1980) and large organic debris helps small stream channels dissipate energy and store sediments (Swanson and Lienkaemper 1978, Swanson et al. 1976). Excessive accumulations of small debris in streams, however, may deplete oxygen levels (Moring 1975).

Forest roads, if constructed near streams or across wetlands, reduce the productivity of riparian and wetland habitats for many wildlife species (fig. 14). Recommendations for the proper location of roads and landings, drainage structures, road surfaces, and road construction and maintenance are discussed by Greene (1950), Lantz (1971b), Larse (1971), U.S. Environmental Protection Agency (1975), and Yee and Roelofs (1980). In contrast to past practices, many new forest roads are being located away from riparian zones and along benches or ridgelines. In order to reduce soil movement on steep hillsides, instead of side-casting, excavated material is end-hauled by truck to stable waste areas.

Many streams are currently paralleled by roads. Managers should take this into consideration if a new streamside road is proposed. The amount of riparian habitat already seriously impacted should be determined and this information carefully weighed in making a final decision on the road location. More than any other management activity, road construction has the most critical and lasting impact on riparian zones (Thomas et al. 1979a).

Improperly located, constructed, or maintained roads may initiate or accelerate slope failure (Yee and Roelofs 1980) which in turn triggers debris torrents. Stream crossings should be at right angles to disturb the minimum amount of riparian vegetation. Bridges and culvert installations should be of the proper size and design to limit channel erosion and debris accumulations and provide unrestricted passage for migrating fish (see chapter 10).

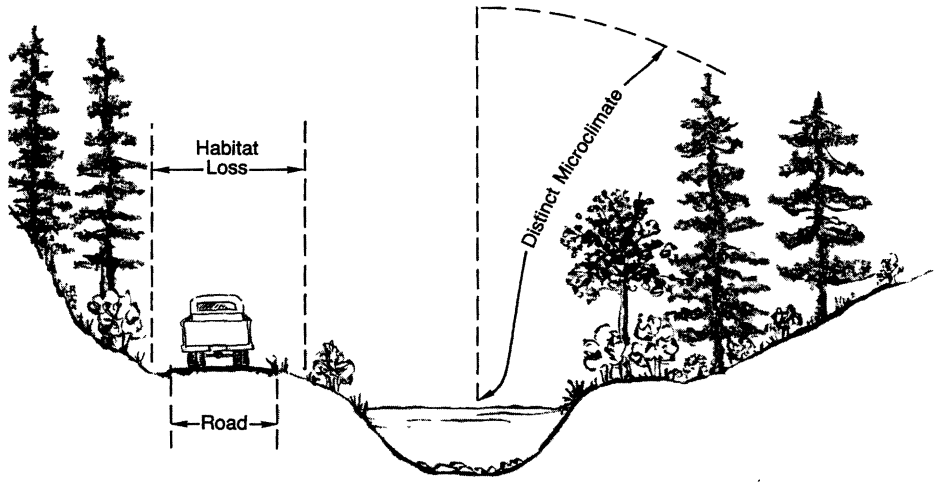


Figure 14.—Road construction in riparian zones reduces their productivity as wildlife habitat. Roads alter vegetative structure, change microclimate, reduce the size of riparian zones, impact water quality in the aquatic zone, eliminate habitat and result in disturbance of wildlife.

Common silvicultural applications of fertilizers and pesticides (herbicides, insecticides, and rodenticides) usually will not seriously impact riparian zones and wetlands if these areas are not treated, and accepted precautions are followed to prevent excessive drift into downslope areas (Miller and Fight 1979, USDA Forest Service 1974, U.S. Environmental Protection Agency 1973 and 1977). These precautions include no-treatment areas or buffers of sufficient width based on site-specific conditions, and restrictions on aerial applications to times when winds are less than five mph, etc. Healthy riparian communities help prevent adverse impacts on water quality by natural filtering of sediments containing pesticides before they reach the stream. Where steep slopes are highly dissected by stream channels, it may be difficult to keep aerial applications of herbicides out of riparian zones and streams. In such cases, the "no spray" alternative should be given serious consideration.

Livestock Grazing

Although livestock grazing in riparian zones and wetlands is not as widespread west of the Cascade Range as it is in the more arid eastside areas, effects can be significant in certain locations. Most livestock grazing on forested lands occurs in southwestern Oregon where weather is relatively hot and water is often in short supply during the summer months. The greatest likelihood for adverse impacts on riparian zones from livestock grazing are therefore in the interior parts of southwestern Oregon, high mountain meadows of the Cascade Range, and along valley bottom corridors of coastal streams.

If grazing by livestock on riparian zones and wetlands is heavy and continuous, the vegetation which provides essential habitat for wildlife can be reduced, changed, or eliminated (Kennedy 1977, Platts 1981, Storch 1979, Thomas et al. 1979b, U.S. Environmental Protection Agency 1979). Uncontrolled grazing of palatable plants often prevents reproduction of desired species and can eventually bring about a complete conversion of vegetative type. Existence of older shrubs and trees that provide required habitat structure for many species of wildlife may be eventually precluded by consumption and by trampling of seedlings (Dahlem 1979, Kennedy 1977).

In addition, heavy livestock use in riparian zones and wet meadows can result in undesirable changes in stream channel morphology, lowered water tables and eventual conversion to dry-site plant species and different types of habitat (Bowers et al. 1979, Platts 1981).

Generally, protection of riparian zones and wetlands can be enhanced by recognition of three basic realities:

1. The heavier the grazing use and longer the grazing period, the more severe the impacts will be on these habitats;
2. Physiological needs of shrubs and trees have not been a priority of past

grazing systems which considered primarily the production and maintenance of grasses and forbs to the exclusion of woody vegetation in riparian areas; and

3. Because of habitat requirements for dependent resources, multiple resource considerations, and high values, different grazing strategies should be applied to riparian zones and wetlands than to upland areas.

Because of the high degree of variability within riparian zones and wetlands, managers can make better decisions by using recommendations of an interdisciplinary team which has analyzed site-specific conditions.

To insure that riparian zones and wetlands remain in satisfactory condition for wildlife use, managers responsible for developing livestock grazing programs should take into consideration the following management principles (Bowers et al. 1979, Platts 1981, Storch 1979, Thomas et al. 1979b, U.S. Environmental Protection Agency 1979):

- If significant livestock use is contemplated, present and potential habitat conditions should be key considerations in determining the grazing management prescribed for specific areas. Where habitat is in unsatisfactory condition, grazing practices and systems that will achieve the desired habitat objectives should be implemented:
  - defer grazing in riparian zones until late fall months;
  - fence and apply rest rotation grazing systems;
  - improve off-stream distribution of livestock by providing alternate sources of water to attract animals away from riparian zones and wetlands;
  - provide salting away from riparian zones and wetlands;
  - utilize periodic herding; and
  - improve rangeland condition by revegetation, prescribed burning, etc.

- To obtain management objectives for important riparian zones and wetlands that have been severely impacted from past use, it may be necessary to allow complete rest from livestock grazing for several years by fencing, which appears to be the only present management technique capable of producing the desired results (U.S. Environmental Protection Agency 1979). It may be a permanent requirement to control livestock use in the most important wildlife habitats. However, permanent elimination of livestock grazing in most other areas may be neither feasible nor desirable, but grazing should be closely controlled to improve habitats in poor condition and to maintain healthy riparian habitats in productive conditions.

- To prevent undesirable alterations of the water source and to maintain wildlife habitats, exclude livestock from parts of wet meadows, springs, and seeps by fencing. Necessary water for livestock should then be piped outside the exclosure into a trough(s) (fig. 15).

- Artificial revegetation of riparian zones and wetlands may result in more rapid response than natural recovery, particularly with native shrubs and trees. Plantings must be protected from heavy grazing to achieve desired results.

- In the planning process, part of the vegetation in riparian zones and wetlands should be allocated to wildlife use at the same time forage is allocated for livestock use.

Mining Operations

Mining activities have frequently occurred in riparian and wetland habitats, resulting in substantial surface disturbance. Whenever a valuable mineral deposit is located, mining can preempt any other land use because of the Mining Law of 1872 – unless the land has been specifically withdrawn from mineral development. Because of this, other resource uses can be precluded by mining.

Gravel and sand mining from floodplains and stream channels has been common throughout forest lands of western Oregon and Washington because it is a convenient and relatively inexpensive source of construction material. Riparian zones adjacent to numerous streams have been greatly altered, first by removal of vegetation and then by taking gravel for construction of logging roads. This practice of mining sand and gravel from streambeds and streambanks has been greatly reduced in recent years by laws and regulations to protect water quality and aquatic habitats. Most rock for logging roads is now mined from quarries or open pit mines thus reducing adverse impacts to riparian zones.

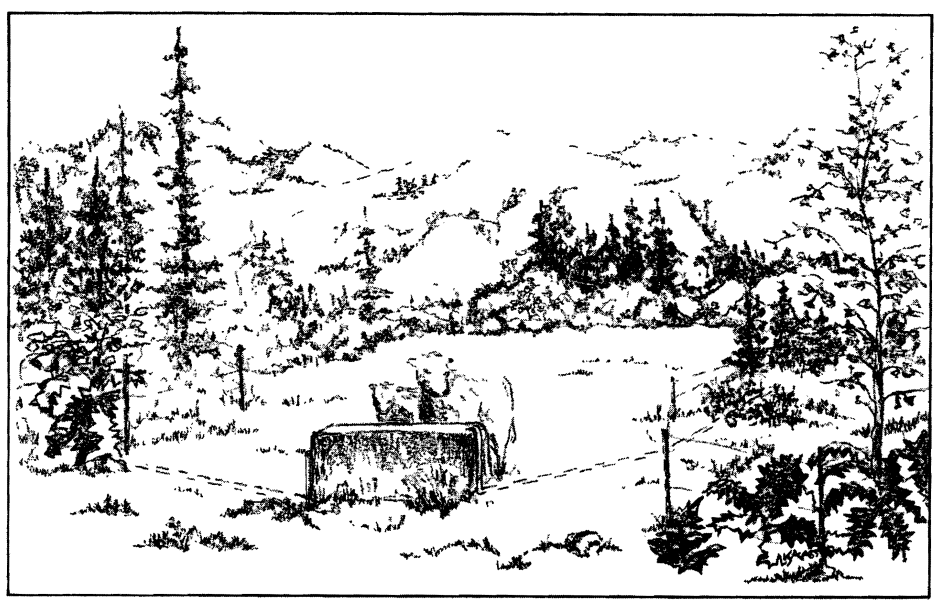


Figure 15.—Important wildlife habitat around springs can be maintained and/or enhanced by fencing small areas to exclude livestock. Water for livestock can be piped outside the exclosure into troughs. Additional wet meadow habitat can be created and maintained by piping overflow water into small fenced areas.

Gold mining by hydraulic (placer) methods has been common in parts of southwestern Oregon. Hydraulic mining for gold in streams and riparian areas can be particularly destructive inasmuch as this activity completely removes vegetation and subsequently creates unstable piles of larger rocks and rubble. Basic productivity of the site for vegetation and habitat quality is drastically reduced.

Protective stipulations and rehabilitation measures should be included in mining plans to minimize impacts on riparian zones and wetlands and to assist in recovery of satisfactory habitat conditions. Access roads should be located outside riparian zones and wetlands. Vegetation removal and surface disturbances should be minimized. Vegetation should be re-established in disturbed areas as soon as mining operations are terminated.

Recreation Management

Construction of recreational facilities in riparian zones increases recreational use which increases the potential for conflicts with wildlife (Thomas et al. 1979a). The impact on wildlife and riparian zones and wetlands depends on the season, type, duration, and magnitude of use. Habitats can be adversely affected by destructive acts, and human disturbance in areas around recreational developments is a major consideration. Campgrounds, picnic tables, and trails should be located outside riparian zones whenever possible.

Recreational facilities should not be located in areas such as heron rookeries, bald eagle nest sites, or important wintering areas for big game. Detailed guidelines for protecting bald eagles are given in chapter 13. Off-road vehicle use in riparian zones and wetlands should be prohibited or closely controlled to prevent undesirable damage to these sensitive habitats.

Energy Development

The construction of dams to generate electricity results in the elimination of existing riparian and wetland habitats located in floodplains inundated by the backwaters of the dam. For many wildlife species, natural migration routes may be disrupted by these backwaters. Vegetation in downstream riparian zones and the natural erosion/deposition process can also be altered if natural stream discharge patterns are changed significantly by the operation of hydroelectric facilities. Some tree species are more tolerant to flooding and saturated soil conditions, while other species are more resistant to drought (Minore and Smith 1971, Walters et al. 1980).

The impact of each dam depends on the amount of habitat lost in relation to the total available local habitat. Compensation by development of like habitat in another location is often not feasible. Other factors being equal, low-head hydrologic projects should be located where they will result in the smallest loss of riparian and wetland vegetation. If more than one such project is located or proposed for an area, the cumulative effects of all the projects should be assessed.

Other large energy developments like geothermal and fossil fuel (coal) plants, or oil and gas production fields have not been major energy producers in past years. Impacts of any such future large-scale, developments on riparian zones and wetlands would have to be analyzed on a site-by-site basis. Impacts and mitigation, however, would be similar to some of the management activities previously discussed in this section.

Wood Fuels

Standing dead trees (snags) and down (windthrown) trees in riparian zones provide important habitats for many wildlife species (see chapters 7 and 8). Large old-growth boles create the habitat diversity characteristics of old-growth forest (Franklin et al. 1981). Optimum wildlife habitat conditions cannot be achieved in riparian zones if many snags and down dead trees are removed for firewood or as marketed forest residue (salvage material) for fuel to produce heat, steam or other products.

Rehabilitation and Enhancement

When riparian zones and wetlands are in satisfactory condition for wildlife, the best management generally is to allow the natural ecosystems to function with minimal disruption. This approach is usually the least costly and most effective way to manage for all native wildlife populations. Simply stated, it means protection from major disturbances caused by man.

Rehabilitation of altered habitats can be hastened by various techniques which promote natural recovery to desired conditions and prevent further deterioration. Some of these methods are listed in habitat improvement handbooks (Nelson et al. 1978, USDA Forest Service 1969). Recommended grasses, shrubs and trees to use for revegetating riparian zones and wetlands in western Oregon are listed in an interagency seeding guide (State of Oregon 1980b).

Enhancement of habitat can often be accomplished by creating more diversity, but a thorough field evaluation should precede any plans to enhance riparian and wetland habitats. Projects should be designed to achieve specific habitat objectives developed for that area. Examples of enhancement projects in riparian zones and wetlands are (1) vegetative plantings of native or preferred wildlife food species, (2) construction of nesting islands or installation of nest boxes, and (3) vegetation manipulation.

Summary

Riparian and wetland habitats are among the most important for wildlife in managed forests, with the riparian zones particularly significant for forest wildlife. Forest managers are only just beginning to recognize the importance of these habitats in providing a variety of wildlife populations for people to enjoy. Riparian zones and wetlands, however, have high potential for resource management conflicts among commodity producers. Managers, with the advice of resource specialists,should seek creative ways to manage these habitats or maintain and improve their productivity. This will be an interesting and important challenge. It is one which will require considerable effort if satisfactory management plans are to be developed and implemented successfully.

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