Ecology and Plant Communities of the Riparian Area Associated with Catherine Creek in Northeastern Oregon

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J. Boone Kauffman, W. C. Krueger, and M. Vavra

ABSTRACT

A multitude of biotic and physical factors, many of them unique to riparian environments, interacted to form an extremely complex ecosystem along Catherine Creek in the Wallowa Mountains. A total of 258 stands of vegetation representing 60 communities was identified. At least 20 species of mammals and 81 species of birds utilize the area from May through October.

The factors believed to be responsible for much of the diversity of riparian communities include soil characteristics, streamflow dynamics, climate, plant community interactions, animal effects, and man's effects. Analysis of the nine most common community types in the study area indicated their composition and structure were significantly affected by these factors.

Riparian zones are associated with streams, lakes, and wet areas, where vegetation communities are predominantly influenced by their association with water (Carter 1978). This "association," particularly with lotic systems, is not only responsible for increased water availability but also for soil deposition, unique microclimate, increased productivity, and the many consequential, self-perpetuating biotic factors associated with riparian zones. Therefore, along streambanks such as Catherine Creek, riparian ecosystems can be defined as assemblages of plant, animal, and aquatic communities whose presence can be either directly or indirectly attributed to stream-related factors (Kauffman 1982).

Riparian zones are recognized as among the most biologically diverse and most productive of all ecosystems in North America (Johnson et al. 1977, Odum 1978, Thomas et al. 1979). Vegetation along streams provides the detrital substrate upon which much of the instream system is based; it cycles nutrients, modifies the aquatic environment (Campbell and Franklin 1979), and strongly influences the quality of habitat for anadromous and resident cold water fish populations (Duff in press, Marcuson 1977, Meehan et al. 1977). In many regions, the riparian/stream ecosystem is recognized as the most productive type of terrestrial wildlife habitat (Ames 1977, Hubbard 1977, Miller 1951, Patton 1977, Winegar 1977). Riparian zones are also very important as a forage and water supply for livestock (Reid and Pickford 1946, Roath and Krueger 1981).

Because of the many values and uses of riparian ecosystems, a thorough synecological understanding of these systems is desirable for land management decisions. The objectives of this research were to describe, both in a qualitative and quantitative manner, the riparian ecosystem associated with a portion of Catherine Creek and to determine factors important in development, structure, and composition of riparian communities.

Description of Study Area

The study area, located on the Eastern Oregon Agricultural Research Center in the southwestern foothills of the Wallowa Mountains in northeast Oregon, was confined to a 50-meter by 3-kilometer strip of riparian vegetation. Approximately one-half of the area had been excluded from grazing since 1978 by the construction of five exclosures. Uplands were dominated by mixed conifer and ponderosa pine (*Pinus ponderosa*) communities.

Summers are typically warm and dry with temperatures rarely exceeding 38°C. Freezing or near-freezing temperatures are possible every month, however. The majority of precipitation occurs as snow from November to May. Mean precipitation for the study area is 600 millimeters.

Catherine Creek is a major tributary of the Grande Ronde River. Average discharge is 119 cfs (3.4 m^3/sec) (USGS 1981), with peak annual flows in late April, May, and early June. During the spring runoff period, discharges of more than 500 cfs (14.2 m^3/sec) are not uncommon.

Methods and Procedures

In this report, **plant communities** are defined as all vegetation stands that contain the same distinct assemblage of plant species. **Vegetation types** are groups of plant communities with similar ecological and taxonomic characteristics. **Life forms** are broad groupings of plant communities and vegetation types referring to the general appearance or physiognomy of the area. For example, a *Poa pratensis/Achillea millefolium* community would be in the *Poa pratensis* vegetation type and in the meadow communities life form.

Initial mapping of plant communities was accomplished by ocular reconnaissance. This entailed use of low-level aerial photographs, general physical descriptions of each vegetation stand, and development of an ocular prominence rating (Kauffman 1982) to identify the species composition of each stand. Once ocular reconnaissance was completed, frequency data were accumulated for all plant species in the more common and recurring communities of the study area. A 0.25-square-meter quadrat was used for frequency readings. A one-sixteenth square-meter nested plot was used to determine a more precise composition of the dominant plants that normally would have a frequency of 100 percent in the larger plot. Thirty frequency plots per stand were measured every one-half meter along a randomly established transect through each stand. Six to eighteen stands of each community type were measured.

Annual above-ground production of the field and shrub layers (standing phytomass) was collected by use of a 0.25-square-meter quadrat. Six stands of each community were measured by clipping 10 plots along a randomly established transect in each stand. All forbs and grasses that had their stembase within the plot were clipped at ground level. Current year's growth of woody vegetation was measured by clipping an estimated fraction of the plant and correcting the partial sample. Vegetation was measured during late July and early August, the time of maximum standing phytomass.

Shrub density (stems/m^2), height, and composition were measured with 10 one-square-meter plots that were permanently established in 30 vegetation stands. Density and height measurements were recorded for all shrub species with a stembase occurring totally within the plot.

Plant species diversity, equitability, and species richness were generated from frequency data which, when sampled within discrete community boundaries, are a valid index of species abundance. The Shannon-Weaver formula was used to calculate diversity (H'), where $H' = -\Sigma pi \log_e pi$. Here, pi is the frequency of the ith species ($i = 1, 2, \ldots, S$), and species richness (S) is the number of species found in the particular plant community (Shannon 1948). Equitability is expressed as $J' = H'/H'$ max, where H' max is calculated as $\log_e S$.

Ten auger samples and one soil pit were used to obtain a qualitative description of soils in all communities. Profile descriptions include soil surface characteristics, depth and structure of each horizon, presence of gleyed horizons, depth to water tables, depth to root-restrictive layers, and notes on general solum characteristics important in plant community development (U.S. Soil Conservation Service 1975).

Avian communities and small mammal communities were estimated in the three most dominant vegetation types occurring in the riparian zone. These included:

- *Poa pratensis*/mixed forb community type;
- *Crataegus douglasii* community type, and
- *Populus trichocarpa*/mixed conifer community type.

Avian communities were censused by the fixed circular plot technique (Anderson 1970). Size of the plots was determined by the maximum horizontal distance possible for detection of birds.

Avian communities were censused in late spring (May 1980), early summer (June 1979), late summer (August 1978, 1979), and early autumn (September-October 1978, 1979), using a total of eight stations per community type. Each station was sampled five times during a census period for a total of 40 observations per community type per census period. The Shannon-Weaver formula was used to calculate diversity and equitability of bird species.

Communities of small mammals were sampled by setting a certain number of kill traps during several trapping periods (Zippin 1958). Fifty museum special traps, unbaited, were placed in a 25 × 50 meter grid for three nights. Each community type was sampled during late summer (August 1979) and early autumn (September 1978, 1979). The *Poa pratensis*/mixed forb community type also was sampled during early summer (June 1979). The Zippin (1958) technique was used to obtain density estimates. Relative abundance of a particular species is expressed as the percent of total captured population.

Descriptive Ecology of Catherine Creek

Several biotic, environmental, and other abiotic factors interacting in the riparian environment have created an extremely diverse ecosystem in the area (Fig. 1). For example, more than 265 plant species were found in the riparian zone. Wildlife species diversity, like plant species diversity, was very rich. At least 20 species of mammals utilized the riparian area during the first 3 years of the study. Eighty-one species of birds were sighted in the area from May through October. Thus far, 34 species are known to use the area as nesting/brood habitat.

The high diversity of wildlife can be attributed partially to the area's high diversity in community and structure. Within the study area, there were 258 stands of vegetation representing 60 plant communities. Community interspersion created a significant amount of edge, particularly in areas with a mosaic of tree, shrub, and meadow community types. This combination was further enhanced by the presence of aquatic systems, such as seeps and wet meadows with standing water, in addition to the stream ecosystem.

There were extreme spatial differences in community types along the area, frequently accompanied by extreme temporal differences. Through a single season, several communities, each with its own unique structure, may exist on one area.

For example, an area could be classified as a *Poa pratensis/Ranunculus acris*/mixed forb community in early spring, a *Veratrum californicum/Poa pratensis/Phleum pratense* community during midsummer, and a

Figure 1. Example of community diversity in the Catherine Creek riparian zone. There are at least six plant communities and eight vegetation stands in this photo. The high level of community and structural diversity creates habitat for a variety of wildlife species and livestock.

Poa pratensis/Phleum pratense/mixed forb community by early autumn. Analysis of the same area throughout the year indicated significant differences in species composition, species diversity, and standing biomass.

Soil Characteristics

Soils on the area varied from well-drained loamy soils more than 100 centimeters deep to unconsolidated sands, gravels, and cobbles. Physical properties of soils that were important to community development included soil texture, structure, depth to root-restrictive layer, infiltration-percolation characteristics, and aerated horizons. Also, soil characteristics interacted with physical properties such as microrelief and depth to the water table in the formation of vegetation communities. For example, hydric plants that occurred in lower areas were replaced by mesic plants, accompanied by only minute upward changes in relief. An increased depth to the water table and a change to coarser soil particles generally occurred with these changes in microrelief.

Presence of an aerated horizon was an apparent factor in community development. Aerated horizons consisting of coarse sands to cobbles apparently were necessary for black cottonwood (*Populus trichocarpa*) and ponderosa pine communities to develop (Anderson, pers. comm. 1980).

Ponded soils, containing finer textured A horizons underlain by a coarse-textured IIC horizon that formed a layer restrictive to water percolation, were correlated to sedge or wet-moist meadow communities. Well-drained, shallow soils usually were correlated with shrub-dominated communities.

Plant Interactions

Floristic effects in altering the microclimate and physical characteristics of an area were important in community development. Competitive interactions among plants, shading effects on understory layers, and habitat modification by plants were evident.

Shading played an important role in determining species composition and plant morphology of understory layers. For example, in Douglas hawthorn (*Crataegus douglasii*) communities, species richness of forbs was much greater in shrub understories than in the intershrub spaces. The understory contained more mesic plant species than the intershrub areas. Conversely, there was less standing phytomass, particularly that of Kentucky bluegrass, in the hawthorn understory.

Kentucky bluegrass morphology was altered greatly in tree- and shrub-dominated communities. In meadow communities, tillering and subsequent percent cover and standing biomass were greater than in forested communities. Kentucky bluegrass density was less and leaf length was greater in forested communities than in meadow communities. Similar differences in morphology were observed for many other plant species.

Selected list of plants in Catherine Creek area

Scientific name	Common name
Abies grandis	grand fir
Achillea millefollium	western yarrow
Agropyron repens	quackgrass
Agrostis alba	redtop
Alnus incana	thinleaf alder
Arenaria macrophylla	sandwort
Arnica chamissonis	leafy arnica
Aster foliaceus	leafy bract aster
Betula occidentalis	water birch
Bromus racemosus	bald brome
Bromus tectorum	cheatgrass
Carex spp.	sedges
Carex aquatilis	water sedge
Carex athostachya	slender-beaked sedge
Carex comosa	bristly sedge
Carex microptera	small-winged sedge

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Selected list of plants in Catherine Creek area (cont.)

Scientific name	Common name
Carex rostrata	awl-fruited sedge
Carex stipata	sawbeak sedge
Cerastium viscosum	chickweed
Collomia spp.	collomias
Crataegus douglasii	Douglas hawthorn
Deschampia caespitosa	tufted hairgrass
Dipsacus sylvestris	common teasel
Elymus glaucus	blue wildrye
Epilobium paniculatum	autumn willowweed
Erodium cicutarium	stork's bill
Fragaria virginiana	blueleaf strawberry
Galium asperrimum	rough bedstraw
Geum macrophyllum	largeleaf avens
Glyceria spp.	mannagrass
Glyceria elata	tall mannagrass
Heracleum lanatum	cow parsnip
Hordeum pusillum	little barley
Juncus balticus	Baltic rush
Lupinus leucophyllus	velvet lupine
Medicago lupulina	black medic
Microsteris gracilis	microsteris
Montia perfoliata	miner's lettuce
Osmorhiza chilensis	wild sweet anise
Phleum pratense	timothy
Pinus ponderosa	ponderosa pine
Poa spp.	bluegrasses
Poa pratensis	Kentucky bluegrass
Poa sandbergii	Sandberg bluegrass
Polygonum douglasii	Douglas knotweed
Populus trichocarpa	black cottonwood
Potentilla gracilis	northwest cinquefoil
Prunella vulgaris	selfheal
Prunus virginiana	common chokeweed
Ranunculus acris	tall buttercup
Rosa woodsii	Woods rose
Salix spp.	willows
Salix rigida	Mackenzie willow
Scirpus microcarpus	panicled bullrush
Senecio pseudaureus	streambank butterweed
Symphoricarpos albus	snowberry
Taraxacum officinale	common dandelion
Trifolium repens	white clover
Urtica gracilis	northwest nettle
Veratrum californicum	California false hellebore
Verbascum thapsus	mullein
Vicia americana	American vetch
Viola adunca	hook violet

Animal Effects on Community Development and Composition

The faunal inhabitants of the riparian ecosystem play a significant role in the ecological processes of the area. Animals (including small mammals, cattle [*Bos taurus*], and big game) and birds played a role in community development. Insects, particularly grasshoppers (*Arphia* and *Trimerotropis* spp.), occurred in high densities each year of the study. Undoubtedly these insects influenced plant composition and physiology, but these effects were not measured.

The beaver (*Castor canadensis*) played an important role in the riparian ecosystem (Fig. 2). In places, beavers have removed young black cottonwood communities (dbh <15 cm) almost completely. Beavers have altered the riparian ecosystem by removing or thinning the overstory, causing changes in community composition and structure. The potential effect of cottonwood removal on the environment included a loss in wildlife habitat, a decrease in shade cover over the creek, a short-term increase but long-term decrease in the detritus input, alterations in runoff and streamflow dynamics, and changes in bank physiognomy.

The burrowing action of rodents, especially the Columbian ground squirrel (*Cittelus columbianus*) and the northern pocket gopher (*Thomomys talpoides*), had an effect on community composition and succession (Fig. 3). In dry meadows with deep, well-drained soils, up to 40 percent of the surface area was disturbed lightly during the early part of the growing season. The disturbed areas created germination sites for several pioneer species of forbs and annual grasses, many of which are found exclusively on these areas (e.g., *Nemophila* spp.). Although this process increased the species diversity and richness of the community, it also permitted invasion of undesirable species such as cheatgrass (*Bromus tectorum*).

Cattle grazing along Catherine Creek had a significant impact on structure, composition, and standing biomass in some communities (Kauffman et al. 1983a, Kauffman 1982), as well as a significant increase in streambank sloughoff (Kauffman et al. 1983b). The impacts of livestock on the riparian/stream ecosystem included forage removal, trampling, and physical damage of vegetation.

Effects of grazing on plant communities were neither constant nor uniform (Figs. 4 and 5). Grazing enhanced species richness in many communities, but it halted or slowed natural succession in others, particularly gravel bars dominated by willows (*Salix* spp.) and moist meadows. Grazing created a drier environment in some communities, decreasing the abundance of mesic plants and increasing those species more naturally suited to drier environments (Kauffman et al. 1983a).

Figure 2. Beaver activity in a thinleaf alder (*Alnus incana*) community. Removal of alders by beaver caused a decrease in structural diversity and in stream shading. The basal sprouting shown here and the increases in standing phytomass of the grass and forb layers created a forage source for big game and livestock.

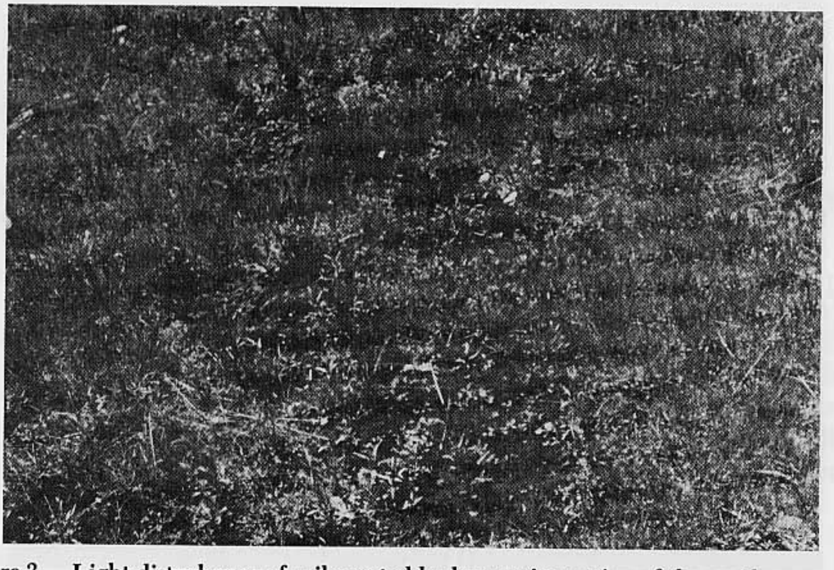

Figure 3. Light disturbance of soil created by burrowing action of the northern pocket gopher in a Kentucky bluegrass (*Poa pratensis*) stand. Note the abundance of forb seedlings in disturbed areas. This greatly increased species diversity but also caused a decrease in forage grasses such as Kentucky bluegrass.

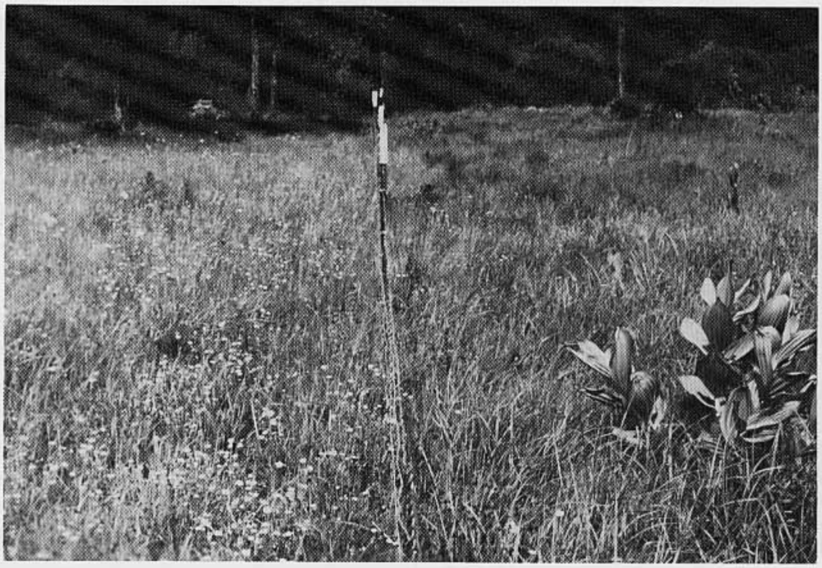

Figure 4. Fenceline contrast of a moist meadow. The area on the right has not been grazed in 3 years; the area on the left is utilized 60 to 70 percent annually in late August and early September. Note the change in seasonal phenology in the ungrazed area, as well as the decrease of forbs and increase in sedges.

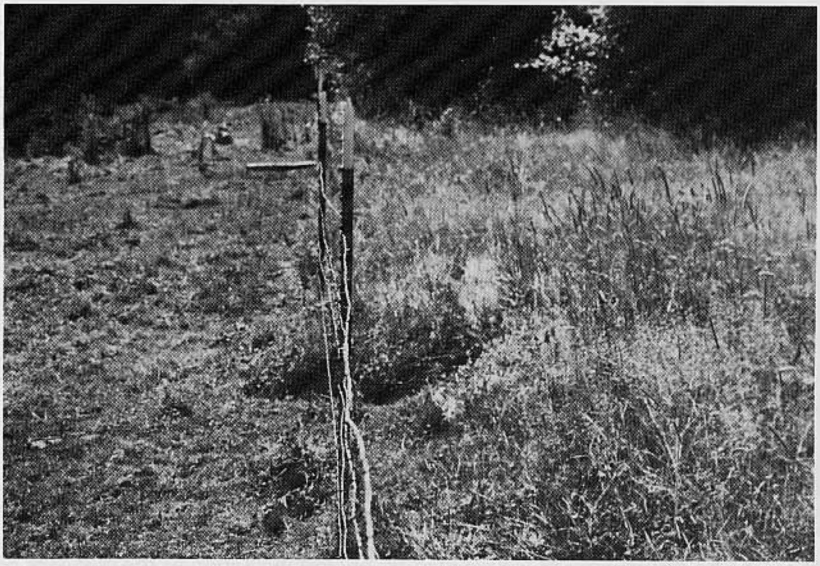

Figure 5. Utilization contrasts along a fenceline. The moist meadow (left) has been 75 percent utilized, mostly by cattle. Area on right side of fence was utilized 15 percent, primarily by insects, big game, and small mammals.

Stream Effects on Synecology of Area

Catherine Creek deposited much of the substrate in which soil development has occurred within the riparian zone. Water availability and water table depths often were related to streamflow dynamics. In addition, the creek was a primary mechanism for transporting germplasm, the material responsible for the formation or creation of many streamside communities.

The creek plays a role in development of riparian communities, but it also plays a role in their destruction (Fig. 6). Because of channel

Figure 6. Results of a stream channel changing course. This stream now flows through an area once occupied by a mature thinleaf alder (*Alnus incana*) community.

changes or natural geologic erosion of streambanks, areas once occupied by mature plant communities were washed out and then reclaimed, leaving the old channel composed of unconsolidated materials on which the process of primary succession can start (Fig. 7). Other stream effects on the riparian/stream ecosystem included scouring of streambanks by ice floes, high water, or large debris (logs or stumps). Scars resulting from high streamflow were evident on many woody species bordering the channel.

Man's Influence on Riparian Ecosystem

Influences of man on the area can be witnessed in many places along the creek. Logging, old irrigation ditches and ditch spoils, and brush clearing are examples of man's historical impact on the area.

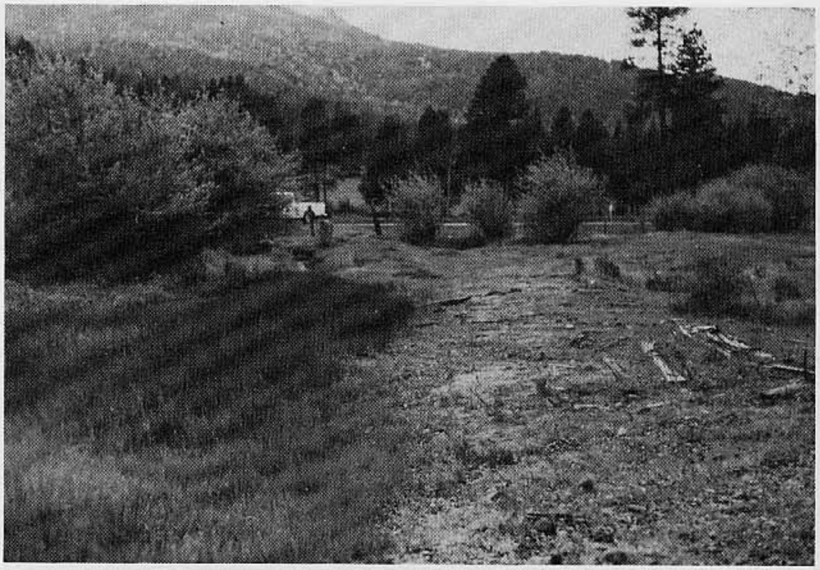

Figure 7. Old irrigation ditch, built around the turn of the century, in the study area. The old ditch (left center) now is composed primarily of Baltic rush (*Juncus balticus*), Kentucky bluegrass (*Poa pratensis*), and sedges (*Carex* spp.). The piles created by ditch spoils (right center) are composed of loosely consolidated rocks, cheatgrass (*Bromus tectorum*), and annual forbs.

Man's influences on the riparian ecosystem probably began in the 1890s, when irrigation ditches were dug through the study area. Most of the large conifers in the riparian zone were logged off before 1930 (Hug 1961). The study area was cleared of brush periodically through the 1950s as a method of increasing forage for livestock. Human activities currently affecting the study area include road construction and cattle grazing in the riparian zone plus upstream land use practices (logging, irrigation, road construction).

Descriptions of Major Community Types

Sixty discrete plant communities and 14 community types were identified on the study area (Table 1). The following major community types were sampled intensively:

- Gravel bar/*Salix* spp./mixed forb community type;
- *Alnus incana* community type;
- *Populus trichocarpa*/mixed conifer community type;
- *Poa pratensis*/mixed forb community type (dry meadow);
- *Poa pratensis/Phleum pratense*/mixed grass community type (moist meadow);

- *Crataegus douglasii* community type;
- *Pinus ponderosa* community type;
- *Symphoricarpos albus/Rosa woodsii* community type; and
- *Bromus tectorum* community type.

Gravel Bar/*Salix* spp./Mixed Forb Community Type

Gravel bar communities, usually dominated by at least one species of the Salicaceae family, were located along the stream channel or on small islands in areas that were formerly part of the old stream channel. Soils were composed of unconsolidated alluvium, ranging from finer textured to stone-sized materials. These communities usually were inundated during spring runoff. Species richness on gravel bars was high, with 98 species of plants identified. More than 40 of the plant species collected on gravel bars occurred almost exclusively on these areas. Species diversity indices for areas sampled were 3.2 to 3.5, the highest of any community sampled.

The gravel bars sampled were dominated by black cottonwood (*Populus trichocarpa*), Mackenzie willow (*Salix rigida*), bluegrasses (*Poa* spp.), sedges (*Carex* spp.), white clover (*Trifolium repens)*, mullein (*Verbascum thapsus*), and many species of shrubs, grasses, grasslike plants, and forbs (Figs. 8 and 9). Standing phytomass on gravel bars ranged from 1,400 to 2,800 kg/ha.

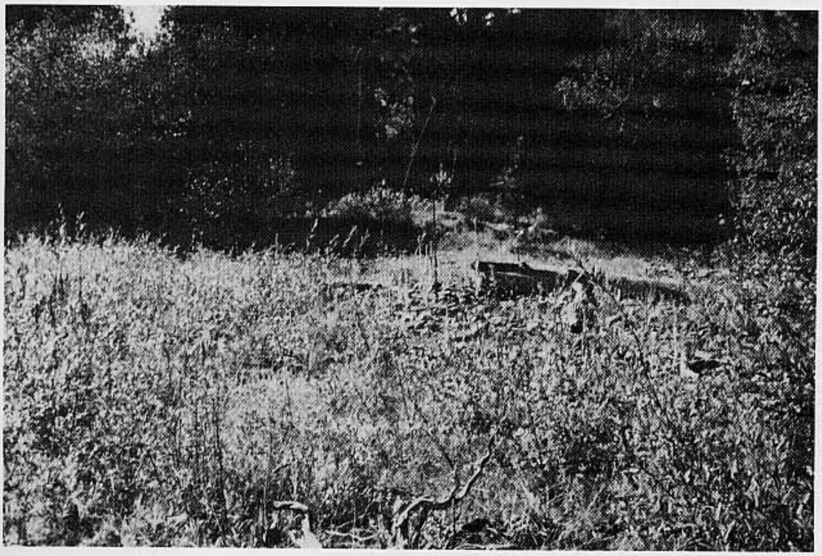

Figure 8. Gravel bar community composed of black cottonwood (*Populus trichocarpa*) saplings, Mackenzie willows (*Salix rigida*), forbs, and grasses. Photo was taken from the streambank.

Table 1. Partial listing of community life forms, community types, and plant communities identified in the Catherine Creek riparian ecosystem

Meadow communities

Poa pratensis/mixed forb community type (dry meadows)
- *Poa pratensis/Achillea millefollium*
- *Poa pratensis/Agropyron repens*
- *Poa pratensis/Agrostis alba*
- *Poa pratensis/Bromus racemosus*
- *Poa pratensis/Bromus tectorum*/mixed forbs
- *Poa pratensis/Lupinus leucophyllus*

Bromus tectorum community type (disturbed meadows)
- *Bromus tectorum*/mixed forbs
- *Bromus tectorum/Bromus racemosus*
- *Bromus tectorum/Poa sandbergii*
- *Verbascum thapsus/Bromus tectorum*

Poa pratensis/Phleum pratense/mixed grasslike plant community type (moist meadows)
- *Poa pratensis/Juncus balticus*
- *Poa pratensis/Phleum pratense*/mixed grasslike plants and forbs
- *Carex aquatilis/Phleum pratense/Poa pratensis* *
- Mixed *Carex* spp./*Phleum pratense/Poa pratensis*

Carex spp. community type (wet meadows)
- *Carex aquatilis/Scirpus microcarpus*
- *Carex aquatilis/Carex stipata/Poa pratensis* *
- *Carex rostrata*
- Mixed *Carex* spp./*Juncus balticus*
- Mixed *Carex* spp./*Agrostis alba*/mixed forbs

Forb-dominated community type
- *Arnica chamissonis/Poa pratensis/Juncus balticus* *
- *Ranunculus acris/Poa pratensis/Agrostis alba*
- *Veratrum californicum/Poa pratensis*/mixed grasslike plants

Other herbaceous community types
- *Bromus racemosus*/mixed forbs
- *Glyceria elata/Juncus balticus*

Low-shrub communities

Symphoricarpos albus/Rosa woodsii community type
- *Symphoricarpos albus/Bromus tectorum*
- *Symphoricarpos albus/Geum macrophyllum/Poa pratensis* *
- *Symphoricarpos albus/Poa pratensis*
- *Symphoricarpos albus/Rosa woodsii*
- *Symphoricarpos albus/Dipsacus sylvestris/Poa pratensis*
- *Rosa woodsii/Poa pratensis*/mixed forbs

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Table 1. Partial listing of community life forms, community types, and plant communities identified in the Catherine Creek riparian ecosystem (cont.)

Tall-shrub-dominated communities

Alnus incana community type
- *Alnus incana/Crataegus douglasii/Poa pratensis*
- *Alnus incana*/mixed grasslike plants and forbs
- *Alnus incana/Poa pratensis*
- *Alnus incana/Populus trichocarpa*
- *Alnus incana/Symphoricarpos albus*
- *Alnus incana/Scirpus microcarpus*

Crataegus douglasii community type
- *Crataegus douglasii/Poa pratensis*/mixed forbs
- *Crataegus douglasii/Prunus virginiana/Poa pratensis*/mixed forbs
- *Crataegus douglasii/Veratrum californicum/Poa pratensis*

Tree-dominated communities

Abies grandis community type
- *Abies grandis/Bromus tectorum*

Pinus ponderosa community type
- *Pinus ponderosa/Alnus incana/Poa pratensis*/mixed grasslike plants/forbs
- *Pinus ponderosa/Bromus tectorum*
- *Pinus ponderosa/Crataegus douglasii/Poa pratensis*/mixed forbs
- *Pinus ponderosa/Hordeum pusillum*
- *Pinus ponderosa/Poa pratensis*
- *Pinus ponderosa/Rosa woodsii*
- *Pinus ponderosa/Symphoricarpos albus*

Populus trichocarpa/mixed conifer community type
- *Populus trichocarpa/Alnus incana*
- *Populus trichocarpa/Alnus incana/Crataegus douglasii/Rosa woodsii*
- *Populus trichocarpa*/mixed conifer
- *Populus trichocarpa/Pinus ponderosa*
- *Populus trichocarpa/Poa pratensis*
- *Populus trichocarpa/Symphoricarpos albus/Rosa woodsii*

Gravel bar communities (Bryophytes/mixed grasses/mixed forbs)

Salix spp. community type
- *Populus trichocarpa*/mixed grasses/mixed forbs
- *Salix rigida*/mixed grasses/mixed forbs
- Mixed *Salix* spp./mixed grasses/mixed forbs

Disturbed communities (old brush piles, landfills, mechanically damaged areas)

Symphoricarpos albus/Urtica gracilis/Bromus tectorum
- *Bromus tectorum*

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* Present in the study area but outside of the 50-meter boundary.

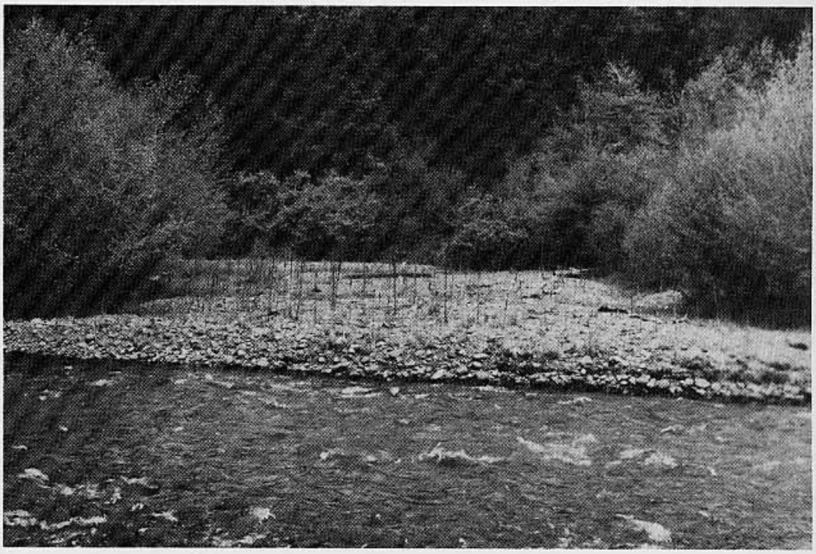

Figure 9. Ecologically young gravel bar stand composed of mullein (*Verbascum thapsus*), forbs, and black cottonwood (*Populus trichocarpa*) saplings. Catherine Creek, a primary mechanism for transporting germplasm, has deposited most of the pioneer species that occur on this site.

Shrub density can be very high. Mean shrub density for stands sampled was 28.8 stems per square meter (288,000/ha), with black cottonwood densities ranging from 14 to 23 stems per square meter (140,000-230,000/ha) and density of willow species ranging from 1 to 4 stems per square meter (10,000-40,000/ha).

Alnus incana Community Type

Thinleaf alder/Kentucky bluegrass/mixed forb communities generally were parallel to the creek, bordering the stream channel, or in areas of high water tables (Fig. 10). Usually there was standing water in the alder community during spring runoff.

Soils were shallow and rocky with a water table depth of less than 50 cm, usually around 18 cm in late May. General profile descriptions include a shallow A horizon (0-18 cm) that was loamy in texture and high in organic matter. The A horizon usually was underlain by a IIC horizon consisting of unconsolidated sands and cobbles.

Quite often, there were several distinct understory communities under one contiguous stand of alders. In general, forb or grass layers were dominated by Kentucky bluegrass in the drier section of a stand and by sedges or rushes, particularly bullrush (*Scirpus microcarpus*) or sawbeak sedge (*Carex stipata*), in the more mesic section of a stand.

Plant Communities Within Catherine Creek Riparian Study Area, 1979

Legend of plant community abbreviations and corresponding stand number designations for plant communities found in Catherine Creek Riparian Study Area.

Communities	*Stand Number*
Popr-Acmi	3, 133, 144
Popr-Agre	50, 60, 63-D, 66, 86, 90, 191
Popr-Agal	33, 70, 71, 172, 193
Popr-Brra	105, 115, 177
Popr-Brte-MF	2, 11, 16, 21, 39, 42, 46, 53, 58, 68, 124, 129, 153, 162, 181-B, 182, 195, 205, 209, 210, 223
Popr-MF	18, 25, 29, 37, 41, 45, 55, 73, 76, 83, 93, 99, 101-A, 138-C, 146, 151-A, 170, 185, 200, 221
Popr-Juba	8, 21-A, 24, 205-B
Popr-Lule	1, 32, 134
Popr-Phpr-MGL-MF	141, 142, 156-A, 165, 206, 212, 219, 230
Brte-MF	10, 15, 19, 27, 28, 30, 30-A, 63-A, 63-G, 67, 80, 134, 135, 154, 192, 214, 215, 218-A
Brte-Brra	54, 108, 114, 119, 120-A, 198
Brte-Posa	36
Veth/Brte	63-C, 127, 190
Caaq-Scmi	75, 104-C, 181-C, 229
Caro	229-A
MC-Agal-MF	112, 114
MC-Phpr-Popr	103, 111, 138-E, 172-A, 187
MC-Juba	12, 13, 207, 220, 226
Raac-Popr-Agal	14, 121
Veca/Popr-MGL	157
Brra-MF	89, 92, 113
Glel-Juba	84
Rowo/Popr	64, 65-A, 78, 88, 91, 119-A, 221-B
Syal/Brte	63-B, 120, 131
Syal/Disy/Popr	109
Syal/Popr	61, 74, 106, 152
Syal/Rowo	63-E, 81, 97, 107, 117
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Alin/MG-MF	17-A, 57, 181, 184, 186
Alin/Popr	25-A, 35, 47, 67-A, 138, 151, 188. 224-A, 225
Alin-Potr	5, 199
Alin/Scmi	194
Alin/Syal	102
Crdo/Popr-MF	9, 17, 20, 23-B, 26, 31, 32-A, 36-A, 40, 44, 48, 51, 59, 66-A, 77, 85, 96, 113-A, 123, 129, 138-D, 145, 150, 153-A, 163, 167, 173, 211, 228, 231
Crdo-Prvi/Popr-MF	100
Crdo/Veca/Popr	140
Abgr-Brte	38
Pipo/Alin/Popr-MGL-MF	194-A, 203, 203-A
Pipo-Brte	94, 136, 179
Pipo/Crdo/Popr-MF	34, 42-A, 69, 155, 156, 160, 161-A, 164, 178, 183
Pipo-Hopu	174
Pipo/Popr	62, 147, 175
Pipo/Rowo	52, 168, 208
Pipo/Syal	45-A, 91, 138-A
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Potr/Alin-Crdo/Rowo	65, 82, 138-B, 217
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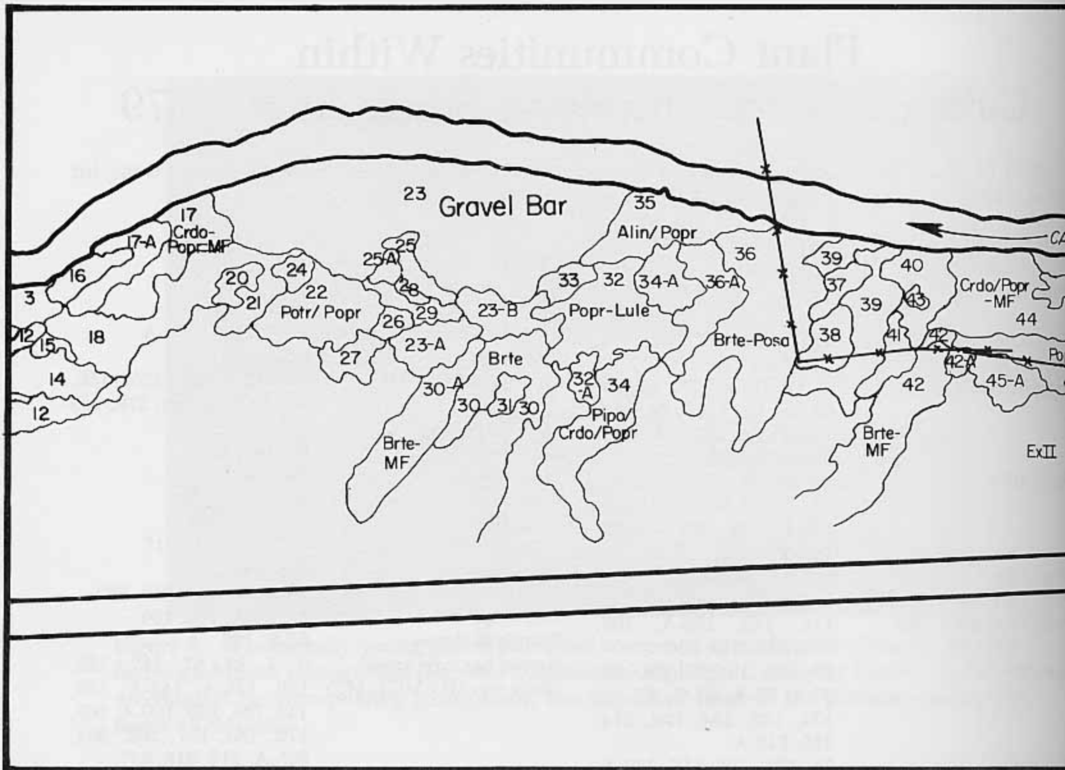
Potr-Pipo	69-A, 79, 201, 218, 222
Potr/Popr	22, 23-A, 130, 196
Potr/Syal-Rowo	63-F, 132
Gravel bar type areas: (Salix spp-MG-MGL-MF)	6, 7, 23, 87, 122, 125, 126, 138-A, 143-A, 148, 149, 158, 159, 159-A, 169, 176, 180, 197, 202, 204, 205-A, 213, 216, 227
Disturbance community:	
Syal/Urgr/Brte	4, 43, 49, 56, 77, 166, 171, 221-A

MC = Mixed Carex species
MCo = Mixed Conifer species
MF = Mixed forbs
MG = Mixed grass species
MGL = Mixed grasslikes (Carex, Scirpus, Juncus, etc.)

—×—×—×—	Exclosure fence
———	Community boundary
59, 101-A	Community number delineations
Ex I, ExII, etc.	Exclosure number
(double wavy line)	Catherine Creek
Popr-MF	Plant community name

Location of the study area on the Hall Ranch of the Eastern Oregon Agricultural Research Center near Union, Oregon.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25-A
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23-A
23-B
30-A
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Brte
Brte-MF
35
Alin/Popr
33
32
34-A
36
36-A
Popr-Lule
32-A
34
Pipo/Crdo/Popr
Brte-Posa
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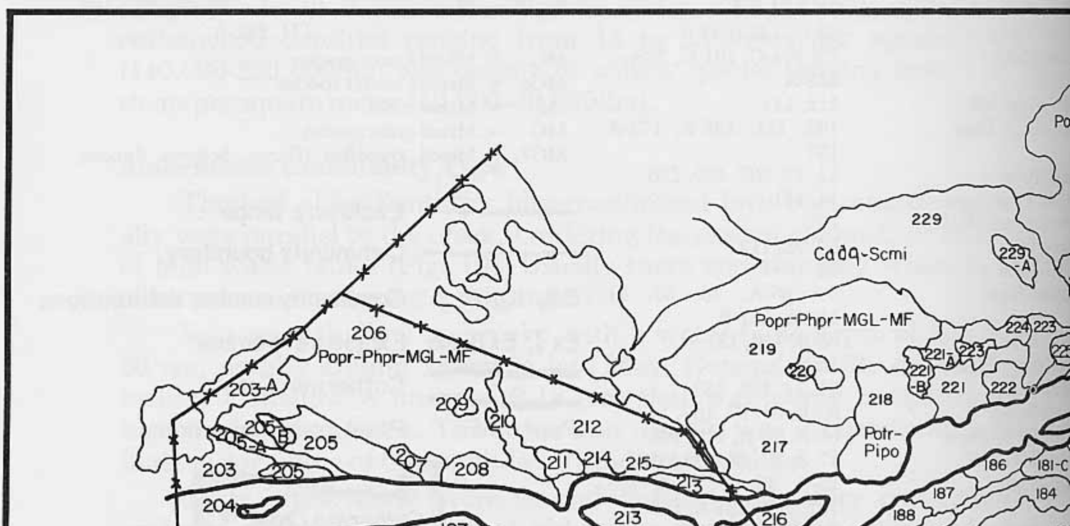
Brte-MF
ExII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Cadq-Scmi
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Popr-Phpr-MGL-MF
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Potr-Pipo
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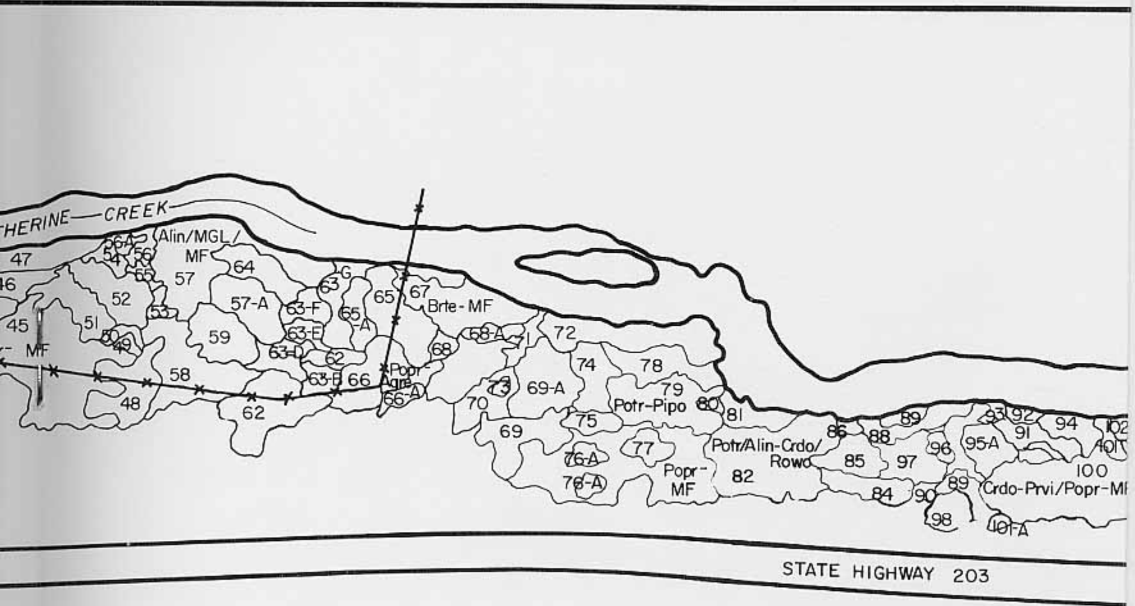
CATHERINE—CREEK
Alin/MGL/ MF
Brte-MF
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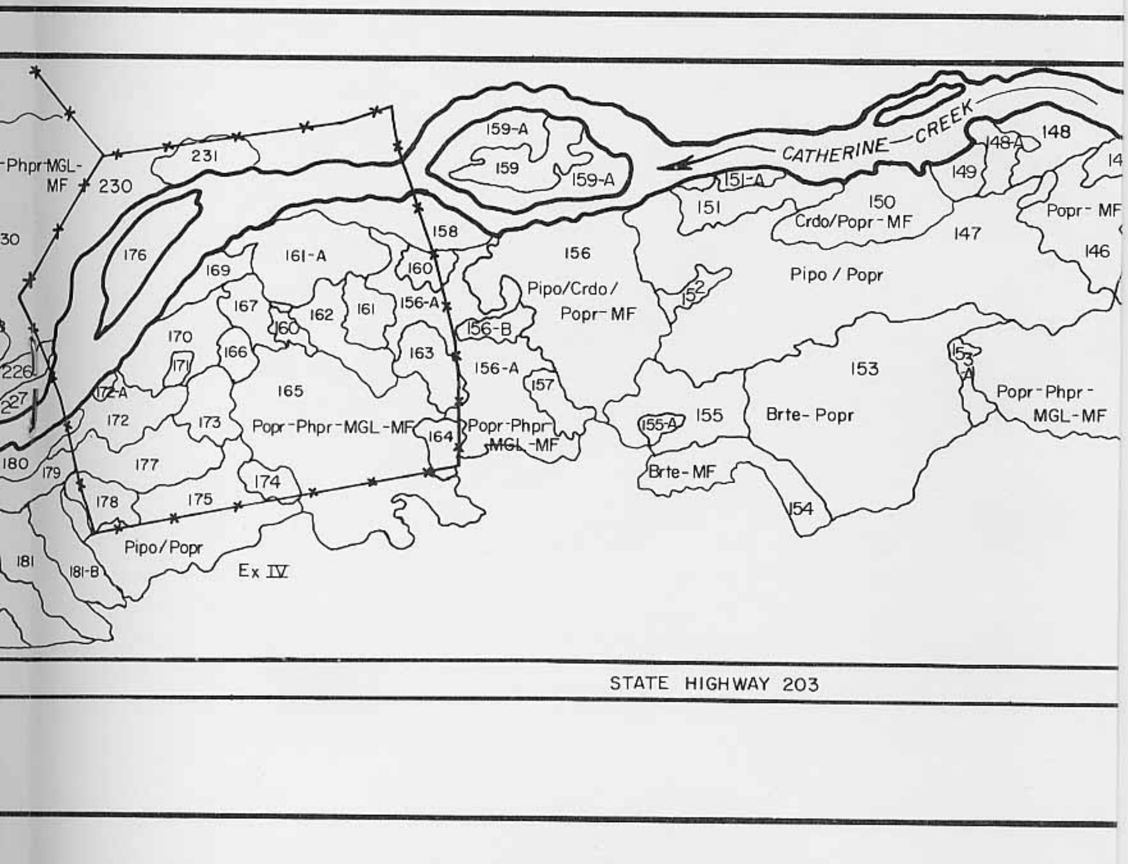
Popr-MF
Crdo-Prvi/Popr-MF
STATE HIGHWAY 203


CATHERINE—CREEK
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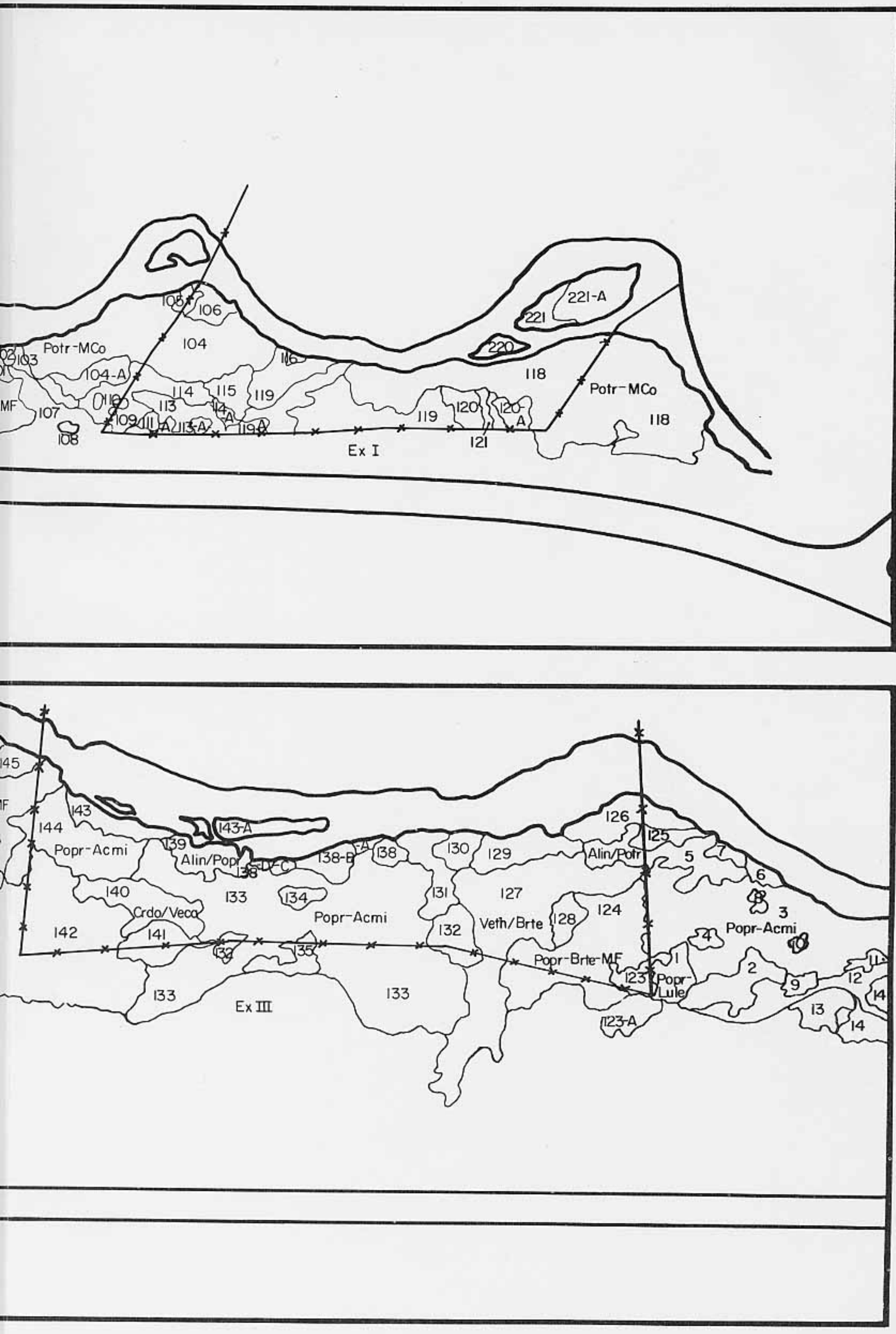

221-A
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Potr-MCo
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MF
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Potr-MCo
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120-A
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143-A
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Popr-Acmi
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Alin/Potr
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Popr-Acmi
Crdo/Veco
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Popr-Lule
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Ex III
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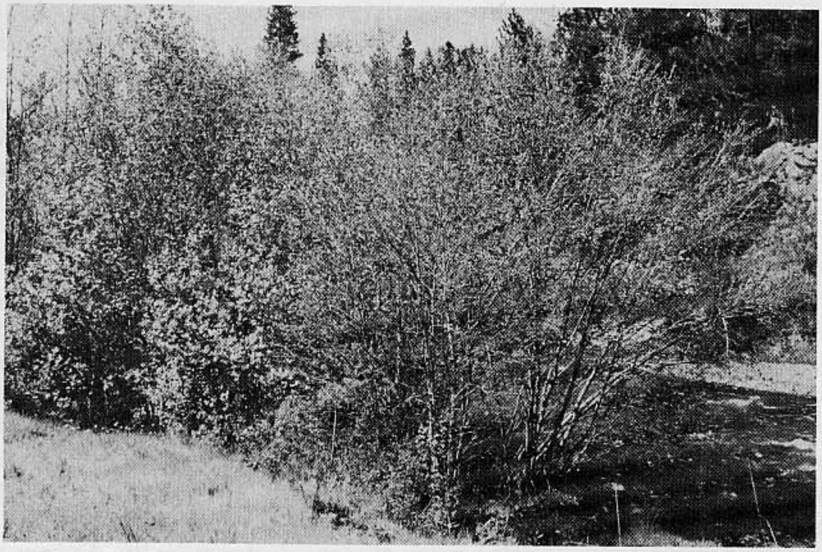

Figure 10. Thinleaf alder/Kentucky bluegrass/mixed forb community. Note linear form of this stand, parallel to the creek. This was typical for almost all naturally occurring thinleaf alder communities along the creek.

Species richness and diversity were great in these communities. A total of 100 species was sampled while collecting frequency measurements. Species diversity for stands sampled varied from 2.7 to 3.3. Equitability ranged from .77 to .86.

Kentucky bluegrass, sawbeak sedge, panicled bullrush, timothy (*Phleum pratense*), mannagrass (*Glyceria* sp.), and Baltic rush (*Juncus balticus*) were the dominant graminoids present. Common forbs included leafy bract aster (*Aster foliaceus*), common dandelion (*Taraxacum officinale*), largeleaf avens (*Geum macrophyllum*), rough bedstraw (*Galium asperrium*), tall buttercup (*Ranunculus acris*), white clover, western yarrow (*Achillea millefolium*), and selfheal (*Prunella vulgaris*).

Standing phytomass ranged from 960 kg/ha to 1,600 kg/ha. Density for alders ranged from 1.5 to 3.0 stems per square meter during 1978 and 1979.

These areas are used by many avian species as nesting/brood habitat and as resting/roosting habitat. Beaver, muledeer (*Odocoileus hemionus hemionus*), elk (*Cervus elpahus nelsoni*), and cattle used alder as a forage source. Alder communities are second only to black cottonwood/mixed conifer communities in providing shade for the creek. The detrital input to the creek from alder communities was important to the instream environment.

The alder communities are relatively early seral communities and may be successional to communities dominated by willows and mixed forbs. Because of their streamside location and unconsolidated substrate, alder communities were highly susceptible to destruction by abrupt channel changes during spring runoff. In protected areas, alders were being replaced by cottonwoods. Alder communities appeared to be seral to cottonwood-dominated communities.

Populus trichocarpa/Mixed Conifer Community Type

Cottonwood/mixed conifer communities were situated in soils similar to those of alder communities. Depth of the A horizons of cottonwood communities varied from 15 to 30 cm. Textures were loamy (silt-sandy loams). A horizons had a high content of organic matter and, as in alder communities, were very dark (< 10 YR 3/3). The A horizons were underlain by an aerated horizon ranging from coarse sands to larger, unconsolidated cobbles. The water table in cottonwood communities usually was less than 60 cm, averaging 18 cm in late May.

Cottonwood communities were the most structurally diverse ones sampled. Some cottonwood stands contained six layers of vegetation, in addition to a crytogram layer (Fig. 11). Seventy-three plant species were recorded within cottonwood communities during the 3 years of the study. The most common understory species included Kentucky bluegrass, blue wildrye (*Elymus glaucus*), sedges, common dandelion, tall buttercup, streambank butterweed (*Senecio pseudaureus*), wild sweet anise (*Osmorhiza chilensis*), and miner's lettuce (*Montia perfoliata*). Species diversity (H′) ranged from 2.7 to 3.1. Equitability (J′) varied among stands from .76 to .85.

Standing phytomass of the understory layers ranged from less than 1,000 kg/ha to almost 2,700 kg/ha. Cottonwood communities provided more shade cover over the creek than any other.

Cottonwood communities were important habitats for many species of wildlife. Species richness for both avian and mammalian populations was greater than in any other community. These communities provided nesting/brood habitat for 23 species of birds and habitat for 9 of 15 ecological foraging guilds utilizing the area (Kauffman et al. 1982).

Mean densities of up to 48 birds/ha were recorded for stands in cottonwood communities. Species richness was highest during the nesting/brood season, when 26 species were observed using the area. This season (early summer) also corresponded to a time of high densities, high diversity of bird species (2.4 to 2.8), and high indices of equitability (.81 to .94).

Density estimates for small mammals were as high as 254 mammals/ha at the end of the growing season and as low as 216 mammals/ha

Figure 11. Black cottonwood/mixed conifer community. Stands such as this one were the most diverse in structure, containing up to six layers of vegetation. The vegetation layers included: (1) a layer dominated by black cottonwood; (2) a conifer layer usually dominated by ponderosa pine; (3) a tall shrub-low tree layer usually dominated by thinleaf alder, Douglas hawthorn, or water birch; (4) a low-shrub layer dominated by snowberry or Woods rose; (5) a graminoid layer dominated by many understory species, most commonly Kentucky bluegrass; and (6) a forb layer.

during early autumn. The mountain vole (*Microtus montanus*) was the most common species captured, with a relative abundance of 70 percent. The deer mouse (*Peromyscus maniculatus*), yellow pine chipmunk (*Eutamias amoenus*), and vagrant shrew (*Sorex vagrans*) made up the remainder of the estimated population. Densities of small mammals were lower than for other communities sampled, and species composition was different from other communities.

Poa pratensis/Mixed Forb Community Type

Kentucky bluegrass communities were among the most widespread communities found on the study area. Historically, these communities probably were dominated by native bunchgrasses, sedges, and rushes. Overgrazing by herbivores may be the chief factor responsible for this drastic change in species composition (Volland 1978).

These dry meadow communities were found on some of the more developed soil profiles of the area. Soils were characterized as deep, well-drained loams. A horizons were dark (< 10 YR 3/3), almost exclusively of a loam texture, and averaged 30 to 40 cm deep. Mottling usually occurred, beginning at the lower end of the A horizon. Depth from the soil surface to a layer restrictive to root growth ranged from 70 to 150 cm in late May.

Communities within the *Poa pratensis*/mixed forb community type varied from an almost monotypic stand of Kentucky bluegrass to communities with a very diverse composition of species. Common species found in these meadows included Kentucky bluegrass, redtop (*Agrostis alba*), stork's bill (*Erodium cicutarium*), western yarrow, white clover, chickweed (*Cerastium viscosum*), common dandelion, velvet lupine (*Lupinus leucophyllus*), and tall buttercup. A total of 78 plant species was recorded during frequency sampling. Species diversity ranged from less than 1.0 in the nearly monotypic stands of Kentucky bluegrass to almost 3.3 in the communities with a large number of forbs and graminoids.

Standing phytomass was high, ranging from 2,500 to 4,200 kg/ha. Kentucky bluegrass accounted for more than 75 percent of the standing phytomass, in some cases accounting for more than 90 percent in the late summer. These communities were preferred foraging sites for both domestic livestock and big game.

Some small mammals were present only in the Kentucky bluegrass community type or occurred there in their greatest numbers. The Columbian ground squirrel used dry meadows almost exclusively. Ground squirrels appeared to be a good indicator of the deep, loamy soils characteristic of this community type. Other small mammals included the mountain vole, the vagrant shrew, the deer mouse, and the northern pocket gopher.

Avian use was heaviest during nesting/brooding season. Densities of up to 28 birds/ha used dry meadow communities during early summer. At this time, the highest diversities in bird species (2.0 to 2.2) and species richness (15 to 20) were observed for dry meadow communities. With the exception of raptorial birds, avian use of dry meadow communities was light at all other seasons of the year.

Poa pratensis/Phleum pratense/Mixed Grass Community Type

Moist meadows occurred in low-lying areas away from the stream channel. Generally, standing water was present during spring and early summer. Some of these moist meadows and most wet meadows (*Carex* spp. community type) were ponded with no external drainage. Wet meadows, in contrast to moist meadows, usually were dominated by sedges and contained only a small amount of hydric grass species.

Poorly drained, finer textured soils characterized moist meadow and wet meadow communities. In moist meadows, A horizons varied from silty clay loams to silty clays. Infiltration and percolation were slow in these communities, often because of a coarse-sand horizon overlain by the finer textured A horizons. Mottling occurred at approximately 18 cm, and gleyed horizons sometimes were found at a depth of 28 cm or more.

Water table depths in late May ranged from 20 to 30 cm in these communities. Water availablility to plants through the growing season was enhanced by the presence of standing water and a shallow water table. In some years, water was not a limiting factor and growth continued throughout the season.

Sixty-four plant species were recorded in vegetation stands of moist meadows. Plant species diversity for individual stands in moist meadows ranged from 2.1 to 3.3.

Moist meadows were dominated by a combination of Kentucky bluegrass, timothy, Baltic rush, oval-head sedges (*Carex athrostachya*, *Carex microptera*, or *Carex comosa*), and large sedges (*Carex aquatilis*, *Carex stipata*, or *Carex rostrata*). Common forbs included tall buttercup, leafy bract aster, northwest cinquefoil (*Potentilla gracilis*), western yarrow, and many hydric forbs. In a few areas, very palatable native bunchgrasses such as tufted hairgrass (*Deschampsia caespitosa*) and tall mannagrass (*Glyceria elata*) were present (Fig. 12).

Standing phytomass in moist meadows was greater than in any other community on the study area. Estimates of standing phytomass

Figure 12. Moist meadow dominated by Kentucky bluegrass (*Poa pratensis*), timothy (*Phleum pratense*), sedges (*Carex* spp.), and many forbs. Standing phytomass is 4,700 kg/ha.

ranged from 3,500 kg/ha to 9,200 kg/ha. More than 90 percent of the phytomass was produced by grasses, sedges, and rushes.

High preferences for moist meadows by cattle and big game were observed. Use by big game was apparent, particularly on timothy and a few palatable forbs. However, this utilization was scattered and light.

High densities of small mammal populations were estimated in moist meadows. The highest densities of the mountain vole were found in moist meadow communities. Peak densities were estimated in summer populations, ranging from 468 to 658 mammals/ha. Here, the mountain vole had a relative abundance of 70 percent. The northern pocket gopher, deer mouse, and vagrant shrew made up the rest of the small mammal population, with relative abundance indices of 15, 7.5, and 7.5 percent respectively.

Crataegus douglasii Community Type

Douglas hawthorn communities were widespread throughout the riparian study area. Hawthorns had one of the widest ecological ranges for shrub species on the study area. They were present in all but the most hydric community types.

In the *Crataegus douglasii* community type, A horizons consisted of silt loam-loamy textures and were relatively thick (33 to 43 cm). Mottling occurred at 33 to 38 cm. All hawthorn stands sampled had A horizons underlain by a coarse-textured (loamy sand-coarse sand) IIC horizon. Sometimes clay balls were interspersed throughout the coarse-textured materials. Depth to a root-restrictive rock layer varied from 69 to 100 cm, usually less than 75 cm.

Species richness was high in hawthorn-dominated communities, particularly in the immediate understories of these shrubs (Fig. 13). Eighty-six species were recorded during frequency measurements. Plant species diversity was among the highest recorded for any community on the study area (2.4 to 3.4).

Field layers of hawthorn stands were varied, ranging from stands dominated by cow parsnip (*Heracleum lanatum*)/Kentucky bluegrass/mixed forbs to sparse stands dominated by Kentucky bluegrass and cheatgrass. Common species found in the field layers included Kentucky bluegrass, redtop, western yarrow, common dandelion, hook violet (*Viola adunca*), white clover, leafy bract aster, American vetch (*Vici americana*), black medic (*Medicago lupulina*), and tall buttercup.

Standing phytomass of the field layer in hawthorn communities ranged from 1,500 to 2,500 kg/ha. Kentucky bluegrass accounted for 61 to 87 percent of the standing phytomass. Mean density of hawthorns in 1979 was 3.4 rooting stems per square meter. Hawthorns were moderately palatable, at least seasonally, and evidence of hedging was appar-

Figure 13. Dense stand of Douglas hawthorn (*Crataegus douglasii*), Kentucky bluegrass (*Poa pratensis*), and Baltic rush (*Junca balticus*). Understory composition in these dense stands typically was higher in forbs but lower in total standing phytomass than Douglas hawthorn stands with more open canopies.

ent on many of the smaller shrubs. The flowers and berries also were used extensively by some wildlife species.

Avian use of hawthorn communities was heaviest during the nesting/brooding season and at the time of berry ripening. Because of their thorny, multistemmed physiognomy, hawthorns provided valuable nesting/brooding habitat for at least 14 species of birds. Mean densities of avian species during nesting/brooding season ranged from 27 to 31 individuals/ha. At this season, bird species diversity and species richness were 2.35 and 16 to 18, respectively.

Density of small mammals was high in hawthorn communities. The highest densities for small mammals in the riparian zone were recorded in the late summer 1979 census; 700 to 800 individuals/ha were estimated to be inhabiting hawthorn communities. Mean densities of small mammals for early autumn were 140 to 200 mammals/ha. The mountain vole had a relative abundance of more than 80 percent of the population at all seasons.

Pinus ponderosa Community Type

Ponderosa pine communities in the riparian zone differed from ponderosa pine communities in uplands because many species in the understory were riparian obligates (Fig. 14). Midstory shrub layers, when present, were dominated by hawthorn, alder, snowberry, or Woods rose, alone or in combination. Understories were dominated by Kentucky bluegrass, cheatgrass, or little barley (*Hordeum pusillum*).

Ponderosa pine communities in the study area had O horizons 8 to 23 cm in thickness that consisted of decaying pine needles and other plant materials. A horizons, 20 to 58 cm thick with loamy textures, were characteristic of all stands of ponderosa pine sampled. Most A horizons were underlain by a thin, coarse-textured IIC. Another C horizon of coarse sands with unconsolidated gravels and pebbles usually could be found underlying the first C horizon. The presence of ponderosa pine stands was highly correlated to these aerated C horizons and appeared to be important in the development of these communities in riparian areas. Water tables in May were more than 81 cm below the soil surface.

A species richness of 64 was recorded during frequency sampling. Species diversity ranged from 2.0 in stands with a combination of a dense canopy cover and a thick mat of pine needles to 3.0 in stands with a more open canopy and weaker O horizons.

Kentucky bluegrass, blue wildrye, and cheatgrass were the dominant graminoids. Common forbs included sandwort (*Arenaria macro-*

Figure 14. Community dominated by ponderosa pine (*Pinus ponderosa*) with midstory layers of Douglas hawthorn (*Crataegus douglasii*) and snowberry (*Symphoricarpos albus*). Understory composition here differs from that of upland ponderosa pine communities because of the presence of many riparian obligates.

phylla), western yarrow, common dandelion, tall buttercup, white clover, leafy bract aster, streambank butterweed, and blueleaf strawberry (*Fragaria virginiana*).

Standing phytomass estimates of the understory layers in ponderosa pine stands were low in relation to other communities in the riparian zone. Mean annual standing phytomass estimates ranged from 1,400 to 2,000 kg/ha.

Wildlife use in ponderosa pine communities was similar to that of wildlife in the uplands dominated by ponderosa pine types. Species common in upland pine communities, such as the porcupine (*Erethizon dorsatum*) and chickaree (*Tamiasciurus douglasi*), were common in the riparian zone only in this community.

Greatest use of ponderosa pine communities by avians was during the nesting season. Cavity nesters and species commonly nesting in upland forested communities were observed nesting here. Utilization by species of the foliage-seed foraging guilds was heavy during seed ripening of pines.

***Symphoricarpos albus/Rosa woodsii* Community Type**

Snowberry/Woods rose communities characteristically were found in small stands less than 10 meters in diameter. These communities appeared to be an indicator of past disturbance in dry sites of the riparian zone.

Snowberry/Woods rose communities generally were found on shallow, rocky, and well-drained soils. In many stands the soils had been disturbed either by man or by natural changes caused by Catherine Creek.

Species richness for snowberry/Woods rose communities was 64, and species diversity ranged from 2.7 to 3.1. These communities were dominated by snowberry and Woods rose in the low shrub layer and by Kentucky bluegrass in the field layer (Fig. 15). Other common species included redtop, bald brome (*Bromus racemosus*), cheatgrass, white clover, common dandelion, western yarrow, leafy bract aster, tall buttercup, and largeleaf avens.

Standing phytomass ranged from 3,200 to 4,000 kg/ha in these communities. Snowberry accounted for 30 to 48 percent of the standing phytomass, and Kentucky bluegrass accounted for 24 to 57 percent.

Wildlife utilization of snowberry/Woods rose communities was light. Big game and avian species both were observed foraging on rose hips during late summer and early autumn. Some use of Woods rose as a nesting site was observed.

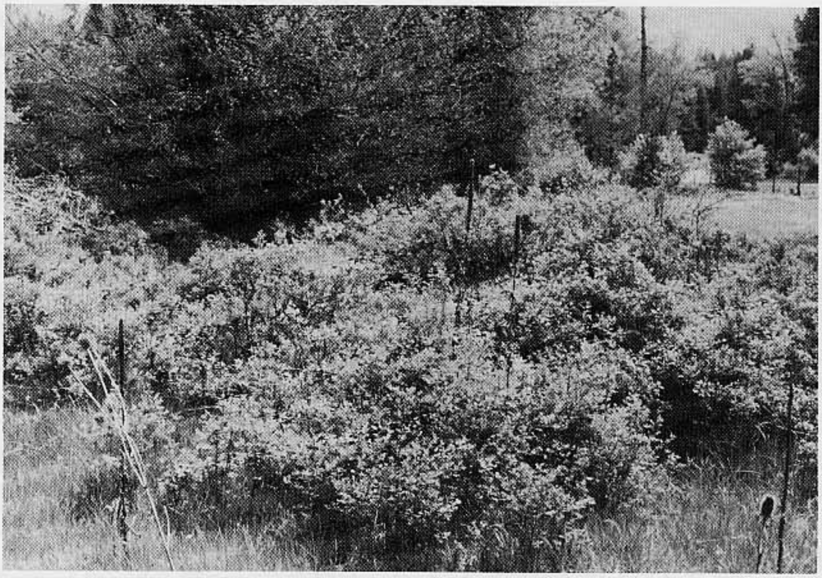

Figure 15. Snowberry/Woods rose stand with an understory of Kentucky bluegrass, blue wildrye, and mixed forbs.

Bromus tectorum **Community Type**

Cheatgrass-dominated communities (Fig. 16) were found in old channels, usually well away from the present course, or in old dredge piles caused by irrigation ditches. Soils were developed weakly or totally structureless, rocky to the surface, and had low water-holding capacities. The soils are drained excessively, causing droughty conditions to prevail. Organic matter was low relative to other communities. Depth to this water table was more than 90 cm.

Fifty plant species were recorded during frequency measurements, with more than 30 percent of them annuals. Species diversity was comparatively low (2.0 to 2.5). Cheatgrass, stork's bill, western yarrow, autumn willowweed (*Epilobium paniculatum*), Douglas knotweed (*Polygonum douglasii*), collomias (*Collomia* spp.), and microsteris (*Microsteris gracilis*) were common in the community.

Maximum standing phytomass in cheatgrass communities was present during late May or early June, about the time cheatgrass was in anthesis. Phytomass was much lower by July, ranging from 970 to 2,000 kg/ha.

Wildlife use was minimal on these communities except for seasonal predation of insects by some avian species. Big game may utilize the area during spring growth when cheatgrass is palatable or during autumn if regrowth is present.

Figure 16. Cheatgrass/mullein community. These areas, found primarily on disturbed sites, are of low value as a forage source or wildlife habitat.

Discussion

The community data presented here (summarized in Table 2) could be misleading, in that species diversity, standing phytomass, and even species composition appear to be similar among many of the community types sampled. This is not entirely true. These data represent the range of measurements during the 3-year study. The 1978 and 1980 years were very productive with high estimates of species richness and standing phytomass. The 1979 year was drier and warmer than the other years of the study, resulting in lower phytomass, species richness, and species diversity.

In addition to year effects, the wide ranges shown in Table 2 also indicate the difficulties in community delineation within riparian zones. Even with 50 plant communities and 14 community types described and separated, it was apparent that some discernible differences in composition and structure existed among stands of each community. There are intangible factors associated with a particular vegetation stand's geographical location on the study area, and many complex intercommunity interactions occur between these stands. Because of these interactions, each of the 258 stands is unique—an assemblage of plant and animal species with many distinguishing characteristics.

Table 2. General descriptions of selected riparian plant communities along Catherine Creek (1978-1980)

Community	Soils	Dominant species in the field layer	Diversity (H′), equitability (J′), and species richness (S)	Phytomass	Miscellaneous
				Kg/ha	
Gravel bars (*Salix* spp./ mixed forbs)	Unconsolidated materials ranging from silts to rocks	*Agrostis* spp. *Trifolium repens* *Taraxacum officinale* *Aster foliaceus* Many forbs, grasses, and grasslike plants	H′ = 3.2 to 3.5 J′ = .83 to .84 S = 98	1,400 to 2,800	Ecologically young community, susceptible to severe damage or destruction during spring runoff
Thinleaf alder/ Kentucky bluegrass/mixed forbs	Shallow, loamy A horizons underlain by unconsolidated materials; shallow water tables	*Poa pratensis* *Carex* spp. *Scirpus microcarpus* *Juncus balticus* *Taraxacum officinale* *Aster foliaceus* Many forbs, grasses, and grasslike plants	H′ = 2.7 to 3.3 J′ = .77 to .86 S = 100	960 to 1,600	Usually located immediately adjacent to the stream channel; susceptible to destruction by spring runoff and channel changes
Black cottonwood/mixed conifer	Shallow, loamy A horizons (usually deeper than those of alder communities) underlain by aerated horizons; soils deeper than those in alder communities	*Poa pratensis* *Elymus glaucus* *Carex* spp. *Taraxacum officinale* *Senecio pseudaureus* *Osmorhiza chilensis*	H′ = 2.7 to 3.1 J′ = .76 to .85 S = 73	1,000 to 2,700	Most structurally diverse communities on the area; very valuable for avian populations, particularly as resting/ brooding habitats

Douglas hawthorn/Kentucky bluegrass	A horizons consist of silt-loam textures; underlain by coarse-textured horizons; deep, well-drained soil profiles	*Poa pratensis* *Agrostis alba* *Achillea millefolium* *Taraxacum officinale* *Viola adunca* *Aster foliaceus* *Vicia americana*	H' = 2.1 to 3.4 J' = .76 to .85 S = 86	1,500 to 2,500	Important wildlife habitat; preferred foraging community by cattle
Kentucky bluegrass/mixed forbs (dry meadows)	Among the more well-developed soil profiles, deep solum (70-150 cm); deep, loamy A horizons; usually has B horizons	*Poa pratensis* *Agrostis alba* *Erodium cicutarium* *Achillea millefolium* *Lupinus leucophyllus* *Ranunculus acris*	H' = 1.0 to 3.3 J' = .58 to .81 S = 78	2,600 to 4,200	Valuable forage area for cattle; historical dominance of bunchgrasses and grasslike plants; now in a zootic climax of Kentucky bluegrass
Kentucky bluegrass/timothy/mixed grasslike plants and forbs (moist meadows)	Poorly drained profiles with a layer restrictive to water percolation; overlain by A horizons with semi-clay-clay textures; gleyed horizons common	*Poa pratensis* *Phleum pratense* *Carex aquatilis* *Carex stipata* Other *Carex* spp. *Ranunculus acris* *Aster foliaceus* *Potentilla gracilis* Many mesic forbs	H' = 2.1 to 3.3 J' = .80 to .84 S = 64	3,500 to 15,000	Highest standing phytomass of all communities on the area; valuable forage-producing communities; susceptible to trampling

(continued next page)

Table 2. General descriptions of selected riparian plant communities along Catherine Creek (1978-1980) (cont.)

Community	Soils	Dominant species in the field layer	Diversity (H′), equitability (J′), and species richness (S)	Phytomass	Miscellaneous
				Kg/ha	
Cheatgrass/mixed forbs	Structureless, rocky to the surface; profiles excessively drained	*Bromus tectorum* *Erodium cicutarium* *Achillea millefolium* *Polygonum* spp. *Collomia* spp. Many annual aliens	H′ = 2.0 to 2.5 J′ = .66 to .85 S = 50	970 to 2,000	Communities appear almost exclusively on disturbed soils caused by old stream channels or old dredge piles from irrigation canals
Snowberry/ Woods rose	Shallow, well-drained soils on old, disturbed areas*	*Poa pratensis* *Agrostis alba* *Bromus racemosus* *Bromus tectorum* *Trifolium repens* *Geum macrophyllum* *Taraxacum officinale*	H′ = 2.7 to 3.1 J′ = .77 to .81 S = 64	3,200 to 4,000	Occur primarily on disturbed sites, old brush piles
Ponderosa pine/ Kentucky bluegrass	O horizon usually present; thick A horizons (up to 60 cm) underlain by IIC and IIIC horizons of unconsolidated coarse materials forming an aerated horizon; deep water tables	*Poa pratensis* *Elymus glaucus* *Bromus tectorum* *Arenaria macrophylla* *Achillea millefolium* *Taraxacum officinale* *Ranunculus acris*	H′ = 2.0 to 3.0 J′ = .67 to .81 S = 64	1,400 to 2,000	Structurally similar to upland *P. ponderosa* types, but understory is dominated by riparian obligates

* No profile description ...

The artificial grouping of similar assemblages of plant species into communities, measurements for a 3-year period in which the environmental effects were different each year, and the complex interactions of geographical location and intercommunity interactions all contributed to ranges in the measured community parameters.

Conclusion

Riparian ecosystems are among the most diverse and complex of all habitats. Many environmental factors that contribute to their diversity and complexity were examined on the riparian zone associated with Catherine Creek. Factors with significant effects on community development included interactions of soil morphology, depth to water tables, streamflow dynamics, microclimate, biotic interactions, and man. These are not all of the ecological processes that interact in riparian community development. The complexity of these ecosystems is caused by many ecological interactions, some readily apparent and some that may not be discovered until years of intense study are completed, if ever. Two hundred and fifty-eight stands of vegetation were mapped, representing 60 identified plant communities. As a basis for understanding some of the ecological processes involved in community development, structure, and composition, nine common plant community types were described quantitatively, using a variety of techniques.

Among communities occupying the riparian ecosystem, variation from extreme changes in physical and environmental gradients probably was greater than the variation of all surrounding upland communities. Standing phytomass in the riparian zones ranged from almost 15,000 kg/ha in some moist meadow stands to practically 0 kg/ha on recently formed gravel bars. Species richness and species diversities were high in several communities, many of which contained more than 100 species. Conversely, some dry meadows and areas disturbed by cheatgrass were practically monotypic vegetation stands.

Wildlife use of the area was high. Eighty-one species of birds utilized the area from May through October. Thirty-four species of birds used the area as nesting habitat during this study. During the nesting/brooding season, densities of more than 30 avian species/ha were not uncommon.

Twenty species of mammals were observed using the riparian study area. Many species appeared to have significant impacts on the community composition and plant succession. Animals having a significant effect include cattle, beaver, northern pocket gopher, and Columbian ground squirrel.

Proximity to water, high diversity of species and communities, high productivity, and perhaps a favorable microclimate are a few reasons these areas are extremely valuable to many wildlife species as well as livestock. Recreationists use riparian zones extensively for many activities. Water quality and quantity for downstream users is of paramount importance for health and food production. Because of the importance of riparian ecosystems and their burgeoning use, a better understanding of the ecological processes within riparian ecosystems is imperative for long-term land use planning.

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