Shrub-Steppe Vegetation of the East Fork and the Middle Fork of the Salmon River Drainages

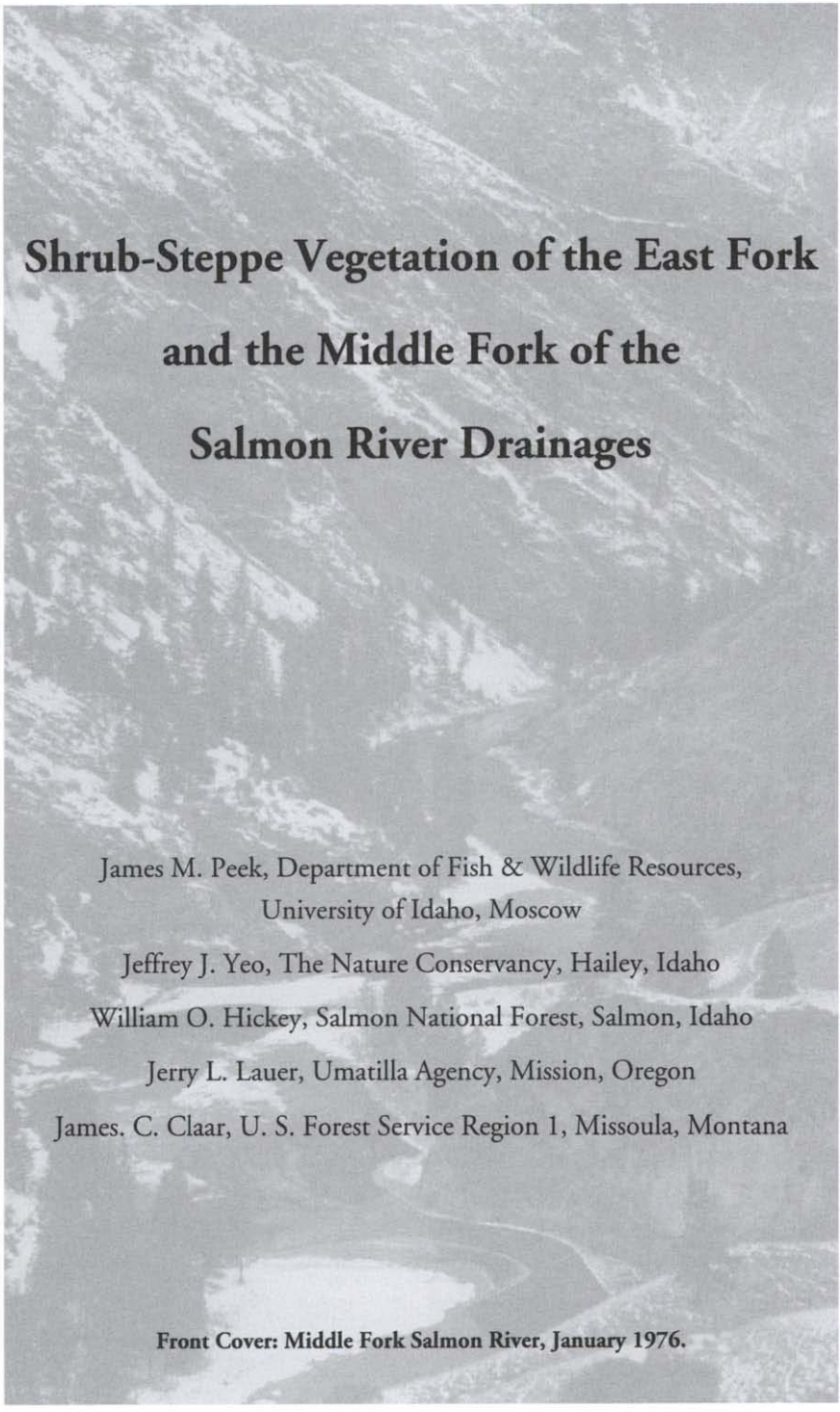
James M. Peek, Department of Fish & Wildlife Resources, University of Idaho, Moscow

Jeffrey J. Yeo, The Nature Conservancy, Hailey, Idaho

William O. Hickey, Salmon National Forest, Salmon, Idaho

Jerry L. Lauer, Umatilla Agency, Mission, Oregon

[illegible], U. S. Forest Service Region 1, Missoula, Montana



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James. C. Claar, U. S. Forest Service Region 1, Missoula, Montana

Front Cover: Middle Fork Salmon River, January 1976.

Table of Contents

Abstract

Authors describe nineteen shrub-steppe communities in the Middle Fork and East Fork of the Salmon River, Idaho. Bluebunch wheatgrass (*Pseudoroegneria spicata*) and Idaho fescue (*Festuca idahoensis*) occur as dominants or major subdominants throughout the region. Big sagebrush (*Artemesia tridentata*), threetip sagebrush (*A. tripartita*), and low sagebrush (*A. arbuscula*) are dominants, especially in the East Fork and southern Middle Fork. Antelope bitterbrush (*Purshia tridentata*) communities exist throughout the region but are most abundant along the Middle Fork, where the species also occurs as a dominant in the understory of ponderosa pine (*Pinus ponderosa*) and Douglas fir (*Pseudotsuga menziesii*) stands on drier sites. Cliffy areas in all regions have curlleaf mountain mahogany (*Cercocarpus ledifolius*) and little greenbush (*Glossopetalon nevadense*) stands, reflecting the specialized habitats on which these communities occur. Shadscale saltbush (*Atriplex confertifolia*) communities occupy the driest sites in the lower East Fork. Common snowberry (*Symphoricarpos albus*), antelope bitterbrush, big sagebrush, threetip sagebrush, Idaho fescue, bluebunch wheatgrass, and needle-and-thread (*Hesperostipa comata*) are well represented in the plant communities. Bluebunch wheatgrass or Idaho fescue or both dominate grassland communities. Needle-and-thread dominates on some xeric, sandy sites. The presence of ponderosa pine or Douglas fir in shrub communities suggests these are successional stages of conifer-dominated community types. At least six conifer communities are represented in ten stands dominated by common snowberry, in thirteen dominated by ninebark (*Physocarpus malvaceus*), five dominated by Idaho fescue, and three dominated by mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*). Seven sites exclosed between 1915 and 1950 provide evidence of reduction in shrubs and expansion of grassland and herbaceous portions of these communities in the Middle Fork. A record of a stand photographed in 1925, 1968, and 1988 appears to corroborate these findings. Changes in species composition of these communities are attributed to changes in species of herbivores, including livestock, mule deer, and elk; to alterations in the natural fire regime; and to weather patterns that affected woody and herbaceous plants differently over the period. The major fire of 2000 in the Middle Fork drainage appears to have increased cheatgrass (*Bromus tectorum*) at least temporarily, and to have reduced nonresprouting shrubs including big sagebrush, curlleaf mountain mahogany, and antelope bitterbrush. Subsequent establishment of new plants from seeds has occurred on sites burned in the most recent fires. Productivity of bluebunch wheatgrass was reduced for one year following the 2000 fire.

Introduction

Central Idaho's mountain-canyon rangelands represent a signature portion of the unique complex of topography, climate, substrate, water, and vegetation that identifies the region. Initially carved by glaciers, and subsequently by cherished rivers and streams, the region contains a wealth of resources: mineral, animal, vegetable, and liquid, recognizable in its steep terrain, sandy soils, forests, and clear streams. However, if the rivers are its life blood, the rangelands or shrub steppe form the backbone of the system. Shrub-steppe vegetation provides important winter ranges for deer, elk, and mountain sheep, for which the region is famous. Other wildlife, such as blue grouse and meadowlark, depend on shrub-steppe vegetation for nesting cover and foraging. The major predators: mountain lion, gray wolf, golden eagle, and red-tailed hawk, in turn depend on the shrub steppe that sustains their prey.

Native Americans, who first inhabited the region, also depended on mule deer and mountain sheep. The biscuitroot (*Lomatium* spp.) and basin wildrye (*Elymus cinereus*) of the shrub steppe provided sustenance and weaving material. Early settlers, trappers, soldiers, and homesteaders depended on the mountain rangelands to sustain their livestock. The rangelands also provided forage for the pack stock that carried supplies to mines of the region. Today, ranchers, outfitters, recreationists, hunters, and fishermen depend on these rangelands in various ways, for forage, habitat, watershed, and for their austere, compelling esthetics. Humans and wildlife depend heavily on these rangelands.

The mountain canyon shrub-steppe lands of central Idaho are defined as those nonforested communities where shrubs, grasses, and forbs (herbs) dominate the landscape. In the driest southeast portion of the region, shrub steppe may occupy the entire elevation gradient, with forest confined to smaller areas. In the western portion along the Salmon River canyon and the South Fork tributary, forested communities predominate. There, shrub steppe is held to the driest and warmest sites. However, even as the familiar rangeland vegetation grades into forested communities, the drier forests often are underlain by many of those same shrub-steppe plants.

The rangeland complex consists of a number of different plant communities adapted to the changes in soil, topography, temperature, and precipitation occurring along the often steep elevation gradients of the region. Many plant communities that occupy dramatically different habitats and have different ecological attributes may not appear different to the observer at a distance. A person floating the Middle Fork, for instance, is able to observe a wide

variety of shrub-steppe complexes. However, each complex offers important contributions for sustaining the wildlife resource. Recognition of the different plant communities becomes a prerequisite to understanding the ecology of the entire system. We describe many of these different plant communities, consider their major plants, provide a dichotomous key to identify the communities using key plants, and report the values of each. We hope this work will stimulate a greater appreciation of this important vegetation complex.

Shrub-steppe plant communities in the East Fork and Middle Fork of the Salmon River (Figure 1) represent an intergrade between the shrub-steppe communities of the Snake River Plain and adjacent valleys, and the lower Salmon River and Snake River regions. Extant classifications of shrub-steppe communities in southern Idaho (Hironaka et al. 1983), western

Figure 1. Salmon River, Middle Fork of the Salmon River, East Fork of the Salmon River, and Big Creek drainages, sites of shrub-steppe communities examined in this study.

Montana (Mueggler and Stewart 1980), and the lower Salmon-Snake River grasslands (Tisdale 1986), demonstrated that plant communities vary across this region. Shrub steppe in the East Fork and Middle Fork is sufficiently unique to warrant a separate classification since existing classifications are not completely applicable. We offer a provisional description of these shrub-steppe plant communities.

Sufficient information was available from adjacent shrub-steppe communities to identify dominants likely to occur in this region. The early classifications by Daubenmire (1970) of the shrub steppe of eastern Washington and northern Idaho included the Snake River and lower Salmon River below Riggins, Idaho. Tisdale (1986) further clarified the canyon grasslands along the Snake River, Clearwater River, and lower Salmon River to 20 miles east of Riggins, immediately adjacent to our study area. Tisdale (1986) described eight grassland communities, of which five are dominated by bluebunch wheatgrass (*Pseudoroegneria spicata*), Idaho fescue (*Festuca idahoensis*), or both. Shrub dominated communities include common snowberry (*Symphoricarpos albus*) and curlleaf mountain mahogany (*Cercocarpus ledifolius*), but big sagebrush (*Artemisia tridentata*) is absent. These plant communities, within the Pacific Northwest Bunchgrass Region, are predominantly underlain by basalt with surface deposits of volcanic ash. This forms a fertile substrate when compared with the decomposed granites of the Idaho Batholith characterizing much of the shrub steppe in the study area.

The sagebrush-grassland communities reported by Hironaka et al. (1983) for southern Idaho extend into the mountain rangelands of this region. Of 32 communities identified, 18 are dominated by bluebunch wheatgrass, Idaho fescue, the various subspecies of big sagebrush, or by all of these. Antelope bitterbrush (*Purshia tridentata*), curlleaf mountain mahogany, threetip sagebrush (*Artemisia tripartita*), and black sagebrush (*A. nova*) are components of other communities.

Mueggler and Stewart (1980) described 29 communities for mountain rangelands of western Montana, including 22 dominated by Idaho fescue or bluebunch wheatgrass, or both. Again, big sagebrush, threetip sagebrush, antelope bitterbrush, black sagebrush, and curlleaf mountain mahogany are associated dominant species.

These investigations of vegetation adjacent to the central Idaho mountain rangelands have several attributes in common. First, bluebunch wheatgrass and Idaho fescue consistently occur as dominants on appropriate sites throughout the broader region of these investigations. Big sagebrush and

antelope bitterbrush also have broad distributions, though both are absent from the low elevations of the lower Salmon River and Snake River region. However, they reappear north of these low canyons and west of the Palouse Prairie region in Washington. Needle-and-thread (*Hesperostipa comata*) is well distributed throughout the region on drier sites, but may be best represented on disturbed sites dominated by other species.

The plant communities described here were examined in the 1970-2003 period, with most work occurring in the 1970s and 1980s. Even with complete protection, plant communities in sagebrush steppe change over long periods, depending on precipitation patterns, nature and intensity of the original disturbance (Anderson and Inouye 2001). Fire also affects the composition and appearance of these communities, as does invasion by exotic plants like cheatgrass (*Bromus tectorum*) and knapweeds (*Centaurea* spp.). Virtually all stands had been disturbed to some degree by livestock, native ungulates, and invasion of exotic species prior to examination. Many stands burned after we had examined them, and we report fire influence where we had observations.

Climate

Finklin (l988) described the climate of these mountain rangelands. Weather stations at Challis (1577 m above mean sea level), Middle Fork Lodge (1365 m), Taylor Ranch (1178 m), and Campbell's Ferry (704 m) provided an indication of the variation in temperature and precipitation in the vicinity of the study areas and across these canyon rangelands.

Generally, annual precipitation decreases from west to east in the canyonlands. Campbell's Ferry on the main Salmon River averaged 60 cm, Taylor Ranch 38 cm, Middle Fork Lodge 43 cm, and Challis 18 cm annually. The station having the lowest elevation, Campbell's Ferry, had the highest precipitation, while the highest station, Challis, had the least precipitation. The Salmon River and its South Fork lie within a 50-cm to 75-cm rainfall belt, the Middle Fork in a 25-cm to 50-cm belt, and the valleys containing the towns of Challis and Salmon lie in a rainfall belt of 25 cm or less (Finklin 1988). Riggins, Idaho, on the extreme western side of the region at 550 m msl, had 43 cm of annual precipitation. That portion of the Salmon River lies within a 38-cm to 50-cm rainfall belt, reflecting precipitation in the lower elevation and very deep canyon country of this area.

Approximately 50% of the precipitation came during November through March, with December and January being the wettest months, except in the eastern canyonlands, where May and June were the wettest. Total annual

snowfall at Challis averages 50 cm, at Middle Fork Lodge 135 cm, at Taylor Ranch 118 cm, and at Campbell's Ferry 182 cm.

Temperatures also show a gradient between the various portions of the study area, although they were not as pronounced as the moisture gradient. Challis had the lowest mean minimum temperature in January at -12°C, followed by Middle Fork Lodge (-11°C), Taylor Ranch (-10°C) and Campbell's Ferry (-7°C). Average maximum July temperatures at Challis were 30°C, at Middle Fork Lodge 30°C, at Taylor Ranch 31°C, and at Campbell's Ferry 33.5°C.

The pattern shows a slightly warmer, wetter climate on the northwest portion of the region and a slightly drier, cooler climate on the eastern side. Storms from the Pacific Ocean move up the Columbia River system into the Salmon River canyons. The eastern rangelands are located within a rain shadow and receive more influence from interior continental weather patterns.

Geology and Soils

Soils in the Middle Fork drainage primarily derive from granitic Idaho batholith parent material. This batholith formed during the Cretaceous period more than 55 million years ago. Shallow, coarse soils, interspersed with granitic outcroppings, characterize the ridges (Larson and Lovely 1972, Ross and Savage 1967).

In the East Fork and on some areas in the Middle Fork, Challis volcanics of tertiary age constitute the predominant formation (Ross and Savage 1967, Moye et al. 1988). The major portion of the area is composed of latite and andesite flows and flow breccia. The upper East Fork portions of the study area are underlain by Germer tuffaceous material, which is the result of explosive volcanic ash showers. Soils derived from the Challis volcanics are generally very fertile (Ralm and Larson 1972). A north to south gradient of a more moist climate but less fertile substrate on the northern portions trends to a less moist but more fertile substrate on the southern portions of the Salmon River Mountains.

Methods

Our data come from Herd Creek, a tributary of the East Fork of the Salmon River, the East Fork of the Salmon River, the Middle Fork of the Salmon, Big Creek (a tributary of the Middle Fork), and the main Salmon River from the Shepp Ranch to the Campbell's Ferry area. Field investigations involved establishing twenty $0.1m^2$ rectangular plots on randomly selected sites (Daubenmire 1959) to obtain canopy coverage and frequency of herbaceous

and low-growing plants. Canopy coverage of each species in each plot was estimated to be in one of six standard categories: 1) 0-5%; 2) 6-25%; 3) 26-50%; 4) 51-75%; 5) 76-95%; 6) 96-100%. Canopy coverage is defined as the vertical projection to ground level of the maximum aerial canopy of the species within the sample plot (Daubenmire 1959).

Productivity of grasses involved clipping study species to 1 cm above ground level in late June when plants were in full flower. Twenty 0.1m^2 plots were clipped at each site. Materials were placed in paper bags, oven-dried for at least 24 hours at 70^{0}C, and measured to the nearest 0.01 gm.

Density of shrubs was tabulated from six 9.2 m^2 circular plots established on each sample site. Presence or absence of each species and frequency were the common measurements for all study sites. Each site was inspected to ensure it represented the vegetation complex to be measured and that the sample area included no ecotones or other communities. Sites selected for this analysis did not show current evidence of disturbance, although evidence of past disturbance, primarily grazing, was apparent in some stands as revealed by examination of species composition.

The classification was guided by program TWINSPAN (Hill et al. 1979), which classifies stands and species according to affinities and produces an ordered two-way table that expresses species' synecological relationships. A Bray-Curtis ordination program (McCune and Mefford 1999) was used to identify relationships between individual species in the East Fork, where substrates were similar. McCune et al. (2002) provide information suggesting this method is a robust means of assessing species relationships. All annual species were omitted in both the classification and ordination. We use the analyses along with information from other vegetation classification investigations of nearby regions, plus observations of stand conditions to interpret our information. Common and scientific names of plants appear in Table 1. Nomenclature follows Hitchcock and Cronquist (1973) and the USDA Natural Resources Conservation Service National Plant Database (1998 website: plants.usda.gov).

Exclosure studies reported by Peek (2000) are expanded upon here because they illustrate changes in vegetation in the Middle Fork drainage. We randomly established a transect of twenty 0.1m^2 plots on representative sites inside exclosures and on similar adjacent sites. Plots were 1 m apart. When more than one vegetative type or topographical situation was present in an exclosure, we established paired plots inside and outside for each type where possible. We examined vegetation to determine if the fences appeared to influence composition and avoided locations immediately adjacent to

Table 1a. Scientific and common names of plant species named in this study.

Woody Plants

Amelanchier alnifolia	Serviceberry
Acer glabrum	Mountain maple
Artemisia tridentata ssp. *tridentata*	Basin big sagebrush
Artemisia tridentata	Big sagebrush
Artemisia tridentata ssp. *vaseyana*	Mountain big sagebrush
Artemisia tridentata ssp. *wyomingensis*	Wyoming big sagebrush
Artemisia tripartita	Threetip sagebrush
Artemisia arbuscula	Low sagebrush
Artemisia nova	Black sagebrush
Atriplex canescens	Fourwing saltbush
Atriplex confertifolia	Shadscale saltbush
Berberis repens	Oregon grape
Ceanothus sanguineus	Redstem ceanothus
Ceanothus velutinus	Shinyleaf ceanothus
Cercocarpus ledifolius	Curlleaf mountain mahogany
Chondrilla juncea	Skeletonweed
Chrysothamnus viscidiflorus	Green rabbitbrush
Ericameria nauseosa	Heath goldenrod
Eriogonum caespitosum	Mat buckwheat
Eriogonum heracleoides	Parsnip-flowered buckwheat, Wyeth buckwheat
Eriogonum microthecum	Slenderbush buckwheat
Eriogonum ovalifolium	Oval-leafed buckwheat
Glossopetalon nevadense	Little greenbush
Holodiscus discolor	Ocean-spray
Juniperus spp.	Juniper
Leptodactylon pungens	Granite prickly phlox
Lonicera utahensis	Utah honeysuckle
Opuntia polyacantha	Prickly pear
Philadelphus lewisii	Syringa
Phlox hoodii	Hood's phlox
Physocarpus malvaceus	Mallow ninebark
Pinus flexilis	Limber pine
Pinus ponderosa	Ponderosa pine
Potentilla fruticosa	Shrubby cinquefoil
Prunus virginiana	Chokecherry
Pseudotsuga menziesii	Douglas fir
Purshia tridentata	Antelope bitterbrush
Ribes aureum	Golden currant
Ribes cereum	Wax currant
Rosa spp.	Roses
Rosa gymnocarpa	Baldhip rose
Rubus parviflorus	Thimbleberry
Sambucus cerulea	Blueberry elder
Spiraea betulifolia	Birchleaf spirea
Symphoricarpos albus	Common snowberry
Symphoricarpos oreophilus	Mountain snowberry

Grasses

Achnatherum hymenoides	Indian ricegrass
Achnatherum lettermanii	Letterman's needlegrass
Achnatherum thurberianum	Thurber's needlegrass
Bromus tectorum	Cheatgrass
Calamagrostis rubescens	Pinegrass
Carex geyeri	Elk sedge
Danthonia spp.	Oatgrass
Elymus cinereus	Basin wildrye
Festuca idahoensis	Idaho fescue
Festuca octoflora	Six-week's fescue
Hesperostipa comata	Needle-and-thread
Koeleria cristata	Junegrass
Melica spp.	Oniongrass
Poa secunda	Sandberg bluegrass
Poa spp.	Bluegrasses
Pseudoroegneria spicata	Bluebunch wheatgrass
Sitanion hystrix	Bottlebrush squirreltail
Sporobolus cryptandrus	Sand dropseed

Forbs or Herbs

Achillea millefolium	Yarrow
Actaea rubra	Baneberry
Adenocaulon bicolor	Trail plant
Agoseris glauca	False dandelion
Arabis holboellii	Rockcress
Arenaria congesta	Ballhead sandwort
Antennaria dimorpha	Pussy-toes
Antennaria microphylla	Roseate pussy-toes
Apocynum androsaemifolium	Dogbane
Arnica cordifolia	Heartleaf arnica
Arnica sororia	Arnica
Aster spp.	Asters
Astragalus filipes	Threadstalk milkvetch
Astragalus spp.	Locoweeds
Balsamorhiza hookeri	Hooker's balsamroot
Balsamorhiza sagittata	Arrowleaf balsamroot
Castilleja inverta	Dwarf pale Indian paintbrush
Castilleja spp.	Paintbrushes
Centaurea spp.	Knapweeds
Cerastium arvense	Chickweed
Collinsia parviflora	Blue-eyed Mary
Cirsium utahense	Utah thistle
Crepis atrabarba	Hawksbeard
Epilobium angustifolium	Fireweed
Epilobium minutum	Small-flowered willow-herb
Erigeron spp.	Fleabane
Frasera albicaulis	Frasera
Fragaria vesca	Woods strawberry
Fragaria spp.	Strawberry
Galium spp.	Bedstraw
Geranium viscosissimum	Sticky geranium
Geum triflorum	Prairie smoke
Heuchera cylindrica	Alumroot
Hieracium albertinum	Hawkweed, Albert Hawkweed
Lewisia rediviva	Bitterroot
Lithophragma parviflora	Woodland star
Lithospermum ruderale	Gromwell
Lomatium foeniculaceum	Harryseed lomatium
Lomatium spp.	Biscuitroots
Lupinus spp.	Lupines
Mentzelia albicaulis	Whitestem mentzelia
Mertensia spp.	Bluebell
Montia spp.	Miner's lettuce
Myosotis spp.	Forget-me-not
Osmorhiza chilensis	Mountain sweet-cicely
Penstemon spp.	Penstemons
Phacelia linearis	Threadleaf phacelia
Phacelia spp.	Phacelia
Phlox longifolia	Longleaf phlox
Polygonum douglasii	Smartweed
Potentilla gracilis	Cinquefoil
Pyrola secunda	Wintergreen
Sedum stenopetalum	Stonecrop
Senecio integerrimus	Groundsel
Silene acaulis	Moss campion
Sisymbrium altissimum	Tumblemustard
Smilacina stellata	Starry false Solomon's seal
Solidago canadensis	Goldenrod
Thalictrum occidentale	Meadow rue
Tragopogon dubius	Salsify
Trifolium spp.	Clovers
Viola adunca	Hook violet

Mosses and Ferns

Selaginella densa	Lesser clubmoss
Woodsia oregana	Woods fern

Table 1b. Common and scientific names of plant species named in this study.

Woody Plants

Antelope bitterbrush	*Purshia tridentata*
Baldhip rose	*Rosa gymnocarpa*
Basin big sagebrush	*Artemisia tridentata* ssp. *tridentata*
Big sagebrush	*Artemisia tridentata*
Birchleaf spirea	*Spiraea betulifolia*
Black sagebrush	*Artemisia nova*
Blueberry elder	*Sambucus cerulea*
Chokecherry	*Prunus virginiana*
Common snowberry	*Symphoricarpos albus*
Curlleaf mountain mahogany	*Cercocarpus ledifolius*
Douglas fir	*Pseudotsuga menziesii*
Fourwing saltbush	*Atriplex canescens*
Golden currant	*Ribes aureum*
Granite prickly phlox	*Leptodactylon pungens*
Green rabbitbrush	*Chrysothamnus viscidiflorus*
Heath goldenrod	*Ericameria nauseosa*
Hood's phlox	*Phlox hoodii*
Juniper	*Juniperus* spp.
Limber pine	*Pinus flexilis*
Little greenbush	*Glossopetalon nevadense*
Low sagebrush	*Artemisia arbuscula*
Mallow ninebark	*Physocarpus malvaceus*
Mat buckwheat	*Eriogonum caespitosum*
Mountain big sagebrush	*Artemisia tridentata* ssp. *vaseyana*
Mountain maple	*Acer glabrum*
Mountain snowberry	*Symphoricarpos oreophilus*
Ocean-spray	*Holodiscus discolor*
Oregon grape	*Berberis repens*
Oval-leafed buckwheat	*Eriogonum ovalifolium*
Parsnip-flowered buckwheat	*Eriogonum heracleoides*
Ponderosa pine	*Pinus ponderosa*
Prickly pear	*Opuntia polyacantha*
Prickly phlox	*Leptodactylon pungens*
Redstem ceanothus	*Ceanothus sanguineus*
Roses	*Rosa* spp.
Serviceberry	*Amelanchier alnifolia*
Shadscale saltbush	*Atriplex confertifolia*
Shinyleaf ceanothus	*Ceanothus velutinus*
Shrubby cinquefoil	*Potentilla fruticosa*
Skeletonweed	*Chondrilla juncea*
Slenderbush buckwheat	*Eriogonum microthecum*
Syringa	*Philadelphus lewisii*
Thimbleberry	*Rubus parviflorus*
Threetip sagebrush	*Artemisia tripartita*
Utah honeysuckle	*Lonicera utahensis*
Wax currant	*Ribes cereum*
Wyeth buckwheat	*Eriogonum heracleoides*
Wyoming big sagebrush	*Artemisia tridentata* ssp. *wyomingensis*

Grasses

Basin wildrye	*Elymus cinereus*
Bluebunch wheatgrass	*Pseudoroegneria spicata*
Bluegrasses	*Poa* spp.
Bottlebrush squirreltail	*Sitanion hystrix*
Cheatgrass	*Bromus tectorum*
Elk sedge	*Carex geyeri*
Idaho fescue	*Festuca idahoensis*
Indian ricegrass	*Achnatherum hymenoides*
Junegrass	*Koeleria cristata*
Letterman's needlegrass	*Achnatherum lettermanii*
Needle-and-thread	*Hesperostipa comata*
Oatgrass	*Danthonia* spp.
Oniongrass	*Melica* spp.
Pinegrass	*Calamagrostis rubescens*
Sand dropseed	*Sporobolus cryptandrus*
Sandberg bluegrass	*Poa secunda*
Six-week's fescue	*Festuca octoflora*
Thurber's needlegrass	*Achnatherum thurberianum*

Forbs or Herbs

Albert hawkweed	*Hieracium albertinum*
Alumroot	*Heuchera cylindrica*
Arnica	*Arnica sororia*
Arrowleaf balsamroot	*Balsamorhiza sagittata*
Asters	*Aster* spp.
Ballhead sandwort	*Arenaria congesta*
Baneberry	*Actaea rubra*
Bedstraw	*Galium* spp.
Biscuitroots	*Lomatium* spp.
Bitterroot	*Lewisia rediviva*
Bluebell	*Mertensia* spp.
Blue-eyed Mary	*Collinsia parviflora*
Chickweed	*Cerastium arvense*
Cinquefoil	*Potentilla gracilis*
Clovers	*Trifolium* spp.
Dogbane	*Apocynum androsaemifolium*
Dwarf pale Indian paintbrush	*Castilleja inverta*
False dandelion	*Agoseris glauca*
Fireweed	*Epilobium angustifolium*
Fleabane	*Erigeron* spp.
Forget-me-not	*Myosotis* spp.
Frasera	*Frasera albicaulis*
Goldenrod	*Solidago canadensis*
Gromwell	*Lithospermum ruderale*
Groundsel	*Senecio integerrimus*
Harryseed lomatium	*Lomatium foeniculaceum*
Hawksbeard	*Crepis atrabarba*
Hawkweed	*Hieracium albertinum*
Heartleaf arnica	*Arnica cordifolia*
Hook violet	*Viola adunca*
Hooker's balsamroot	*Balsamorhiza hookeri*
Knapweeds	*Centaurea* spp.
Locoweeds	*Astragalus* spp.
Longleaf phlox	*Phlox longifolia*
Lupines	*Lupinus* spp.
Meadow rue	*Thalictrum occidentale*
Miner's lettuce	*Montia* spp.
Moss campion	*Silene acaulis*
Mountain sweet-cicely	*Osmorhiza chilensis*
Paintbrushes	*Castilleja* spp.
Penstemons	*Penstemon* spp.
Phacelia	*Phacelia* spp.
Prairie smoke	*Geum triflorum*
Pussy-toes	*Antennaria dimorpha*
Rockcress	*Arabis holboellii*
Roseate pussy-toes	*Antennaria microphylla*
Salsify	*Tragopogon dubius*
Small-flowered willow-herb	*Epilobium minutum*
Smartweed	*Polygonum douglasii*
Starry false Solomon's seal	*Smilacina stellata*
Sticky geranium	*Geranium viscosissimum*
Stonecrop	*Sedum stenopetalum*
Strawberry	*Fragaria* spp.
Threadleaf phacelia	*Phacelia linearis*
Threadstalk milkvetch	*Astragalus filipes*
Trail plant	*Adenocaulon bicolor*
Tumblemustard	*Sisymbrium altissimum*
Utah thistle	*Cirsium utahense*
Whitestem mentzelia	*Mentzelia albicaulis*
Wintergreen	*Pyrola secunda*
Woodland star	*Lithophragma parviflora*
Woods strawberry	*Fragaria vesca*
Yarrow	*Achillea millefolium*

Mosses and Ferns

Lesser clubmoss	*Selaginella densa*
Woods fern	*Woodsia oregana*

fences.

Woody plant density in and adjacent to exclosures was measured in twenty $4m^2$ circular plots (1.13 m radius) adjacent to the herbaceous transects. Counts of stems were made at ground level inside plots. Where individual plants had crowns with stems rising just below or at ground level and were obviously one plant, one plant was recorded. This occurred with antelope bitterbrush, curlleaf mountain mahogany, big sagebrush, currants (*Ribes* spp.), heath goldenrod (*Ericameria nauseosa*), green rabbitbrush (*Chrysothamnus viscidiflorus*), and mallow ninebark (*Physocarpus malvaceus*) in this area. Height of a representative plant of each species in the plot was recorded. Dead plants were recorded when present, and percentage of decadent growth on each shrub was estimated.

Twigs, representing current annual growth (CAG) over 1 cm long, were counted for each species inside each plot. The plot was envisioned as a cylinder; twigs within the cylinder were counted whether originating from stems that occurred inside or not. A twig density was calculated to serve as a partial measure of productivity. Lengths of 50 or more randomly selected twigs were measured, air-dried, and individually weighed. The entire collection was then weighed and oven-dried at 70° C for 24 hours and reweighed. The ratio of oven-dried weight to air-dried weight was multiplied for each twig weight to convert to the oven dried weight for each individual twig. Photographs were taken of all stands, and a description of the location of each transect was recorded.

Comparisons of exclosures and adjacent unprotected sites were made using midpoints of the coverage estimation classes, and standard descriptive statistics for each species on the site were obtained using SAS-PC or STATISTIX. Paired T-tests were used to determine significant differences (P=0.05) for selected vegetative parameters inside and outside of the exclosures. Coverage and density data were transformed using log (number+ 1) to account for nonnormal distributions. A Wilcoxon test also was used to compare with the t-tests, but no changes in conclusions resulted from the t-test comparisons.

Results

Species Relationships

A total of 35 perennial species in 63 stands in the East Fork were included in the Bray-Curtis ordination. Moisture and temperature gradients explained 81% of the variance in the analysis, with moisture explaining 61% of the variance and the temperature explaining approximately 20%. The moisture gradient is more extended than the temperature gradient, reflecting the typical

extremes for both attributes that occur on these steppe communities.

Eight grasses and sedges are positioned along the two gradients (Figure 2). As would be expected from its broad distribution in the intermountain west, bluebunch wheatgrass occupies the middle portions of both moisture and temperature gradients. This species is a major climax dominant as well as a major component of many sites where it is not the most dominant plant.

Idaho fescue, the other major climax dominant grass in this region, occupies cooler and moister habitats than bluebunch wheatgrass. Both species have a broad ecological amplitude, since they may occur as dominant understory plants in Douglas fir (*Pseudotsuga menziesii*) and ponderosa pine (*Pinus ponderosa*) forests in this region (Steele et al. 1981).

Indian ricegrass (*Achnatherum hymenoides*) occupies the hot, dry ends of the gradients. It appears to have a fairly narrowly defined habitat requirement in this region, and most commonly occurs in the East Fork.

Needle-and-thread occupies drier portions of the moisture gradient, and is common at low elevations in the bigger valley portions of the Middle Fork, for instance around Brush Creek and Warm Springs Creek.

Junegrass (*Koeleria cristata*) occupies a moister portion on the gradient

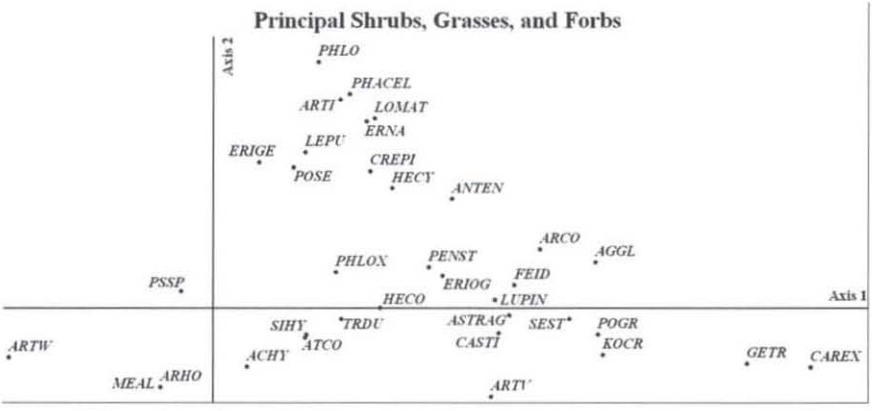

Figure 2. Ordination of principal grasses, shrubs and forbs found in stands examined in the East Fork drainage along moisture and temperature axes. ACHY= *Achnatherum hymenoides*, AGGL= *Agoseris glauca*, ANTEN= *Antennaria* spp., ARCO= *Arenaria congesta*, ARHO= *Arabis holboelli*, ARTV= *Artemisia tridentata vaseyana*, ARTW= *Artemisia tridentata wyomingensis*, ASTRAG= *Astragalus* spp., ATCO= *Atriplex confertifolia*, CAREX = *Carex* spp., CASTI= *Castilleja* spp., CREPI= *Crepis* sp., ERIGE= *Erigeron* spp., ERIOG= *Eriogonum* spp., ERNA= *Ericameria nauseosa*, FEID= *Festuca idahoensis*, GETR= *Galium triflorum*, HECO= *Hesperostipa comata*, HECY= *Heuchera cylindrica*, KOCR= *Koeleria cristata*, LEPU= *Leptodactylon pungens*, LOMAT= *Lomatium* spp., LUPIN= *Lupinus* spp., MEAL= *Mentzelia albicaulis*, PENST= *Penstemon* spp., PHACEL= *Phacelia* spp., PHLO= *Phlox longifolia*, PHLOX= *Phlox* spp., POSE= *Poa secunda*, POGR= *Potentilla gracilis*, PSSP= *Pseudoroegneria spicata*, SEST= *Sedum stenopetalum*, TRDU= *Tragopogon dubius*.

than Idaho fescue. Sandberg bluegrass (*Poa secunda*) is more closely associated with the drier side of the moisture gradient when using cover data rather than presence-absence data. These two species are the most common short grasses which occur as secondary plants beneath the more dominant, taller grasses in this region. Junegrass is more common at higher elevations and on the more mesic sites, while Sandberg bluegrass is more frequent at lower elevations and more xeric sites. Both species dry to a gray litter by mid- to late summer, but green growth starts in fall with the initial rains.

Cheatgrass is a ubiquitous annual most common on the drier sites. We chose not to consider it in the classification because of its exotic status, but it must be considered a permanent occupant of many plant communities in the region. Cheatgrass closely approximates the water requirements of bluebunch wheatgrass (Harris 1967), and coexists with the native species on many sites. In extreme cases of disturbance, caused by fire in some habitats, grazing in others, and extended camping and associated human use in still others, cheatgrass may dominate and replace the native species. Cheatgrass has become the dominant grass on many sites in the Middle Fork where the fires of 2000 occurred, but our photographs of the plant communities were taken before these fires and illustrate the appearance of the vegetation prior to this dominance.

The sagebrushes illustrate unique and rather subtle adaptations to different habitats in this region. The sagebrushes consist of three species, low sagebrush (*Artemisia arbuscula*), threetip sagebrush, and big sagebrush, with big sagebrush further separated into three subspecies: basin big sagebrush (*A. tridentata* ssp. *tridentata*), Wyoming big sagebrush (*A. tridentata* ssp. *wyomingensis*), and mountain big sagebrush (*A. tridentata* ssp. *vaseyana*), that occupy different habitats and are morphologically distinguishable by their leaves (Hironaka et al. 1983). Mountain big sagebrush occupies the higher elevation cold dry sites, while Wyoming big sagebrush occupies the driest and warmest sites. Basin big sagebrush occurs along streams and valleys, especially in the eastern portions of the region. Threetip sagebrush occupies a slightly moister and warmer habitat than does mountain big sagebrush. Low sagebrush occupies a specific habitat of poorly drained soils underlain by a clay pan and may be supersaturated into early summer (Hironaka et al. 1983). We found it in the East Fork on rocky benches at mid-elevations and ridgetops that exhibited these soil characteristics. Schultz (1986) classified the habitats occupied by the sagebrushes according to a moisture gradient, with basin big sagebrush occupying the most mesic sites, followed by mountain big sagebrush, threetip sagebrush, and low sagebrush. Wyoming big sagebrush

occupied the most xeric sites.

Antelope bitterbrush was not included in the ordination because it was scarce or absent in most of the areas examined in the East Fork drainage. It commonly occurs with mountain big sagebrush as a dominant, as a major understory species under ponderosa pine, and as a seral species in Douglas fir-common snowberry stands on the South Fork and the Middle Fork (Steele et al. 1981, Peek et al. 1978).

Curlleaf mountain mahogany and little greenbush (*Glossopetalon nevadense*) are Great Basin species that persist on the northern edges of their ranges in these canyon rangelands. They occupy unique habitat on cliffs along the river systems and the drier portions of the moisture gradient. Curlleaf mountain mahogany, the species with the broadest ecological amplitude of the two, occurs on slopes with Idaho fescue and antelope bitterbrush as well as on rocky river bars. Little greenbush is primarily confined to cliffs in this region.

Chokecherry (*Prunus virginiana*) tends to occupy warmer habitats than serviceberry (*Amelanchier alnifolia*). Common snowberry occurs on warmer habitats than does mountain snowberry (*Symphoricarpos oreophilus*).

Forbs generally are more abundant on the more mesic, cooler habitats (Figure 2). The more succulent forbs, such as the cinquefoils (*Potentilla gracilis*), fleabanes (*Erigeron* spp.), locoweeds (*Astragalus* spp.), hawkweeds (*Hieracium albertinum*) and balsamroots (*Balsamorhiza* spp.), tend to occupy the wetter portions of the moisture gradients. Bitterroot (*Lewisia rediviva*), phacelia (*Phacelia* spp.), pussy-toes (*Antennaria dimorpha*), and sandworts (*Arenaria* spp.) occupy more xeric portions of the moisture gradient. Whitestem mentzelia (*Mentzelia albicaulis*) and rockcress (*Arabis holboellii*) are present on the drier ends of the moisture gradient in the ordination.

The forb complex best expresses itself on the northern and western portions of the study area, where the climate is more moist and warm. The drier sites along the East Fork support fewer species, but even here, sites at higher elevations where more moisture falls appear to have as many species as do comparable sites farther north and west. This shrub steppe produces a relatively high number of annual forbs, which grow and flower in spring and early summer.

Plant Communities

Three attributes of the vegetation pattern stand out for the region, coinciding with the moisture gradient. First, sagebrush communities are common and well developed on the southern portions of the area, and

become scarce and less well developed along the main Salmon River and in the South Fork. Second, the more mesic shrub-steppe communities tend to occur as understories in Douglas fir or ponderosa pine communities. Thus, an Idaho fescue/Bluebunch wheatgrass community may be positioned next to a Douglas fir stand, where the herbaceous union appears much the same as it would without the conifer component. Third, an increasingly larger component of forbs occurs in the communities along the southeast to northwest gradient. Table 2 lists constancy and frequency of species in the following shrub-steppe communities. Table 3 provides a key to the nonforested shrub-steppe communities.

Bluebunch wheatgrass/Sandberg bluegrass Community

On dry sites, a community dominated by bluebunch wheatgrass occurs without the presence of a large, dominant forb (Figure 3). Sandberg bluegrass typically is present but may be absent on the most xeric sites. We examined five stands, including two in the Middle Fork and three in Big Creek. Cheatgrass invades all the stands, which also are susceptible to invasion by noxious weeds such as knapweed and skeletonweed (*Chondrilla juncea*).

Tisdale (1986) classified these communities as being in the Bluebunch wheatgrass/Arrowleaf balsamroot/Sandberg bluegrass community in spite of the absence of arrowleaf balsamroot (*Balsamorhiza sagittata*). However, he

Figure 3. A Bluebunch wheatgrass/Sandberg bluegrass community in the Pole Creek area, Middle Fork Salmon River, June 1973.

Table 2. Constancy and frequency of plant species found in shrub-steppe communities in the East Fork and Middle Fork of the Salmon River, Idaho. Constancy is the percentage of stands in which the species occurred. Frequency is the percentage of plots in each stand in which the species occurred, averaged over all stands for the community.

SPECIES	PSSP	PSSP	PSSP	FEID	ARTRT	ARTRW	ARTRW	ARTRV	ARTRV	ARTR4	ARTR4	ARAR	ARAR	ATCO	ATCO	PUTR	PUTR	GLNE	CELE
	POSE	POSE	POSE	PSSP	PSSP	PSSP	PSSP	PSSP	FEID	PSSP	FEID	PSSP	FEID	SPCR	ACHY	FEID	PSSP		
		HECO	BASA				POSE												
Amelanchier alnifolia																			17/1.
Artemisia arbuscula												+/90	+/90						
Artemisia nova														50/1					
Artemisia spinescens														100/1	67/8				
Artemisia tridentata t.					100/45														
Artemisia t. vaseyana								100/72	100/53			+/90				20/1	43/1		17/9.
Artemisia t. wyomingensis						100/42	100/46								67/5				
Artemisia tripartita										100/59	100/67	+/5							
Atriplex canescens															33/1				
Atriplex confertifolia														100/8	100/30				
Cercocarpus ledifolius																			100/20
Chrysothamnus viscidflorus					50/1	50/1.	22/1.	27/2	40/2.			+/5							
Ericameria nauseosa								45/1	30/1.		55/6			100/1	33/1	40/1	29/1		1/1.
Eriogonum caespitosum						100/10	11/1.	18/1	20/2.										
E. heracleoides	25/10							18/1	10/4.			+/65							33/2.
E. microthecum			11/2.			28/1.	55/1.			14/2							29/1		

Table 2 (continued). Constancy and frequency of plant species found in shrub-steppe communities, East Fork and Middle Fork of the Salmon River, Idaho.

SPECIES	PSSP	PSSP	PSSP	FEID	ARTRT	ARTRW	ARTRW	ARTRV	ARTRV	ARTR4	ARTR4	ARAR	ARAR	ATCO	ATCO	PUTR	PUTR	GLNE	CELE
	POSE	POSE	POSE	PSSP	PSSP	PSSP	PSSP	PSSP	FEID	PSSP	FEID	PSSP	FEID	SPCR	ACHY	FEID	PSSP		
		HECO	BASA				POSE												
E. ovalifolium	33/1	6/1.	67/5	42/1.			18/1.		40/3		55/10					100/5		30/1	50/2
E. umbellatum										43/5									
Glossopetalon nevadense								9/1.									14/1	100/27	
Leptodactylon pungens			6/1.			7/1.	27/1.	18/2		43/20	11/7.								
Penstemon deustus	66/7	20/1	17/1.							14/2	11/1.						14/1.		
Philadelphus lewisii																		20/1.	67/1.
Phlox hendersonii										14/4	22/6.								
Phlox hoodii						33/2.	64/2.	27/5	10/1.	28/3	44/17	+/80	+/5						
Phlox longifolia	33/3		22/5	46/28				73/16	20/8	14/1	11/2.								83/11
Prunus virginiana								9/1.									14/2		
Purshia tridentata								36/1								100/12	100/12	20/1.	17/2.
Ribes cereum	25/1				50/1	17/1.													34/1
Ribes velutinum								18/1									14/1	20/1.	55/2
Sambucus cerulea																		10/1.	
Symphoricarpos albus	33/3																		
Symphoricarpos oreophilus									30/4.										
Achnatherum hymenoides														100/23	100/37				

SPECIES	PSSP	PSSP	PSSP	FEID	ARTRT	ARTRW	ARTRW	ARTRV	ARTRV	ARTR4	ARTR4	ARAR	ARAR	ATCO	ATCO	PUTR	PUTR	GLNE	CELE
	POSE	POSE	POSE	PSSP	PSSP	PSSP	PSSP	PSSP	FEID	PSSP	FEID	PSSP	FEID	SPCR	ACHY	FEID	PSSP		
		HECO	BASA				POSE												
Achnatherum thurberianum							9/2.												
Bromus tectorum	100/30	20/19	94/62	83/3	50/13			45/27	20/80	14/13.	11/4.					100/52	100/59	100/54	100/55
Calamagrostis rubescens+A85				8/2.															
Carex petasata			6/2.	8/2.					60/11		11/1.	/5							
Elymus cinereus					50/10														
Festuca idahoensis				100/37					100/66		100/44		/80			100/24		40/2	95/20
Festuca octoflora			11/1.	13/9.				27/4.											
Hesperostipa comata		100/58		4/1.	50/17							/10		100/18			28/9	10/2.	30/4
Poa nevadensis														100/8					
Poa secunda	66/11																		
Pseudoroegneria spicata	100/41	100/65	100/62	100/72	100/38	100/69	100/75	100/72	80/16	100/85	100/54	/40	/50		66/30	100/64	100/43	100/44	100/62
Sitanion hystrix					50/25		9/4.					/55		100/32	66/3				
Sporobolus cryptandrus														100/78					
Achillea millefolium	66/14	40/1	72/7	83/22				27/1.	20/5.	14/4.	11/1.					60/10	57/7	20/1	34/3
Agoseris glauca	33/2		11/1.	42/8				27/1	20/7	14/1.								10/1.	17/12
Allium spp.			17/1.				9/1.							50/3					
Amsinckia lycopsoides			28/2	4/1.				9/1.								60/3			
Anaphalus margaritacea									10/8.										
Antennaria dimorpha	25/2			29/5				9/2.											

Table 2 (continued). Constancy and frequency of plant species found in shrub-steppe communities, East Fork and Middle Fork of the Salmon River, Idaho.

SPECIES	PSSP	PSSP	PSSP	FEID	ARTRT	ARTRW	ARTRW	ARTRV	ARTRV	ARTR4	ARTR4	ARAR	ARAR	ATCO	ATCO	PUTR	PUTR	GLNE	CELE
	POSE	POSE	POSE	PSSP	PSSP	PSSP	PSSP	PSSP	FEID	PSSP	FEID	PSSP	FEID	SPCR	ACHY	FEID	PSSP		
		HECO	BASA				POSE												
Antennaria microphylla						17/1	18/1	18/1.	70/42	86/30	88/40	/50	/5						
Apocynum androsaemifolium	33/4	20/7	11/1.	8/3.													14/2		
Arabis holboellii		40/1	6/1.	38/6	50/3		18/1	42/4	30/2								28/1	20/3	
Arabis californica			6/1.	17/1.															
Aralia californica			6/1.						10/1.	14/2.						20/2	28/2		
Aralia nudicaulis	33/3										11/1.								
Arenaria congesta				8/3.			9/1.		30/16	43/16	11/2.	/80	/65						
Arnica cordifolia				4/1.															
Arnica sororia				13/3.															
Aster spp.		40/1	6/1.	4/1.					10/1.								43/1		
Aster scopulorum							27/9					+/80	+/60						
Aster purshii								29/1											
Astragalus filipes								36/7	60/31	29/4		+/60	+/75						17/6
Astragalus purshii	33/2	20/1	6/1.			3/1.	36/1		10/1.							20/2			
Astragalus stenophyllus		20/1	28/3	33/12					10/1.		44/4								
Balsamorhiza hookeri				17/6															
Balsamorhiza incana				13/1.															17/1

Balsamorhiza sagittata			61/11	63/19				36/2	20/1.							60/7	57/1	10/1.	83/8
SPECIES	PSSP	PSSP	PSSP	FEID	ARTRT	ARTRW	ARTRW	ARTRV	ARTRV	ARTR4	ARTR4	ARAR	ARAR	ATCO	ATCO	PUTR	PUTR	GLNE	CELE
	POSE	POSE	POSE	PSSP	PSSP	PSSP	PSSP	PSSP	FEID	PSSP	FEID	PSSP	FEID	SPCR	ACHY	FEID	PSSP		
		HECO	BASA				POSE												
Castilleja inverta	25/+			29/5.				18/2	70/7		22/7								17/2
Castilleja spp.			6/1.		50/3		27/1		10/4.				+/20						
Chaenactis douglasii		80/1	17/2	4/1.													28/1	20/1	
Chenopodium album						5/1.													
Cirsium utahense		20/1	44/2	8/1.			1/1.	27/1								40/6	57/1		
Clarkia pulchella																	14/11	10/2.	
Collinsia parviflora	25/12	20/1	28/7	50/27				18/6	50/8								43/6	10/10	17/14
Collomia linearis			33/1	29/10				9/1.											
Coryphantha vivipara								18/5											
Crepis acuminata						28/1	18/1	18/1	10/1.			+/10	+/60						
Crepis atrabarba	25/12			33/3				9/1.		43/9									34/1
Cryptantha pulchella			6/1.																
Cryptantha scoparia																		10/1.	
Cryptantha watsonii				4/1.															
Cymopterus bipinnatus													+/70						
Delphinium bicolor				4/1.															
Descurainia pinnata	33/11	100/10	33/8	29/6	100/5			36/3	10/1.					100/30	33/2		43/2	70/12	
Dodecatheon conjugens				8/3.															
Epilobium paniculatum		80/3	50/6	13/1.				27/2										30/3	

Table 2 (continued). Constancy and frequency of plant species found in shrub-steppe communities, East Fork and Middle Fork of the Salmon River, Idaho.

Erigeron compositus	33/1						18/1				11/2.								10/1.
SPECIES	PSSP	PSSP	PSSP	FEID	ARTRT	ARTRW	ARTRW	ARTRV	ARTRV	ARTR4	ARTR4	ARAR	ARAR	ATCO	ATCO	PUTR	PUTR	GLNE	CELE
	POSE	POSE	POSE	PSSP	PSSP	PSSP	PSSP	PSSP	FEID	PSSP	FEID	PSSP	FEID	SPCR	ACHY	FEID	PSSP		
		HECO	BASA				POSE												
Erigeron pumilus		40/1	11/1.	21/2			9/3.	36/8	10/2.										
Erysimum asperum				4/1.															
Frasera albicaulis			6/1.	4/1.															17/1
Frasera atropurpurea				4/1.															
Frasera speciosa									10/1.										
Fritillaria pudica	25/1			25/2.				18/1											
Galium triflorum			28/5							14/1								10/2.	17/2
Geum triflorum	25/1			25/5					50/7		11/1.								
Gilia aggregata								18/1	10/1.								14/1		34/4
Gilia tenerrima			11/2.	4/1.				9/1.										10/1.	
Hackelia cinerea		20/1.	28/3					10/1.									14/4		
Haplopappus acaulis							18/6												
Heuchera cylindrica				8/10.					50/5	28/3	22/2.								
Hieracium albertinum				21/1.														10/1.	34/1
Hymenopappus filifolius													+/5						
Hypericum perforatum	33/2																		
Lappula redowskii					100/13														

Lepidium spp.														50/3					
SPECIES	PSSP	PSSP	PSSP	FEID	ARTRT	ARTRW	ARTRW	ARTRV	ARTRV	ARTR4	ARTR4	ARAR	ARAR	ATCO	ATCO	PUTR	PUTR	GLNE	CELE
	POSE	POSE	POSE	PSSP	PSSP	PSSP	PSSP	PSSP	FEID	PSSP	FEID	PSSP	FEID	SPCR	ACHY	FEID	PSSP		
		HECO	BASA				POSE												
Lewisia rediviva			11/1.	8/1.				27/2					+/5					10/1.	
Lithophragma parviflora			6/1.	33/11														10/1.	17/1
Lithospermum ruderale	66/2		22/1	46/2					20/1							60/2	14/2	30/4	34/1
Lomatium spp.			50/14	13/4.			9/1.												17/1
Lomatium foeniculaceum	33/1	40/1.	6/1.					9/1.	10/1.		44/14							30/	
Lomatium triternatum				46/10				9/1.											
Lupinus sericeus	33/1	20/1.	56/4	58/9		45/1	54/2	9/1.	70/29	43/5	67/21					20/3	14/1		17/1
Machaeranthera canescens														50/1	33/1				
Mentzelia albicaulis		100/6	39/9	8/2.	50/10			27/2									57/7	40/3	
Mentzelia laevicaulis				4/1.															
Mertensia longiflora				4/1.															
Mertensia viridis									50/4		22/2								
Mimulus nanus		40/1	6/1.														14/1	40/1	
Montia siberica	25/1			4/1.															
Myosotis spp.				8/1.															
Opuntia polyacantha														50/7	66/1				
Pedicularis contorta										14/2									

Table 2 (continued). Constancy and frequency of plant species found in shrub-steppe communities, East Fork and Middle Fork of the Salmon River, Idaho.

Penstemon glandulosus				4/1.															
SPECIES	PSSP	PSSP	PSSP	FEID	ARTRT	ARTRW	ARTRW	ARTRV	ARTRV	ARTR4	ARTR4	ARAR	ARAR	ATCO	ATCO	PUTR	PUTR	GLNE	CELE
	POSE	POSE	POSE	PSSP	PSSP	PSSP	PSSP	PSSP	FEID	PSSP	FEID	PSSP	FEID	SPCR	ACHY	FEID	PSSP		
		HECO	BASA				POSE												
Penstemon spp.			28/2.		50/3		36/6							100/5		20/4	28/3	40/1	17/1
Penstemon procerus								9/2.	40/9	28/14	33/7		+/45						
Phacelia hastata		60/1															28/1	10/1.	17/1
Phacelia linearis	66/9	60/5	72/13	42/8				18/1	10/1.								57/5	80/15	17/2
Physaria geyeri			33/7	4/1.				18/1									28/2		
Polygonum douglasii	66/12		39/14	46/11						14/1						40/1	14/1	10/3.	17/2
Potentilla gracilis									20/8										
Ranunculus glaberrimus				4/1.															
Saxifraga spp.	25/2			25/5.					10/2.										17/4
Scutellaria antirrhinoides			11/2.					18/1											
Sedum lanceolatum									20/8	42/7	22/2	/15	+/45						
Sedum stenopetalum				13/4.															
Senecio integerrimus									40/4		11/6.		+/5					10/1.	
Silene acaulis			6/1.						10/2.										
Silene oregana	25/2	20/1		6/1.				9/1.											
Sisymbrium altissimum			6/1.															10/1.	
Stephanomeria exigua						3/1.												20/3	

Taraxacum officinale				17/2.	100/5								+/5						
SPECIES	PSSP	PSSP	PSSP	FEID	ARTRT	ARTRW	ARTRW	ARTRV	ARTRV	ARTR4	ARTR4	ARAR	ARAR	ATCO	ATCO	PUTR	PUTR	GLNE	CELE
	POSE	POSE	POSE	PSSP	PSSP	PSSP	PSSP	PSSP	FEID	PSSP	FEID	PSSP	FEID	SPCR	ACHY	FEID	PSSP		
		HECO	BASA				POSE												
Tragopogon dubius		60/2	39/1.	42/3	50/3			27/2	10/1.					100/10		20/1	42/1	10/1.	
Trifolium spp.		20/1	6/1.					9/1.										10/1.	
Valeriana acutiloba									10/4.										
Viola nuttallii											11/1.								
Woodsia oregana			11/1.	33/9													14/1	10/1.	17/1
Zygadenus venenosus																20/1			

[1]Species codes: ACHY= *Achnatherum hymenoides;* ARTRT= *Artemisia tridentata tridentata;* ARTRV= *Artemisia t. vaseyana;* ARTRW= *Artemisia t. wyomingensis;* ARTR4= *Artemisia tripartita;* ARAR= *Artemisia arbuscula;* ATCO= *Atriplex confertifolia;* BASA= *Balsamorhiza sagittata;* CELE= *Cercocarpus ledifolius;* FEID= *Festuca idahoensis;* GLNE= *Glossopetalon nevadense;* HECO= *Hesperostipa comata;* POSE= *Poa secunda;* PSSP= *Pseudoroegneria spicata;* PUTR= *Purshia tridentata;* SPCR= *Sporobolus cryptandrus.*

Table 3. Key to nonforested shrub-steppe communities, Salmon River Mountains, including the East Fork of the Salmon River, the Middle Fork of the Salmon, Big Creek (a tributary of the Middle Fork), and the main Salmon River from the Shepp Ranch to the Campbell's Ferry area.

1a. Douglas fir, Ponderosa pine, or other conifer species present 2
1b. Conifers not present 3a

2. Not shrub steppe: refer to Steele et al. (1981) for identification of forested communities, see discussion on page 45.

3a. Little greenbush present as more than occasional component; cliff sites. Curlleaf mountain mahogany/Little greenbush/Bluebunch wheatgrass community, page 41.
3b. Little greenbush absent or scarce; cliffs or other sites 4a

4a. Curlleaf mountain mahogany present as more than occasional component 5a
4b. Curlleaf mountain mahogany absent or scarce 6a

5a. Idaho fescue present–Curlleaf mountain mahogany/Idaho fescue community, page 43.
5b. Idaho fescue absent–Curlleaf mountain mahogany/Bluebunch wheatgrass community, page 44.

6a. Antelope bitterbrush present more than occasional component 7a
6b. Antelope bitterbrush absent or scarce 8a

7a. Idaho fescue present: Antelope bitterbrush/Idaho fescue community, page 40.
7b. Idaho fescue absent: Antelope bitterbrush/Bluebunch wheatgrass community, page 38.

8a. Mountain big sagebrush present as more than occasional component 9a
8b. Mountain Big sagebrush absent or scarce 10a

9a. Idaho fescue present: Mountain big sagebrush/Idaho fescue community, page 35.
9b. Idaho fescue absent: Mountain big sagebrush/Bluebunch wheatgrass community, page 34.

10a. Threetip sagebrush present, more than occasional component 11a
10b. Threetip sagebrush absent or scarce 12a

11a. Idaho fescue present: Threetip sagebrush/Idaho fescue community, page 36.
11b. Idaho fescue absent: Threetip sagebrush/Bluebunch wheatgrass community, page 35.

12a. Low sagebrush present as more than occasional component 13a
12b. Low sagebrush absent or scarce 14a

13a. Idaho fescue present: Low sagebrush/Idaho fescue community, page 37.
13b. Idaho fescue absent: Low sagebrush/Bluebunch wheatgrass community, page 37.

14a. Basin big sagebrush present as more than occasional: Basin big sagebrush/Bluebunch wheatgrass community, page 31.
14b. Basin big sagebrush absent or scarce. 15a

15a. Wyoming big sagebrush present as more than occasional component 16a
15b. Wyoming big sagebrush absent or scarce 17a

16a. Wyoming big sagebrush/Bluebunch wheatgrass community, page 33.

17a. Shadscale saltbush present as more than occasional component. 18a

18a. Sand dropseed abundant: Shadscale saltbush/Sand dropseed community, page 30.
18b. Sand dropseed absent: Indian ricegrass abundant, page 30.

17b. Shadscale saltbush occasionally present but not abundant 19a

19a. Idaho fescue present as more than occasional: Idaho fescue/Bluebunch wheatgrass community, page 30.
19b. Idaho fescue absent, Bluebunch wheatgrass common 20a

20a. Needle-and-threadgrass present, abundant. Bluebunch wheatgrass/Sandberg bluegrass/Needle-and-thread community, page 27.
20b. Needle-and-threadgrass absent or scarce. 21a

21a. Arrowleaf balsamroot present as more than occasional component: Bluebunch wheatgrass/Arrowleaf balsamroot/Sandberg bluegrass community, page 28.
21b. Arrowleaf balsamroot not present, Bluebunch wheatgrass dominant: Bluebunch wheatgrass/Sandberg bluegrass community, page 16.

recognized the community existed, identified by the absence of conspicuous perennial forbs. This community is present in western Montana (Mueggler and Stewart 1980). Higher frequencies of Sandberg bluegrass, junegrass, and lupines (*Lupinus* spp.) occur in the Montana stands than in those we examined. Daubenmire (1970) considered these communities a Bluebunch wheatgrass/Sandberg bluegrass community. Again, arrowleaf balsamroot had relatively low frequency and cover. The Washington-northern Idaho stands all contain cheatgrass, similar to our stands.

We consider five stands in the Middle Fork a needle-and-thread phase of the Bluebunch wheatgrass/Sandberg bluegrass community. These communities contain equivalent frequencies of needle-and-thread and bluebunch wheatgrass. They occur on southerly exposed, lower slopes, and do not appear to have been subject to recent disturbance, based on the absence of cheatgrass in four of the five stands when we examined them. Arrowleaf balsamroot is absent, and other large forbs including biscuitroots and locoweeds are scarce. These stands primarily consist of the two bunchgrass species, but were extensively invaded by cheatgrass following the 2000 fires.

This community was not recorded by Tisdale (1986) or Daubenmire (1970) farther north and west. Tisdale (1986) did not report needle-and-thread in the Bluebunch wheatgrass/Arrowleaf balsamroot/Sandberg bluegrass community. Hironaka et al. (1983) reported needle-and-thread occurred in the Wyoming big sagebrush/Bluebunch wheatgrass community on sandy, coarse textured, or calcareous soils. The community with a needle-and-thread phase was recorded in western Montana (Mueggler and Stewart 1980), where many of the same species were common but more showy forbs were present. The phase we describe may reflect a slightly moister climate that excludes big sagebrush but does not favor the expression of the forb complex. It is also possible that this phase is a long-lived late seral stage of the Bluebunch wheatgrass/Arrowleaf balsamroot/Sandberg bluegrass community, which could eventually evolve towards more forbs and less needle-and-thread, in the absence of fire. Fire also will reduce big sagebrush and antelope bitterbrush in stands, which then will appear as a grass-dominated community until reestablishment of shrubs.

Productivity and composition of a bluebunch wheatgrass/Sandberg bluegrass stand was evaluated over the 1988-2003 period, including three years following the 2000 fire (Figure 4). Production of bluebunch wheatgrass averaged 55.64 gm/m^2 (11.32 to 98.36 gm/m^2) over the period. Production estimates for 2000 were taken in late June; the fire occurred in August. The year following the fire, production was the second lowest over the 16-year

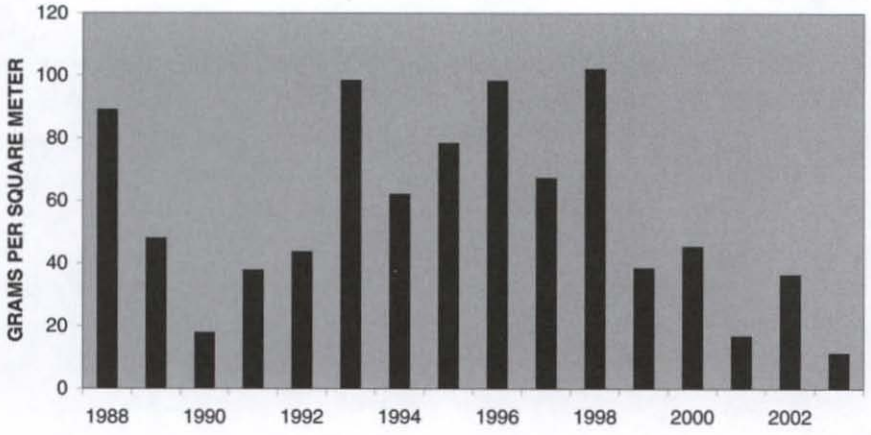

Figure 4. Bluebunch wheatgrass production in a Bluebunch wheatgrass/Sandberg bluegrass community near the Taylor Ranch, Big Creek drainage, from 1988-2003.

period. Productivity of bluebunch wheatgrass on this site is highly correlated with April-May-June precipitation (adjusted correlation coefficient = .723). April-June precipitation at the Taylor Ranch station averaged 13.8 centimeters over the period, when 2001 precipitation of 10.25 cm became the fourth lowest for the 16-year period. This suggests the fire suppressed productivity for one growing season, exacerbated by a lower rainfall pattern for that year. The following year (2002) production again was closer to the predicted level based on the amount of precipitation. We noted no changes in vegetative composition following the fire on this site.

Bluebunch wheatgrass/Arrowleaf balsamroot/Sandberg bluegrass Community

Fifteen stands, including eight in the Middle Fork, two in Big Creek, and five on the main Salmon River are dominated by bluebunch wheatgrass and arrowleaf balsamroot (Figure 5). Occasional shrubs are present but Idaho fescue is absent. We designate these communities as a Bluebunch wheatgrass/Arrowleaf balsamroot/Sandberg bluegrass community. Bluebunch wheatgrass and arrowleaf balsamroot characterize the appearance of this community, being present in all stands at relatively high frequency.

Substantial variation occurs in the least-disturbed stands within this community. One stand on the Middle Fork with very low frequency of bluebunch wheatgrass contains high coverage of biscuitroot species, and did not have any cheatgrass prior to the 2000 fires. Two other stands of relatively

low frequency of bluebunch wheatgrass have high amounts of cheatgrass and arrowleaf balsamroot. Stands with high frequencies of Sandberg bluegrass also have high frequencies of bluebunch wheatgrass, cheatgrass, and annual forbs. Other stands have high frequencies of biscuitroots, equaling the frequencies for bluebunch wheatgrass and arrowleaf balsamroot.

Annual forbs are common in most stands. Seedstalks of the bluebunch wheatgrass may grow to 120 cm or more in height in some stands. This community is the most common grassland community in the region, and serves as both a major forage producer for big game, and a cover provider for nesting blue grouse and associated species. The community appears to withstand wildfire without undergoing much change in composition except for the invasion of cheatgrass.

We evaluated production and composition of one site within this community type from 1989 to 2003. The site burned completely during the 2000 fire. Productivity of bluebunch wheatgrass in 2001 was 30.1 gm/m^2, or 65.8% of the mean productivity of 45.83 gm/m^2 over the period, recovering to 58.5 gm/m^2 or 127.6% of the mean in 2002. April-June precipitation was approximately 73% of the mean over that period at the Taylor Ranch weather station. No changes in species composition were apparent.

Figure 5. A Bluebunch wheatgrass/Arrowleaf balsamroot/Sandberg bluegrass community at Waterfall Creek, Middle Fork Salmon River, May 1975.

Idaho fescue/Bluebunch wheatgrass Community

We studied and identified twenty-four stands as an Idaho fescue/Bluebunch wheatgrass community. Thirteen of these were in the Middle Fork, eight in Big Creek, and three on the main Salmon River. Observations apart from study of individual stands indicate this community is best represented in the Middle Fork drainage, including Big Creek, within the study area. These stands occur on all aspects, at elevations ranging from 1000 m to 1900 m. Bluebunch wheatgrass has the highest frequencies in plots in all three areas, followed by Idaho fescue and Sandberg bluegrass. Cheatgrass also occurs in high frequency in all stands.

The greatest variety of forbs occurs in the Middle Fork stands, probably reflecting in part the larger number of stands sampled across a broader stretch of that river. However, a wider variation occurs in aspect and elevation of stands sampled in this drainage than in the other two. Also, more disturbance appears in some stands, as reflected by the higher constancy and frequency of annuals. Arrowleaf balsamroot, yarrow (*Achillea millefolium*), lupines, and biscuitroots are the most conspicuous and common forbs.

This community is broadly distributed throughout the intermountain region. Daubenmire (1970) described this community in the Palouse region as consisting predominantly of the two dominant bunchgrasses and Sandberg bluegrass; shrubs and perennial forbs were inconspicuous.

On the Snake River and lower Salmon River areas, perennial forbs are well represented, suggesting a more mesic community than in eastern Washington (Tisdale 1986). Junegrass is not well represented in this community in either the lower Salmon River or on this study area, and as expected when compared with contiguous areas, species composition is similar. Mueggler and Stewart (1980) considered this community the most common type in western Montana mountain rangelands. In all regions, bluebunch wheatgrass is the most common species. Shrubs are scarce in the lower Salmon River stands, but are more frequent in the western Montana stands and in our study region.

Shadscale saltbush Communities

Salt desert shrublands dominated by shadscale saltbush (*Atriplex confertifolia*) are present on the most xeric sites we examined. Shadscale saltbush is present in all sites, while big sagebrush, heath goldenrod, and prickly pear (*Opuntia polyacantha*) were common (Figure 6). Fourwing saltbush (*Atriplex canescens*) and Wyoming big sagebrush are well represented. Indian

ricegrass is the dominant grass in all stands, followed by bottlebrush squirreltail (*Sitanion hystrix*). Sand dropseed (*Sporobolus cryptandrus*) grows in Malm Gulch near the confluence of the East Fork with the main Salmon River, and is more common farther north on foothills near Challis. Stands with Sand dropseed have greater species diversity than stands lacking that species and are considered a separate commmunity from the Shadscale saltbush/Indian ricegrass community.

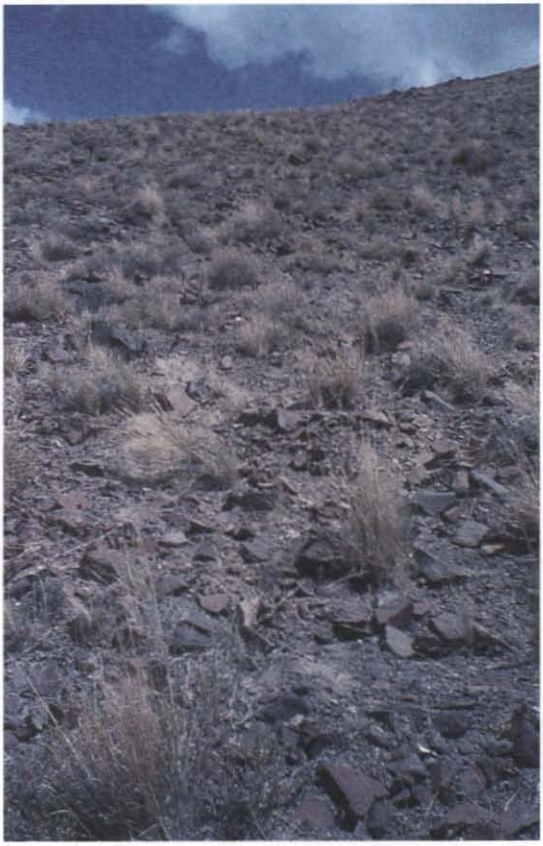

Figure 6. A Shadscale saltbush/Indian ricegrass community in Malm Gulch, East Fork Salmon River, June 2000.

Hironaka et al. (1983) found shadscale saltbush on xeric or saline soils on the Snake River Plain, but did not describe communities dominated by this species. Tisdale (1986) and Mueggler and Stewart (1980) did not mention either of the saltbush species.

Basin big sagebrush/Bluebunch wheatgrass Community

In the lower, drier creek bottoms, especially on the southern and eastern portions of the region, a Basin big sagebrush/ Bluebunch wheatgrass community exists (Figure 7). We examined two stands considered representative for the East Fork. Basin wildrye is common in some stands. Its presence indicates disturbance, most likely from grazing or ground squirrel activity. Basin big sagebrush may grow to more than 3 m tall, and dominates the appearance of these stands. Very often the understories are sparse, because the shrubs are so dense. The two stands we measured were disturbed, but indicate the species composition that may persist.

Figure 7. A Basin big sagebrush/Bluebunch wheatgrass stand, Herd Creek, East Fork Salmon River, June 1985.

Bluebunch wheatgrass is the predominant grass, with bottlebrush squirreltail, bluegrasses (*Poa* spp.), and needle-and-thread common. Heath goldenrod, prickly phlox (*Leptodactylon pungens*), and wax currant (*Ribes cereum*) are associated shrubs. Forb composition is depauperate, but our sparse information undoubtedly underestimates the potential for forb production on the sites.

Hironaka et al. (1983) described this type farther south, stating that all areas they examined had been altered. The soils were generally more fertile than adjacent uplands that often support Wyoming big sagebrush in the region. This community probably occupied most of the flood plains of the major streams of our study area adjacent to deciduous woody plants typical of the riparian complex. Representatives we observed may not reflect the development of this community where it was originally best expressed. The community could be considered the dry end of the riparian zone complex that occurs in this region.

Daubenmire (1970) classified a Basin big sagebrush/Bluebunch wheatgrass community farther north, where antelope bitterbrush was absent. Hironaka et al. (1983) reported this type contained antelope bitterbrush. Mueggler and Stewart (1980) did not find antelope bitterbrush present in this community in Montana.

Wyoming big sagebrush/Bluebunch wheatgrass Community

We studied this community in the East Fork, but it probably occurs in the Middle Fork as well. We examined a total of 29 stands. Elevations range from 1750 m to 2150 m, on west, south, and east exposures. A high frequency of Wyoming big sagebrush occurs on most sites. Green rabbitbrush, mat buckwheat (*Eriogonum caespitosum*), and Hood's phlox (*Phlox hoodii*) most commonly appear in these stands, at low frequencies.

Bluebunch wheatgrass is the major grass species. Lauer and Peek (1976) identified a phase in the East Fork that includes Sandberg bluegrass in the understory (Figure 8). Stands that include this species in the composition may be considered a phase. Indian ricegrass is the other grass most frequently encountered in the community.

The Sandberg bluegrass phase has a richer forb component than the bluebunch wheatgrass phase. Lupines are common to both phases, while dwarf pale Indian paintbrush (*Castilleja inverta*), ballhead sandwort (*Arenaria congesta*), rockcress, asters (*Aster* spp.), and locoweeds occur more frequently in the Sandberg bluegrass phase.

Hironaka et al. (1983) identified this community farther south, reporting Sandberg bluegrass consistent in the understory. In our study area, bluebunch wheatgrass occurs as plants exceeding 15 cm to 20 cm in diameter, larger than

Figure 8. A Wyoming big sagebrush/Bluebunch wheatgrass/Sandberg bluegrass community, East Fork Salmon River, July 1975.

plants in eastern Idaho. Wyoming big sagebrush also grows up to 75 cm tall in our study area. This was considered the most xeric community dominated by sagebrushes in our samples.

Mountain big sagebrush/Bluebunch wheatgrass Community

Ten stands are classified as a Mountain big sagebrush/Bluebunch wheatgrass community, including three in the East Fork and seven along the Middle Fork (Figure 9). Elevations ranged from 1050 m to 2200 m, on all aspects. The type occurs on all slopes from flat to 80%. This is a highly variable, and very common plant community in this region.

Mountain big sagebrush, heath goldenrod and green rabbitbrush are common woody plants in the type. Heath goldenrod and green rabbitbrush have low frequencies but relatively high constancies, while longleaf phlox (*Phlox longifolia*) and mountain big sagebrush have higher frequencies. Antelope bitterbrush, mat buckwheat, parsnip-flowered buckwheat (*Eriogonum heracleoides*), longleaf phlox, Hood's phlox, and prickly phlox are relatively frequent as well.

Bluebunch wheatgrass and Sandberg bluegrass exhibit high frequencies in our stands. Needle-and-thread occurs on the lower, drier portions of this type. Threadstalk milkvetch (*Astragalus filipes*), roseate pussy-toes (*Antennaria*

Figure 9. A Mountain big sagebrush/Bluebunch wheatgrass community, Herd Creek drainage, June 1985.

microphylla), and rockcress, forbs of low succulence, are common in the type. Several lower elevation sites, especially in the Middle Fork and Big Creek, show high frequencies of cheatgrass, sixweek's fescue (*Festuca octoflora*), and needle-and-thread, suggesting disturbance. These sites also show higher proportions of annual forbs than do other sites.

All mountain big sagebrush plants were killed on one Big Creek site by the 2000 fire. New plants were observed starting 2 years afterwards. We surmise that these plants established from seed sources present in the soil or were transported from adjacent sites by wind or birds.

Mountain big sagebrush/Idaho fescue Community

Ten stands are classified as a Mountain big sagebrush/Idaho fescue community, including one in Big Creek, one on the Middle Fork, and eight in the East Fork. Elevations range from 1350 m on the Middle Fork to 2400 m on the East Fork, on all aspects and slopes. The type shows high frequencies of the two dominant species, plus bluebunch wheatgrass, bluegrasses, and junegrass. Green rabbitbrush and heath goldenrod are common shrubs. Common snowberry flourishes in the East Fork stands. Threadstalk milkvetch, Indian paintbrushes (*Castilleja* spp.), roseate pussytoes, lupines, prairie smoke (*Geum triflorum*), longleaf phlox, and alumroot (*Heuchera cylindrica*) are common forbs. An appreciable number of forbs occur in this community.

Daubenmire (1970) described a Basin big sagebrush/Idaho fescue community on the Palouse uplands, where moisture was sufficient to support Idaho fescue. Bluebunch wheatgrass and Sandberg bluegrass were common in the type, but junegrass was not recorded. The forb complex also was quite similar to stands we examined. A large number of annuals were present.

Hironaka et al. (1983) found both Basin big sagebrush/Idaho fescue and Mountain big sagebrush/ Idaho fescue communities south of this study area. The Mountain big sagebrush/Idaho fescue type was the same type that we describe. The presence of common snowberry in the higher elevation stands on the East Fork suggests an intergrade with a community dominated by this species. However, we saw this shrub most commonly as an understory beneath Douglas fir.

Threetip sagebrush/Bluebunch wheatgrass Community

Threetip sagebrush/Bluebunch wheatgrass communities abound in the East Fork (Figure 10). The six stands all occur on northerly exposed slopes at elevations ranging from 1900 m to 2235 m. As its Idaho fescue counterpart,

Figure 10. A Threetip sagebrush/Bluebunch wheatgrass community in Pine Gulch, Herd Creek drainage, East Fork Salmon River, June 1985.

this community also occurs at lower elevations in the Middle Fork, where we found it in exclosures (Peek 2000).

Threetip sagebrush exhibits a very high frequency in plots representing this community. The only other common shrub is prickly phlox. Bluebunch wheatgrass also exhibits high frequency, followed by Sandberg bluegrass. Roseate pussy-toes, ballhead sandwort, hawksbeard (*Crepis atrabarba*), penstemons (*Penstemon* spp.), and stonecrop (*Sedum stenopetalum*) are common forbs.

This community occurs in eastern Washington and southern Idaho, but not in western Montana. The moisture regime is generally a bit lower than where Idaho fescue is present, and the Threetip sagebrush/Idaho fescue habitat is present in Montana. Hironaka et al. (1983) reported a Threetip sagebrush/Needle-and-thread community in southern Idaho. The Threetip sagebrush/Bluebunch wheatgrass community appears restricted to the eastern half of Idaho, including the Salmon city area.

Threetip sagebrush/Idaho fescue Community

Nine stands are classified as a Threetip sagebrush/Idaho fescue community, including one in Big Creek, and eight in the East Fork. This community also

is present in the Middle Fork. It occurs on a south slope at 1600 m on Big Creek, and on northerly exposed sites at 1890 m to 2470 m on the East Fork. Threetip sagebrush dominates the shrub component. Hood's phlox and heath goldenrod are less constant shrubs in the community. Bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass are the common grasses. The Big Creek site contains cheatgrass, suggesting past disturbance. Roseate pussy-toes, buckwheats, lupines, and biscuitroots are common forbs in this community.

This community occurs in eastern Washington (Daubenmire 1970), southern Idaho (Hironaka et al. 1983) and western Montana (Mueggler and Stewart 1980). Cheatgrass is common in the eastern Washington stands, but not in the Montana or southern Idaho stands.

Low sagebrush Communities

We studied only two stands dominated by low sagebrush, both in the East Fork (Figure 11). Bluebunch wheatgrass is common in both stands, and Idaho fescue is common in one. We consider these two stands representative of a Low sagebrush/Bluebunch wheatgrass community and a Low sagebrush/Idaho fescue community. The stands we observed are very similar in

Figure 11. A Low sagebrush/Bluebunch wheatgrass community, Herd Creek drainage, East Fork Salmon River, June 1985.

composition to those described by Hironaka et al. (1983) for the Snake River drainages farther south. Both communities occur in western Montana as well (Mueggler and Stewart 1980).

These communities support a moderate variety of forbs on our study sites, with ballhead sandwort, asters, and threadstalk milkvetch common. Bottlebrush squirreltail is well represented in Low sagebrush/Bluebunch wheatgrass stands, and bluegrasses and junegrass are common in both.

Antelope bitterbrush/Bluebunch wheatgrass Community

Seven stands, including one on the main Salmon River, three on the Middle Fork, and three in Big Creek, are classified as an Antelope bitterbrush/Bluebunch wheatgrass community, having both species present in all stands at high frequencies (Figure 12). These stands are on southerly exposed, steep slopes, at 1300 m to 1690 m.

Figure 12. An Antelope bitterbrush/Bluebunch wheatgrass community, Cave Creek drainage in the Big Creek drainage, July 1988.

Associated shrubs commonly include mountain big sagebrush, heath goldenrod, oval-leafed buckwheat (*Eriogonum ovalifolium*), and slenderbush buckwheat (*Eriogonum microthecum*). Cheatgrass is present in all stands, often in high frequencies. Needle-and-thread is present in two stands along the Middle Fork where cheatgrass is also abundant, suggesting disturbance. Idaho fescue is present in three stands, at relatively low frequencies. A variety of forbs are present, primarily annuals and nonsucculents. Yarrow, arrowleaf balsamroot, phacelias, longleaf phlox, Utah thistle (*Cirsium utahense*), and salsify (*Tragopogon dubius*) are among the more commonly encountered species.

Daubenmire (1970) reported this community was poorly represented on areas farther north, where the Antelope bitterbrush/Idaho fescue type was more common. The presence or absence of Idaho fescue is considered the diagnostic difference between the two communities. Tisdale (1986) did not observe the community in the lower Salmon-Snake River complex. Hironaka et al. (1983) reported an Antelope bitterbrush/Bluebunch wheatgrass and an Antelope bitterbrush/Needle-and-thread community on the Snake River Plains and adjacent areas, but no Antelope bitterbrush/Idaho fescue communities. Mueggler and Stewart (1980) reported Antelope bitterbrush/Bluebunch wheatgrass was present in the Bitterroot Valley of Montana but seldom encountered the Antelope bitterbrush/Idaho fescue type. They concluded Idaho fescue had to be abundant (over 5% canopy cover) to be considered the dominant grass in the community, and that big sagebrush could be present.

Disturbance likely accounted for the high presence of needle-and-thread and cheatgrass in some of our stands as Youtie et al. (1988) reported in north-central Washington. Big sagebrush may be associated at low frequencies as well. Our area appears to reflect an intergrade between the drier Snake River communities and the more mesic communities farther north, where Idaho fescue was better expressed in antelope bitterbrush stands. In areas of more moisture in this region, this community likely intergrades into a community dominated by ponderosa pine, as Daubenmmire (1970) reported for the eastern Oregon-Washington region.

Antelope bitterbrush was greatly diminished by the 2000 fire in the Big Creek drainage. However, some plants did escape, others resprouted from root collars, and still other plants appeared from seed sources. It appears this species will eventually reestablish itself at some level in many of the stands where it occurred prior to the fire, but it probably will not reach the densities that previously occurred.

Antelope bitterbrush/Idaho fescue Community

An Antelope bitterbrush community with an understory of Idaho fescue occurs in Big Creek (four stands) and the main Salmon River (one stand). Antelope bitterbrush is at low frequency in the Big Creek sites, and much higher on the Salmon River. Mountain big sagebrush is present on one Big Creek site and heath goldenrod occurs on two sites. Antelope bitterbrush also occurs in the East Fork but was not studied there.

Bluebunch wheatgrass, cheatgrass, and Idaho fescue are present in all stands. The two former species are higher in frequency than the last. Common forbs include yarrow, arrowleaf balsamroot, and oval-leafed buckwheat.

Aerial shoots of antelope bitterbrush usually are killed when burned, and many plants do not survive the hot fires typical of the July-September fire regime in the region. However, when burned under prescriptions calling for moist, cool soils in April and May, plants may resprout from root collars. Bunting et al. (1985) reported two ecotypes, a decumbent or prostrate form and a columnar form; the former was more apt to sprout from root collars than the latter when burned. The decumbent ecotype appears most prevalent in this region. We observed resprouting from root collars in the Big Creek drainage three growing seasons after the 2000 fires appeared to have killed those plants.

Antelope bitterbrush grows as a seral species in Douglas fir/Common snowberry communities in this region (Peek et al. 1978). The river bars support Ponderosa pine/Antelope bitterbrush communities that may be seral stages of the Douglas fir/Common snowberry community. These stands are present near Thomas Creek on the Middle Fork and along the South Fork. Probably most, if not all, communities dominated by antelope bitterbrush along the South Fork would succeed to either Ponderosa pine/Antelope bitterbrush or Douglas fir/Common snowberry in the absence of fire or other disturbance. However, fire frequencies are naturally high in these hot and dry canyons. The chances of conifers establishing are low if the natural fire regime is allowed to persist.

Should competing ground cover remain unaffected, antelope bitterbrush would not persist at relatively high densities in the natural fire regime either. One explanation finds the river bars, historically subject to heavy grazing, provided the bare soils where ripe antelope bitterbrush seeds could germinate. However, many sites supporting antelope bitterbrush have not been extensively grazed by domestic livestock. Here, establishment and retention of antelope bitterbrush may depend on how wildfires burn across an area, and whether fires leave some sites unburned or some plants lightly burned and capable

of resprouting. As with curlleaf mountain mahogany, the probability of any one antelope bitterbrush seed surviving must be extremely low. Having a few individual plants recruited into the stand over time is still inevitable, given climatic conditions that permit it.

Curlleaf mountain mahogany/Little greenbush/Bluebunch wheatgrass Community

This community appears in ten stands, including eight along the Middle Fork and two along the main Salmon River (Figure 13). One stand occurs on a northwest facing slope, while the rest occur on southerly exposed slopes. Elevations range from 725 m on the Salmon to 1600 m on the Middle Fork, reflecting the broad range in which this community occurs. The slopes are almost always very steep, averaging 74% (60% to 85%) on study sites. This is the shrub community most frequently seen on cliffs along the rivers in this region.

Figure 13. A Curlleaf mountain mahogany/Little greenbush/Bluebunch wheatgrass community, Middle Fork Salmon River drainage.

Both curlleaf mountain mahogany and little greenbush dominate the community, although curlleaf mountain mahogany may be widely dispersed on some sites. Both species are highly palatable to big game frequenting these communities. Curlleaf mountain mahogany, when killed by fire, depends on seed to reestablish itself (Bunting et al. 1985). Little greenbush will resprout following fire in this region.

Longleaf phlox and heath goldenrod are most frequently associated with curlleaf mountain mahogany and little greenbush, while syringa (*Philadelphus lewisii*), buckwheats, and currants are common. Bluebunch wheatgrass and cheatgrass grow on all stands examined. Cheatgrass exhibits the highest frequency of any species in this community. Annual forbs, including small-flowered willow-herb (*Epilobium minutum*), tumblemustard (*Sisymbrium altissimum*), threadleaf phacelia (*Phacelia linearis*), and blue-eyed Mary (*Collinsia parviflora*) are also common. Idaho fescue is common at low frequencies, and may indicate another community.

These communities are subject to extensive natural disturbance. They often have extensive amounts of bare ground and almost always include rocky areas. The steep slopes promote extensive soil movement during storms or whenever a rock dislodges. The high occurrence of annuals, especially cheatgrass, also reflects this disturbance.

The drier stands occur along the Middle Fork, as exhibited by the lowest frequencies of bluebunch wheatgrass and fewer forbs. The presence of groundsel (*Senecio integerrimus*), blueberry elder (*Sambucus cerulea*), and clover (*Trifolium* spp.) in stands along the main Salmon reflects the more mesic conditions of that part of the area. Microsites having higher moisture regimes may support more succulent forbs in this community.

Curlleaf mountain mahogany stands are present on the lower Salmon River, where little greenbush is not common (Tisdale 1986). Curlleaf mountain mahogany communities also are present in southern Idaho (Hironaka et al. 1983) and western Montana (Mueggler and Stewart 1980), but little greenbush is not reported.

Curlleaf mountain mahogany was diminished following the 2000 fire; yet observations showed numerous new seedlings establishing on some sites. Abundant sites favorable for seedling establishment occur on the cliffs where this species exists. As long as seed sources are present, this species may regain dominance on sites within communities where it was once common.

Curlleaf mountain mahogany/Idaho fescue Community

Six stands are dominated by curlleaf mountain mahogany, each having an understory in which Idaho fescue and bluebunch wheatgrass consistently occur (Figure 14). We studied one stand in the Middle Fork, and five on the main Salmon River. Elevations of these stands range from 975 m to 1460 m on the Salmon, to more than 1500 m in Big Creek. These stands generally occur on southerly exposed, steep slopes, and rocky outcrops.

Serviceberry, antelope bitterbrush, heath goldenrod, syringa, currants, and parsnip flowered buckwheat are associated shrubs in this community. Syringa is most prevalent on small rockslides and other sites where no soil was exposed and grasses were absent. Arrowleaf balsamroot is a common forb, as are buckwheats and longleaf phlox. Cheatgrass is present in all stands examined.

Tisdale (1986) reported the occurrence of this type in the lower Salmon River area, and Hironaka et al. (1983) found curlleaf mountain mahogany associated with junipers (*Juniperus* spp.), Douglas fir, ponderosa pine, and limber pine (*Pinus flexilis*) in southern Idaho. Mueggler and Stewart (1980) did not report the community in western Montana. A Douglas fir/Curlleaf mountain mahogany/Idaho fescue community is present on some more

Figure 14. A Curlleaf mountain mahogany/Idaho fescue stand, Middle Fork Salmon River drainage.

northerly exposed sites in our region (Steele et al. 1981). Understories are essentially similar, but a sparse stand of fir signifies a higher moisture regime or better soils.

The presence of curlleaf mountain mahogany suggests a habitat where fire is infrequent, since the species is killed by fire. In areas yielding dense understories of grasses, which are either enhanced or unaffected by fire, reseeding of this nonresprouting plant may be slow. However, our observations of these sites following the 2000 fires suggest seedlings can establish shortly after the burns, if adjacent unburned plants are present to provide the seed source. Many of these stands have plants more than 3 m tall and exceeding 50 years of age. We hypothesize conditions necessary for regeneration of this highly palatable shrub, which typically produces abundant seed crops annually (Dealy 1971), include microsites having sparse cover of associated competing species, and probably reduced browsing pressure. The probability that any one individual seed will establish and survive to a height beyond the reach of big horn, deer, and elk is likely extremely low. But, given the abundant seed production, the long life expectancy of mature plants, and the apparent low fire frequency on these sites, the probability that the species will persist in stands of highly variable age classes becomes high over a long time.

An alternative hypothesis in some situations finds conditions for establishment and survival of this species are infrequent and related to prolonged drought, when the associated competing species are reduced in vigor. Stands established in this manner should consist of individuals representing age distributions that coincide with these conditions.

Curlleaf mountain mahogany/Bluebunch wheatgrass Community

One stand of curlleaf mountain mahogany on Big Creek was classified as a Curlleaf mountain mahogany/Bluebunch wheatgrass community because Idaho fescue was absent (Figure 15). This type is more common than our information suggests. It occurs on southerly exposed cliffs and steep slopes where little greenbush is absent. Lauer and Peek (1976) recorded it in the East Fork, and Hironaka et al. (1983), Tisdale (1986) and Mueggler and Stewart (1980) reported it from adjacent regions. In Montana the type was most prevalent on limestone outcrops, but in the Salmon River region it occurs on granite and metamorphics.

These stands contain extensive coverage of cheatgrass, suggesting disturbance. They also serve as important mule deer winter and spring range. The high frequency of use by deer when plants are beginning to grow and soils are wet provides substantial sites for establishment of annuals.

Figure 15. A Curlleaf mountain mahogany/Bluebunch wheatgrass stand, Middle Fork Salmon River drainage.

Fire frequencies in these stands are low, as are those in stands containing Idaho fescue. How mahogany establishes and survives in the face of competing species, grazing, and fire shows similarities to Idaho fescue survival. Curlleaf mountain mahogany sites containing bluebunch wheatgrass tend to be more severe than those containing Idaho fescue, yet suitable microsites for seedling establishment are more prevalent where substantial bare ground occurs.

Herbaceous and Shrub Communities Succeeding to Conifers

We examined a number of shrub communities considered seral stages of conifer-dominated communities. The presence of ponderosa pine or Douglas fir or both species was the primary diagnostic means of identifying these communities, which otherwise resembled shrub-steppe communities in species composition at the time of our sampling. In some cases, comparisons with the conifer communities described for the region by Steele et al. (1981) were used to help ascertain the identity of the communities. At least six forest habitat types are represented by these communities.

Ten stands, all on the main Salmon River canyon, were dominated by common snowberry (Table 4). These stands had high cheatgrass and annual forb coverage, suggesting disturbance probably due to fire. The presence of heath goldenrod in 40% of these stands also indicates disturbance through fire,

Table 4. Species constancy and frequency in ten stands dominated by Common snowberry, compared with constancy values in four forested communities described by Steele et al.(1981).

	Constancy/ Frequency	Pipo/ Syal [1]	Psme/ Syal- Syal	Psme/ Syal- Pipo	Psme/ Feid- Pipo
Berberis repens	10/22	30	100	60	20
Ceanothus sanguineus	0/0.1	-	-	-	-
Ericameria nauseosa	40/0.4	-	-	-	-
Eriogonum heracleoides	70/5.5	-	-	-	-
Holodiscus discolor	10/0.1	-	-	-	-
Lonicera utahense	10/0.1	-	30	10	-
Philadelphus lewisii	10/0.1	-	-	-	-
Phlox longifolia	10/0.1	-	-	-	-
Prunus virginiana	20/0.9	70	30	50	20
Spiraea betulifolia	30/1.6	20	30	80	20
Symphoricarpos albus	100/27.0	100	100	100	20
Bromus tectorum	100/42.0	-	-	-	-
Carex spp.	10/1.5	50	70	90	30
Festuca idahoensis	60/13.3	10	30	40	10
Poa spp.	20/4.4	20	15	-	-
Pseudoroegneria spicata	100/64.2	50	30	40	80
Achillea millefolium	90/23.4	90	70	70	80
Agoseris glauca	30/0.8	-	-	-	-
Apocynum androsaemifolium	20/1.9	-	-	-	-
Arabis holboellii	10/0.1	-	-	-	-
Astragalus stenophyllus	40/2.1	-	-	-	-
Balsamorhiza sagittata	80/25.8	40	70	30	-
Cirsium utahense	10/0.1	1	-	-	-
Clarkia pulchella	10/14.0	-	-	-	-
Erigeron spp.	10/0.5	-	-	-	-
Eriogonum ovalifolium	20/0.8	-	-	-	-
Hieracium albertinum	50/0.7	-	20	-	-
Hypericum perforatum	10/0.1	-	-	-	-
Lathyrus nevadensis	10/0.1	30	20	-	20
Lithospermum ruderale	100/1.3	-	-	-	-
Lomatium spp.	70/2.9	-	-	-	30
Lupinus spp.	70/14.9	10	-	-	-
Penstemon spp.	30/4.2	10	-	-	-
Phacelia hastata	20/0.1	-	-	-	-
Phacelia linearis	50/5.5	-	-	-	-
Phlox spp.	50/7.6	-	-	-	-
Polygonum douglasii	50/14.0	-	-	-	-
Senecio integerrimus	30/0.5	-	-	-	-
Tragopogon dubius	80/7.4	-	-	-	-

[1]Feid= *Festuca idahoensis*; Pipo= *Pinus ponderosa*; Psme=*Pseudotsuga menziesii*; Syal=*Symphoricarpos albus*

since this species resprouts following burning. A variety of species palatable to big game are present in these stands, including bluebunch wheatgrass, elk sedge (*Carex geyeri*), Idaho fescue, Oregon grape (*Berberis repens*), chokecherry, balsamroot, locoweeds, hawkweed, biscuitroots, and lupines. These communities are considered seral stages of Ponderosa pine/Common snowberry, or Douglas fir/Common or Mountain snowberry habitat types. They do not have the dense coverage of snowberry that Tisdale (1986) reported for snowberry communities in the lower Salmon River area, but more closely approximate the cover of snowberry in the conifer-dominated communities. The major difference between these communities and the habitat types described by Steele et al. (1981) is that species representative of drier conditions are present in the seral stands, and no conifer overstory occurs. These species include heath goldenrod, Wyeth buckwheat (*Eriogonum heracleoides*), longleaf phlox, rockcress, and thistles.

Hironaka et al. (1983) and Mueggler and Stewart (1980) did not find snowberry-dominated communities south and east of this region, but Tisdale (1986) and Daubenmire (1970) reported them farther north and west. The constancy values for species in the Salmon River stands approximate those for similar species or species within the same genera reported by Daubenmire (1970). The absence of pinegrass (*Calamagrostis rubescens*) in our stands, low coverage of sedges, and presence of longleaf phlox, hawkweed, lupines, salsify and groundsel resemble the eastern Washington information. However, we judge the Salmon River stands seral communities as high fire frequencies may preclude establishment of identifying conifers on severely burned sites. Extensive desiccation and disturbance were evident in the species composition. More intensive examination of these stands could clarify their status.

The Douglas fir/Mallow ninebark community was represented in thirteen stands, including three on the Middle Fork and eleven in the main Salmon River canyon (Table 5). All had Douglas fir seedlings or small trees present, and ninebark was dominant in the shrub union. Snowberry, Oregon grape, and birchleaf spirea (*Spiraea betulifolia*) were common woody plants. Oceanspray (*Holodiscus discolor*), redstem and shiny-leaf ceanothus (*Ceanothus sanguineus* and *C. velutinus*), serviceberry, and roses (*Rosa* spp.) were relatively common. The presence of the two Ceanothus species particularly indicates development of the current stands following hot fire.

The grass and sedge component closely approximates the composition of the Douglas fir/Mallow ninebark/ponderosa pine phase described by Steele et al. (1981). Bluebunch wheatgrass, pinegrass, elk sedge, and bluegrasses are common in the climax stands and in our stands. Our stands have higher

Table 5. Comparison of constancy and frequency values of shrub communities observed in the Middle Fork and the main Salmon River with constancy values of the Douglas fir/ninebark communities reported by Steele et al. (1981).

SPECIES	MIDDLE FORK	SALMON	BOTH	Douglas fir/ninebark Ponderosa pine phase
		--constancy/frequency---		constancy
Acer glabrum	50/0.1	-	8/0.1	50
Amelanchier alnifolia	100/40	82/2.7	85/2.4	100
Berberis repens	50/6.0	55/6.7	53/6.5	70
Ceanothus sanguineus	-	77/9.1	62/8.3	-
Ceanothus velutinum	-	33/5.7	38/4.9	30
Eriogonum heracleoides	50/8.0	9/0.5	15/1.6	-
Holodiscus discolor	-	66/12.7	46/10.6	-
Lonicera utahensis	-	18/0.6	15/0.5	20
Philadelphus lewisii	50/0.1	9/0.1	15/0.1	-
Physocarpus malvaceus	100/16.0	100/48.3	100/43.3	100
Potentilla fruticosa	27/1.6	23/1.3	-	-
Prunus virginiana	50/7.0	-	8/1.1	30
Purshia tridentata	-	-	-	10
Ribes cereum	50/1.0	-	8/0.1	-
Rosa gymnocarpa	-	82/5.7	69/4.8	40
Rubus parviflorus	-	9/0.1	8/0.1	20
Spiraea betulifolia	50/30.0	91/22.8	85/23.9	100
Symphoricarpos albus	100/4.1	36/7.3	55/6.8	60
Bromus tectorum	50/13.0	31/4.7	38/60	-
Calamagrostis rubescens	50/21.0	82/41.1	27/38.1	60
Carex geyeri	50/4.0	91/20.5	85/17.9	70
Festuca idahoensis	50/24.0	18/8.7	31/11.1	+
Koeleria cristata	-	9/1.2	8/1.0	-
Poa spp.	50/5.0	36/6.5	38/6.2	30
Poa secunda	50/26.0	9/0.2	15/4.6	-
Pseudoroegneria spicata	100/51.3	15/10.5	38/20.1	+
Achillea millefolium	50/3.0	73/17.6	69/15.4	30
Agoseris glauca	50/1.0	-	8/0.2	-
Antennaria dimorpha	50/6.0	-	8/0.9	-
Antennaria microphylla	-	18/3.4	15/2.8	+
Apocynum androsaemifolium	51/19.0	9/3.2	15/5.6	-
Arabis holboellii	100/7.1	-	15/1.1	-
Arnica cordifolia	50/7.0	9/0.5	15/1.5	90
Arnica sororia	50/1.0	-	8/0.2	-
Aster spp.	-	18/3.0	15/2.5	40
Balsamorhiza hookeri	50/11.0	-	8/1.6	-
Balsamorhiza sagittata	-	18/0.2	8/0.2	10
Collinsia parviflora	50/23.0	-	8/3.5	-
Crepis atrabarba	50/22.0	-	-	-
Epilobium angustifolium	-	18/0.2	8/0.2	10
Frasera albicaulis	-	36/0.9	31/0.7	30
Fragaria vesca	50/17.0	73/9.1	69/10.3	60
Galium spp.	50/4.0	8/0.6	15/0.5	30

Table 5 continued.

SPECIES	MIDDLE FORK	SALMON	BOTH	Douglas fir/ninebark Ponderosa pine phase
	--constancy/frequency---			constancy
Heuchera cylindrica	50/2.0	-	8/0.3	-
Hieracium albertinum	50/17.0	55/5.2	54/7.0	50
Lithophragma parviflora	50/15.0	-	15/2.3	-
Lithospermum ruderale	-	18/0.8	15/0.7	-
Lomatium spp.	100/39.0	-	15/6.0	10
Lupinus spp.	-	27/1.8	23/6.6	-
Mentzelia albicaulis	50/2.0	8/0.1	15/1.4	-
Mertensia spp.	50/7.0	8/1.5	15/1.4	-
Montia spp.	50/17.0	-	8/2.6	-
Myosotis spp.	50/6.0	-	8/0.9	-
Penstemon spp.	100/22.0	-	15/3.4	30
Phlox longifolia	50/30.0	27/5.0	31/8.9	-
Polygonum douglasii	-	27/0.4	23/3.7	-
Potentilla gracilis	50/7.0	-	8/1.1	-
Pyrola secunda	-	36/6.8	31/5.8	10
Sedum stenopetalum	-	27/6.6	23/5.5	-
Senecio intergerrimus	-	8/0.1	8/0.1	-
Silene acaulis	100/10.0	-	15/1.5	-
Thalictrum occidentale	-	18/2.2	15/1.9	10
Trifolium spp.	-	9/5.5	8/4.6	-
Viola adunca	-	9/0.5	8/0.4	10
Woodsia oregana	100/32.0	-	15/4.8	-

Genera present in habitat type (Steele et al. 1981) not found in shrub fields: *Chimaphila, Disporum, Goodyera, Lathyrus, Mitella.*

frequencies of Idaho fescue than do the descriptions for the ponderosa pine phase of the habitat type.

A high forb variety is present, where strawberry (*Fragaria* spp.) acts as a potential indicator for the type in the region. Yarrow, hawkweed, clover, wintergreen (*Pyrola secunda*), lupines, and baneberry (*Actaea rubra*) were also common. We observed plants common in more mature stands studied by Steele et al. (1981) including paintbrush, trail plant (*Adenocaulon bicolor*), sticky geranium (*Geranium viscosissimum*), mountain sweet-cicely (*Osmorhiza chilensis*), starry false Solomon's seal (*Smilacina stellata*), and goldenrod (*Solidago canadensis*). These are not common in seral communities we studied.

Seral stands of the Douglas fir/Idaho fescue community were represented by five stands, two along the Middle Fork and three along the main Salmon

River (Table 6). Young Douglas fir plants again signified the successional status of these stands. Idaho fescue and bluebunch wheatgrass have consistently high coverage. Balsamroot, penstemons, hawkweed, woodland star (*Lithophragma parviflora*), and fireweed (*Epilobium angustifolium*) were common forbs. Cheatgrass was present in all stands, as were annual forbs such as threadleaf phacelia, chickweed (*Cerastium arvense*), and blue-eyed Mary. These stands are regenerating from past fires.

Five stands contained ponderosa pine seedlings (Table 7). One stand along the main Salmon river appeared as a seral Ponderosa pine/Antelope bitterbrush community, indicated by high coverage of antelope bitterbrush. This stand was probably the Idaho fescue phase of that community, as described by Steele et al. (1981). This community is widespread along the canyonlands of this region.

Three stands in the East Fork having mature Douglas fir over dense stands of mountain big sagebrush were described (Table 8). These stands would be classified as a sagebrush phase of the Douglas fir/Mountain snowberry/Elk sedge community by Steele et al. (1981). However, these stands have no evidence of disturbance, and contain significant coverage of species representative of drier sites. These drier site species were not present in the description for the putative habitat type and phase. Mountain snowberry is scarce in these stands. We propose that the earlier designation of a Douglas fir/Elk sedge/Big sagebrush community more appropriately describes these communities (see page 97 of Steele et al. 1981).

These seral communities, and communities with sparse conifer overstories, are important forage-producing habitats for wildlife. Their relatively dense understories of grasses and broadleaved forbs, such as arrowleaf balsamroot, provide ample cover for ground nesting species such as blue grouse. These stands undoubtedly support substantial numbers of small mammals on which hawks and owls depend. We can expect the songbird complex to increase in diversity as trees mature and as diversity of cover increases.

Just how species composition and cover change as stands mature following fire varies greatly, depending on intensity and timing of the fire, seed sources, precipitation patterns, kind and intensity of herbivory, ability of species to resprout, and other influences. As overstories shade understories, the least shade tolerant species decrease and may eventually disappear. Some species proliferate at intermediate stages following fire, including Albert hawkweed (*Hieracium albertinum*) and antelope bitterbrush in Douglas fir/Common snowberry communities. In the immediate vicinity of firs

Table 6. Constancy and frequency values of plant species in three stands compared with constancy values in two phases of Douglas fir/Idaho fescue communities described by Steele et al. (1981).

SPECIES	CONSTANCY/ FREQUENCY (3 stands)	STEELE ET AL. CONSTANCY	
		Ponderosa pine phase	Idaho fescue phase
Bromus tectorum	100/18.8	-	-
Festuca idahoensis	100/76.6	100	100
Koeleria cristata	60/13.1	30	20
Poa secunda	80/17.6	-	-
Pseudoroegneria spicata	100/43.2	80	70
Achillea millefolium	40/29.2	80	50
Agoseris glauca	20/0.3	-	-
Antennaria dimorpha	20/1.1	-	10
Apocynum androsaemifolium	40/1.7	-	-
Balsamorhiza sagittata	60/10.0	-	-
Castilleja inverta	40/2.1	-	-
Cerastium arvense	20/1.4	-	-
Collinsia parviflora	60/17.6	-	-
Crepis atrabarba	40/12.0	-	-
Descurainia pinnata	20/0.6	-	-
Epilobium angustifolium	60/7.9	-	10
Erigeron pumilus	20/2.0	-	-
Fritillaria pudica	40/0.1	-	-
Geum triflorum	40/0.4	30	50
Hieracium albiflorum	60/4.2	-	-
Lithospermum ruderale	60/0.1	-	-
Lomatium triternatum	20/8.8	30	-
Lupinus spp.	20/0.1	-	10
Montia perfoliata	20/0.3	-	-
Penstemon spp.	80/2.4	20	-
Phacelia hastata	40/1.0	-	10
Phacelia linearis	80/5.6	-	-
Silene oregana	20/1.6	-	-
Scutellaria antirrhinoides	20/1.6	-	-
Berberis repens	20/2.4	20	-
Eriogonum heracleoides	20/7.2	-	-
Philadelphus lewisii	20/0.1	-	-
Ribes cereum	20/0.8	50	50

Table 7. Constancy and frequency values of plant species in shrub communities within Ponderosa pine habitats with comparisons of constancy values in Ponderosa pine/Bitterbrush and Ponderosa pine/Common snowberry communities described by Steele et al. (1981).

SPECIES	CONSTANCY/ FREQUENCY (5 stands)	STEELE ET AL.[1] Pipo/ Putr/Feid	Pipo/ Syal
Bromus tectorum	80/21	-	-
Carex geyeri	60/12	30	50
Festuca idahoensis	80/27	100	10
Koeleria cristata	20/17	30	-
Poa spp.	60/5	-	-
Pseudoroegneria spicata	100/57	70	50
Achillea millefolium	80/13	100	90
Agoseris glauca	40/2	-	-
Allium spp.	20/2	-	-
Amsinckia spp.	20/5	-	-
Anaphalis margaritacea	20/7	-	-
Antennaria microphylla	20/2	30	10
Arnica cordifolia	20/25	-	-
Balsamorhiza sagittata	80/38	70	40
Berberis repens	20/10	-	30
Cirsium utahense	20/1	-	-
Collomia linearis	40/34	-	-
Epilobium angustifolium	20/8	-	-
Eriogonum ovalifolium	20/8	-	-
Frageria vesca	20/5	-	30
Galium triflorum	20/24	-	10
Gilia aggregata	20/5	-	-
Hieracium albertinum	80/12	-	10
Lathyrus nevadensis	20/45	-	30
Linnaea borealis	20/13	-	-
Lithospermum ruderale	40/2	-	-
Lomatium spp.	40/28	-	-
Lupinus spp.	80/21	30	10
Mentzelia albicaulis	20/24	-	-
Penstemon spp.	20/1	-	10
Phacelia linearis	40/2	-	-
Phoenicaulis cheiranthoides	20/25	-	-
Physaria geyeri	20/2	-	-
Polygonum douglasii	80/28	-	-
Sedum stenopetalum	40/2	-	-
Senecio triangularis	20/1	-	-
Tragopogon dubius	40/2	-	-
Viola adunca	20/13	-	20
Amelanchier alnifolia	20/10	70	80
Philadelphus lewisii	20/1	-	-
Pinus ponderosa	60/1	100	100
Purshia tridentata	40/23	100	30
Ribes cereum	40/2	30	40
Spiraea betulifolia	40/7	-	20
Symphoricarpos albus	60/15	30	100

[1] Feid = *Festuca idahoensis* ; Pipo = *Pinus ponderosa*; Putr = *Purshia tridentata*; Syal= *Symphoricarpos albus*.

Table 8. Constancy and frequency values of three stands in the East Fork dominated by Mountain big sagebrush with constancy values of three Douglas fir communities described by Steele et al. (1981).

Species	Constancy/ Frequency	Steele et al. 1981 Douglas fir/ Bluebunch Wheatgrass	Douglas fir/Idaho fescue Ponderosa Pine phase	Idaho Fescue phase
			-----Constancy----	
Artemisia tridentata vaseyana	100/63	60	50	90
Chrysothamnus viscidiflorus	67/8	-	-	-
Erigeron filifolius	67/3	-	-	-
Eriogonum caespitosum	100/22	-	-	-
Leptodactylon pungens	67/5	-	-	-
Phlox hoodii	33/13	-	-	-
Phlox longifolia	33/3	-	-	-
Pseudotsuga menziesii	100/7	10	10	10
Purshia tridentata	33/3	50	50	-
Ribes cereum	40/1	50	50	50
Symphoricarpos oreophilus	67/1	50	20	50
Bromus tectorum	20/8	-	-	-
Carex spp.	33/10	20	30	20
Festuca idahoensis	100/48	30	100	100
Koeleria cristata	100/1	-	30	20
Poa secunda	33/3	30	-	-
Pseudoroegneria spicata	100/60	90	80	70
Achillea millefolium	67/1	30	80	50
Agoseris glauca	40/5	-	-	-
Antennaria microphylla	33/5	20	20	100
Balsamorhiza sagittata	40/1	50	-	20
Castilleja spp.	33/2	-	-	20
Crepis acuminata	67/3	40	-	-
Erigeron compositum	33/1	-	-	-
Eriogonum umbellatum	67/5	-	-	-
Geum triflorum	20/10	10	30	50
Lomatium spp.	20/2	60	30	-
Lupinus spp.	33/3	-	-	-
Stephanomeria exigua	33/1	-	-	10
Silene acaulis	20/7	-	-	-
Annual forbs	33/10	-	-	-
Major species in habitat type not present in East Fork stands:				
Amelanchier alnifolia		50	70	-
Arnica cordifolia		-	20	20
Ceanothus velutinus		40	20	-
Fragaria virginiana		10	30	20
Geum triflorum		10	30	50
Lomatium dissectum		60	30	-
Phacelia hastata		40	-	10
Pinus ponderosa		50	100	-
Prunus virginiana		50	20	-
Ribes cereum		50	50	50
Rosa woodsii		20	50	-
Smilacina racemosa		20	30	-
Viola purpurea		40	-	-

and pines (the so-called drip zone), plant distribution is more sparse, and species composition differs. Miners' lettuce (*Montia* spp.), chickweed, other annual forbs, cheatgrass, and six-week's fescue may predominate along with the cast needles of the overstory trees. Successional stands may be long-lived and essentially permanent components of the landscape where frequent fires preclude development of conifers. Fires undoubtedly contribute to thinner, uneven-aged overstories in these dry sites. A knowledge of the values of these seral stands, likely successional patterns, and potential climax stands, serves to guide management for various goals. These factors also can predict the natural vegetation complex on wilderness sites.

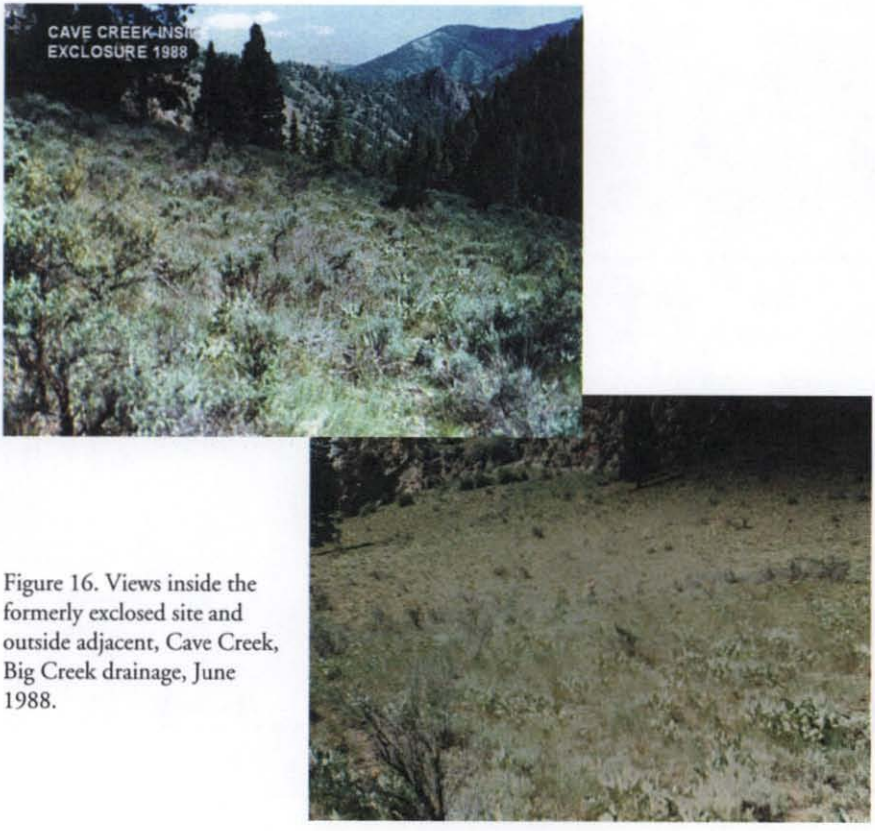

Figure 16. Views inside the formerly exclosed site and outside adjacent, Cave Creek, Big Creek drainage, June 1988.

Exclosures

Examinations of the exclosures at Hood Ranch, Sheep Creek, and Reservoir Creek in the Middle Fork of the Salmon River drainage, and Cave Creek in the Big Creek drainage were completed between June 1988 and July 1992. The descriptions provide comparisons of composition inside and outside of exclosures established to exclude livestock and big game at least 30 years ago. Sites photographed in 1925 and 1968 above the Flying B Ranch were photographed again for comparisons.

Cave Creek Exclosure

This site includes a formerly exclosed area and adjacent unprotected areas (Figure 16). The site has a gently sloping, west-facing exposure. The major difference between the formerly exclosed portion and adjacent site was in the shrub component (Table 9). Big sagebrush density was approximately 2.5 times greater on the formerly exclosed site. Dead sagebrush stem density also was greater. The height of big sagebrush plants on the formerly exclosed site was double that of plants on unprotected areas.

Antelope bitterbrush heights were significantly greater on the formerly exclosed site, but stem densities were nearly identical to those on adjacent sites. Twig density was greater outside the formerly exclosed site, but the difference was not significant. Dead stem density was negligible outside the exclosure and very low inside for this species.

The major difference in the herbaceous union was expressed by the high coverage of cheatgrass outside the formerly exclosed area, and very low coverage inside. The high standard deviation outside reflected the patchy distribution of this species. Coverage of other species was not appreciably different, but green weight production of bluebunch wheatgrass was 16.7 gm/m^2 inside the exclosure and 29.5 gm/m^2 outside of the exclosure at the time of measurement, indicating a more vigorous grass community outside.

The differences between the formerly exclosed site and the unprotected site adjacent strongly suggest the area had been disturbed. The consistency of antelope bitterbrush density supports this species as a dominant. Adding the high coverage of bluebunch wheatgrass indicates an Antelope bitterbrush/Bluebunch wheatgrass community. The high amount of big sagebrush in the formerly excluded area suggests grazing disturbance in past periods allowed the increase of this species, which was then protected from game browsing by fencing. Fencing retarded succession by allowing sagebrush retention. Big sagebrush was still undergoing substantial mortality inside the formerly

Table 9. Vegetative characteristics of the Cave Creek exclosure site.

HERBACEOUS SPECIES (coverage > 5%)	INSIDE (CANOPY COVER ± S.D.)	OUTSIDE	T-test T	P
Achillea millefolium	2.1±4.5	5.0±6.8	1.51	.142
Achnatherum lettermanii	6.5±13.8	8.8±15.1	0.77	.443
Balsamorhiza sagittata	6.4±14.5	4.6± 11.7	0.48	.631
Bromus tectorum	0.3±0.8	20.0±23.6	6.60	.0001
Pseudoroegneria spicata	19.8±27.7	14.8±27.9	0.45	.656
SHRUBS				
Artemisia tridentata				
Height (cm)	160.5±25.5	47.8±16.0	8.33	.0001
Stems/m²	0.63±1.00	0.25±0.40	4.00	.0003
Dead stems/m²	0.33±0.23	0.01±.005	6.02	.0001
Twigs/m²	104.6±84.9	21.6±34.7	4.78	.0001
Purshia tridentata				
Height (cm)	134.8±35.8	85.3±24.8	4.99	.0001
Stems/m²	0.05±0.1	0.05±0.10	.47	.6430
Dead stems/m²	0.01±.05	0		
Twigs/m²	2.72±8.3	7.2±14.9	1.11	.2792

exclosed area, but mortality appeared to persist at a low level outside. The greater coverage of cheatgrass outside the exclosure may be explained both by the disturbance of past livestock and by ongoing wildlife grazing. Cheatgrass may diminish in coverage on the site over time. The Housley Ranch, started in the early 1900s in Cave Creek, was abandoned about 1919 (Hartung 1978). The long history of livestock grazing in the Cabin Creek area immediately downstream from Cave Creek suggests livestock grazing was an important influence on vegetation trends in the Cave Creek area as well.

"Flying B" Exclosure

The exclosure was established on an east-facing site in 1949 (Figure 17). Antelope bitterbrush was planted inside the exclosure. The outside transect was established north of the exclosure, which occurred on the ridge above the airstrip owned by the "Flying B." Mule deer used this area extensively. Horses also grazed the ridge.

The most striking aspect of the site was the dominance of balsamroot, both inside and outside of the exclosure (Table 10). The low coverage of bluebunch wheatgrass, lesser clubmoss (*Selaginella densa*), Idaho fescue and

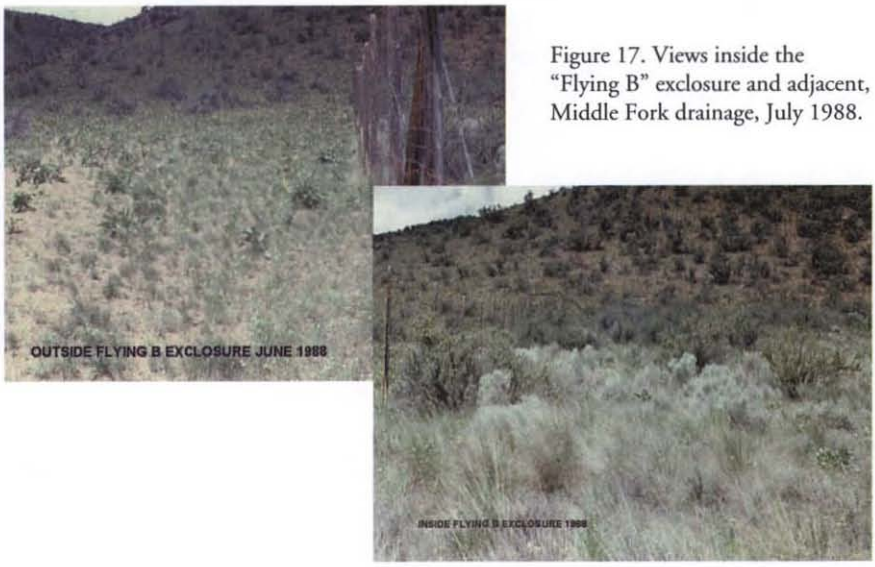

Figure 17. Views inside the "Flying B" exclosure and adjacent, Middle Fork drainage, July 1988.

Table 10. Vegetative characteristics of the "Flying B" exclosure site.

HERBACEOUS SPECIES (coverage > 5%)	INSIDE S (CANOPY COVER ± S.D.)	INSIDE N	OUTSIDE N	T-test T	T-test P
Balsamorhiza sagittata	12.6±26.8	34.8±39.3	21.6±20.3	0.98	.329
Bromus tectorum	32.4±31.1	16.0±26.4	4.5±9.2	.582	.563
Cerastium arvense	0	10.1±21.6	4.7±6.4	.046	.963
Festuca idahoensis	14.0±26.6	7.1±13.8	0.3±0.8	14.96	.056
Phlox longifolia	3.4±6.0	1.3±3.4	0.5±1.1	.686	.497
Hesperostipa comata	2.3±8.4	10.8±28.7	0		
Poa secunda	0.1±0.6	3.0±8.8	0		
Pseudoroegneria spicata	12.5±23.2	12.9±22.3	0.4±0.9	3.51	.0017
Selaginella densa	26.3±39.2	22.6±38.6	0		
SHRUBS					
Purshia tridentata					
Height (cm)	0	168.8±32.0	119.0±53.8	2.64	.012
% decadence	0	24.5±16.4	59.5±15.4	6.97	.0001
Twig lengths (cm)	0	1.25[1]	4.75±2.1	8.237	.0001
Artemisia tripartita					
Height (cm)	0	64.3±14.8	19.5±7.8	10.56	.0001
% decadence	0	20.7±16.2	20.0±16.9	0.11	.907
Twig lengths (cm)	0	40.8±5.0	8.0± 3.5	5.93	.0001

[1]No twigs over 1.25 cm long. One plant, 35 cm high with a 10-cm leader, was established on bare soil inside the exclosure.

needle-and-thread outside the exclosure reflected responses to grazing pressure when compared with vegetation inside the exclosure. Threetip sagebrush, a palatable deer forage, outside of the exclosure was only 30% of the height inside the exclosure; twig lengths were 47% as long outside as they were inside.

Antelope bitterbrush plants inside the exclosure were tall, contained moderate amounts of dead stems, and were essentially unproductive. No current annual growth was higher than 1 cm. Antelope bitterbrush plants outside were shorter, contained large amounts of dead stems, and CAG averaged 4.8 cm long. Threetip sagebrush provided a converse pattern, growing shorter and less productive outside than inside.

The site showed evidence of extensive current and past grazing. This site appears to be a Threetip sagebrush/Idaho fescue community, in which antelope bitterbrush is seral or exists at low density in the undisturbed state. Antelope bitterbrush was essentially not reproducing on the site (one plant 35 cm tall had established on bare soil inside the exclosure). Deer use was probably responsible for the lower heights and shorter twig lengths of threetip sagebrush and for the lower heights and longer twig lengths of antelope bitterbrush outside the exclosure when compared with plants located inside. This suggests threetip sagebrush was more sensitive to grazing pressure than was antelope bitterbrush. An alternative explanation for the low heights and vigor of threetip sagebrush is that both deer and horses grazed it, while only deer browsed the antelope bitterbrush. Herbaceous conditions outside the exclosure were attributed to grazing by horses. The prevalence of antelope bitterbrush on this site may result from past grazing history. The antelope bitterbrush also may have been planted in areas where it was not especially suited, as the antelope bitterbrush inside the exclosure was not vigorous and had not been so for years.

Sheep Creek Exclosures

An acre-sized exclosure established in 1961 included a smaller exclosure (20 X 20 feet) established in 1930, allowing comparisons over 59 and 27 years of protection with unprotected conditions. Crested wheatgrass was planted inside the small exclosure, where 15 plants remained (Table 11). There were ten live and four dead antelope bitterbrush plants in the small exclosure, averaging 226.5 cm tall, as compared with the 165.8 cm height of seven antelope bitterbrush plants immediately adjacent on an unexclosed site. Three heath goldenrod plants occurred in the exclosure, 95 cm, 95 cm and 125 cm tall.

Table 11. Vegetative characteristics of the Sheep Creek exclosure site.

LARGE EXCLOSURE

HERBACEOUS SPECIES (coverage > 5%)	INSIDE (CANOPY COVER ± S.D.)	OUTSIDE	Paired T-test T	P
Pseudoroegneria spicata	4.4±19.6	0.8±3.4	0.32	.748
Mentzelia albicaulis	6.4±13.8	4.1±14.1	.791	.4348
Bromus tectorum	4.4±9.5	1.4±3.4	0.96	.3509
Lomatium foeniculaceum	0	0.3±.77		
Selaginella densa	45.9±38.3	21.1±29.0	2.097	.0427
Phlox longifolia	6.4±9.6	0.1±0.6	3.962	.0005
Hesperostipa comata	16.6±23.9	29.8±27.7	.9575	.3444
Eriogonum heracleoides	4.9±21.8	0		
SHRUBS				
Purshia tridentata				
Height (cm)	209.8±80.3	195±86.8	.833	.4084
Number of live plants	43			
Number of dead plants	13			

SMALL EXCLOSURE

HERBACEOUS SPECIES (coverage > 5%)	INSIDE (CANOPY COVER ± S.D.)	OUTSIDE	Paired T-test T	P
Bromus tectorum	4.4±9.5	1.4±3.4	0.96	.3509
Hesperostipa comata	3.8±6.7	26.3±28.3	3.32	.0019
Lomatium foeniculaceum	6.3±11.9	0.3±0.8	2.384	.0255
Phlox longifolia	20.8±30.2	0		
Pseudoroegneria spicata	3.4±9.3	0.8±3.3	1.18	.248
Selaginella densa	54.5±39.9	31.6±38.1	1.103	.2771
SHRUBS				
Purshia tridentata				
Height (cm)	226.5±88.3	165.8±66.3	1.134	.2748
Number of live plants	10 0			
Number of dead plants	4 0			

Perhaps the most striking differences in the herbaceous union inside and outside the small exclosure were the dominance of needle-and-thread outside and the higher coverage of Harryseed lomatium (*Lomatium foeniculaceum*), longleaf phlox and tall tumblemustard inside. The cause is unclear, but different past and present grazing regimes, and the relatively small size of the exclosure, which may enhance moisture retention, may be responsible.

The larger exclosure provided similar comparisons and included more species (Table 11), but Harryseed lomatium was less prevalent in the large exclosure than in the smaller one. Whitestem mentzelia was common on this site and was not observed elsewhere in the Middle Fork exclosures. If grazing is to be considered the major factor influencing differences between excluded and unprotected areas in this canyon, why should parsnip-flowered buckwheat and longleaf phlox, both relatively unpalatable half-shrubs, be more prevalent inside the exclosures than outside? Other factors were probably involved, including competition for moisture between plant species, successional patterns of vegetation following protection from different kinds of disturbances, different soil and moisture regimes among the various exclosures (this site is the highest, located on a ridgetop), and climatic change from periods of relative drought to periods of high precipitation.

Forty-three live antelope bitterbrush plants occurred inside the large exclosure. These were comparable in height to plants inside the small exclosure. Dead plants constituted 23% of the standing antelope bitterbrush stems. Needle-and-thread characterized the understory inside the exclosure, while a large variety of species constituted relatively equivalent proportions of the vegetative cover outside. Cheatgrass occurred primarily beneath antelope bitterbrush plants, while needle-and-thread occurred in openings between shrubs, where effects of shade and moisture competition were less. The higher coverage of lesser clubmoss inside this exclosure reflected lack of disturbance of the soil surface. This site was considered primarily an Antelope bitterbrush/ Bluebunch wheatgrass community. It may be the most severe site enclosed in the general area.

Reservoir Creek Game Exclosure

The Reservoir Creek exclosures were established in 1949. The "game" exclosure, located on the west and southerly exposed slopes south of Reservoir Creek, contained a variety of sites and at least two communities (Table 12). Outside replications on comparable adjacent sites were difficult to locate; finally, we found one outside replicate of the antelope bitterbrush stand in the exclosure on an adjacent slope north of the exclosure.

Table 12. Vegetative characteristics of the Reservoir Creek game exclosure site.

East end of exclosure				
HERBACEOUS SPECIES	INSIDE	OUTSIDE	Paired T-test	
(coverage > 5%)	(CANOPY COVER ± S.D.)		T	P
Bromus tectorum	4.4±9.5	5.4±6.6	0.77	.452
Ericameria nauseosa	1.0±28.5	0.8±3.4	1.14	.269
Hesperostipa comata	0.8±3.4	12.0±24.9	2.02	.058
Poa secunda	3.4±6.0	0.1±0.6	1.94	.067
Pseudoroegneria spicata	23.0±31.7	15.6±22.4	0.31	.759
Selaginella densa	15.0±30.9	2.6±8.9	1.91	.0716
SHRUBS				
Purshia tridentata				
Height (cm)	167.0	130.5	2.72	.0135
% decadent	22.5	28.0	1.00	.3299
Twig length (cm)	1.25	5.24	3.83	.0004

North and west side of exclosure					
HERBACEOUS SPECIES	INSIDE(n)	INSIDE (W)[3]	Outside(W)[3]	T-TEST	
(coverage > 5%)	(CANOPY COVER ± S.D.)			T	P
Crepis atrabarba	6.5±14.5	0	0		
Ericameria nauseosa	0	4.6±14.	4.7±20.1	0	1.00
Festuca idahoensis	47.9±27.7	0	0		
Poa secunda	6.8±6.9	0.1±0.6		4.65	.0002
Pseudoroegneria spicata	10.5±16.9	7.3±20.8	23.9±26.2	2.13	.0468
SHRUBS					
Purshia tridentata					
Height (cm)	104.5[1]	123.2[2]	104.5	.46	.6513
% decadent	16[1]	36[1]	21	2.54	.020
Twig length (cm)	1.25	1.25	5.75	7.61	.0001

[1]Severe site without significant grass understory.

[2]Less severe site with moderate grass understory

[3]Inside(n) is near ridge, more mesic site than inside(w) which is on a steep south facing slope.

The crest of the ridge inside the exclosure was considered a Threetip sagebrush/Idaho fescue community. We found no replicates adjacent to the exclosure. The aspect was northwest. The community consisted of a vigorous stand of Idaho fescue. Bluebunch wheatgrass, Sandberg bluegrass, hawksbeard, threetip sagebrush, and antelope bitterbrush comprised between 3% and 10% canopy coverage.

The rest of the exclosure faced south to southwest and probably contained an Antelope bitterbrush/Bluebunch wheatgrass community on the more xeric sites. The higher canopy coverage values of bluebunch wheatgrass and antelope bitterbrush outside the exclosure were taken from the adjacent slope and may reflect less severe growing conditions there. Antelope bitterbrush plants in the exclosure were most decadent on sites having the highest grass coverage. The youngest and thriftiest plants inside this exclosure occurred on the most severe sites, where grass cover was lowest. A few plants were less than 30 cm tall, indicating seedling establishment, but antelope bitterbrush plants were commonly reproducing by layering. Intensively browsed plants outside the exclosure showed three to four times more leader growth than did those inside. Dead and decadent antelope bitterbrush was significantly greater inside than outside the exclosure, the difference being related to associated grass cover. Mule deer were the major users of this site; a few pellet groups appeared inside the exclosure.

Reservoir Creek Stock Exclosure

This exclosure was on a gentle slope below the game exclosure and farther south. It appeared to be an Antelope bitterbrush/Bluebunch wheatgrass community (Table 13). Deer use was abundant in this exclosure and some horse use occurred. Hunters apparently used the exclosure as a corral in the recent past. On the east side, bluebunch wheatgrass exhibited the highest coverage values, both on a representative site replicated outside, and on an unreplicated severe site inside. Cheatgrass was present on the severe site but not on the replicated sites. Needle-and-thread coverage was higher on the unprotected site than inside, while heath goldenrod showed higher coverage inside than outside. The more severe site had lower coverage values of antelope bitterbrush, and big sagebrush was present, suggesting a Big sagebrush/ Bluebunch wheatgrass community. Needle-and-threadgrass may be a high seral dominant, which ultimately would be replaced by bluebunch wheatgrass on this site.

Needle-and-thread dominated the south side of this exclosure and the adjacent unprotected site, with antelope bitterbrush and big sagebrush in the

Table 13. Vegetative characteristics of the Reservoir Creek stock exclosure site.

HERBACEOUS SPECIES (coverage > 5%)	INSIDE (low) (CANOPY COVER ± S.D.)	INSIDE (high) (CANOPY COVER ± S.D.)	OUTSIDE (high) (CANOPY COVER ± S.D.)	T-test T	T-test P
Arenaria congesta	0	7.1±9.7	11.0±14.7	0.26	.8008
Bromus tectorum	6.6±23.8	0	0		
Festuca octoflora	0	15.5±21.1	7.9±6.7	1.82	.0842
Hesperostipa comata	0	42.6±25.4	57.1±25.6	1.94	.0676
Pseudoroegneria spicata	18.3±30.5	0	0		
SHRUBS					
Artemisia tridentata					
Height (cm)	129.0±23.8	110.3±47.3	0	2.35	.0296
% decadent	36.0±20.4	46.5±17.2	0	1.69	.1077
Twig length (cm)	13.0±5.3	9.3±3.0	0	4.64	.0001

overstory. Although big sagebrush was not recorded in the plots, it occurred on the site and was taller, less decadent, and exhibited longer leader growth inside the exclosure than outside. The plants outside the exclosure were extensively browsed.

Wyeth Burial Site

This burial site, excluded from grazing by a low pole fence, is on a flat bench across from the "Flying B" on Idaho Fish and Game Department land and is approximately 3.3 m by 6.6 m in size (Figure 18). It was surrounded by a big sagebrush community, but only one small sagebrush plant occurred inside the fence. Needle-and-thread was dominant, with coverage estimated at more than 80%. Cheatgrass was present, with coverage estimated at 10%. Some bluebunch wheatgrass was present at 5% coverage. Three dead heath goldenrod plants occurred on this site. No forbs were present. This greatly disturbed site provided evidence that needle-and-thread was seral to bluebunch wheatgrass on these benches. At least some of the benches along the river were probably a Mountain big sagebrush/ Bluebunch wheatgrass community, to which this site presumably would succeed if left undisturbed.

Sunflower Creek (Hood Ranch) Exclosure

The fence at this site was torn down in the mid-1980s, but the outline of the exclosure was readily apparent from a line of bluebunch wheatgrass along one side, wire lying on the ground near one corner, and trails along other

Figure 18. Wyeth burial site near Warm Springs Creek (Mormon Ranch), Middle Fork Salmon River. This site was established in 1915. Photograph July 1988.

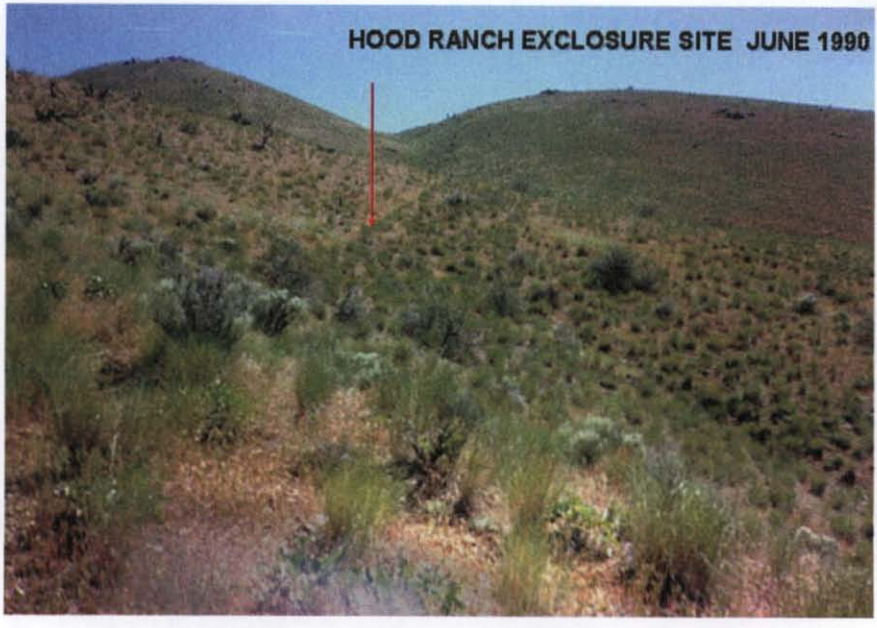

Figure 19. Views inside the formerly exclosed site and outside adjacent, Sunflower Creek (Hood Ranch), Middle Fork Salmon River. June 1990.

sides (Figure 19). It was 0.4 ha in size. An 0.4-ha plot was established adjacent to the exclosure site for comparisons.

The herbaceous union did not show significant differences in coverage of bluebunch wheatgrass, cheatgrass, or arrowleaf balsamroot, the three major plant species (Table 14). The slightly higher coverage of cheatgrass, and presence of field chickweed outside of the exclosure, were offset by the slightly higher coverage of annual mustards inside. A significant difference in bluebunch wheatgrass seed stalk heights was apparent on the exclosure site (mean 75.7 cm) and the adjacent site (mean 69.2 cm, T= 2.9734, P=.0039).

The shrub component showed rather dramatic differences inside and outside the exclosure site. Live antelope bitterbrush was nearly absent outside the exclosure site in its vicinity. Within the exclosure site, 47 of 90 plants were alive, while 3 of 66 were alive adjacent to the site. One of the three plants outside was 34 cm tall, while the other two were more than 200 cm tall. A variety of size classes were represented inside the exclosure. Fifteen of 20 heath goldenrod plants were alive inside the exclosure site, while 28 of 42 were alive outside, an insignificant difference. These plants were all heavily browsed. Mountain big sagebrush, represented by three plants inside the exclosed site, was not found on the adjacent plot. Heath goldenrod was taller inside than on the adjacent site.

This site was considered an Antelope bitterbrush/Bluebunch wheatgrass community, based on the presence of these species on the exclosed site. The reduction in shrub components outside was attributable to the site being a major elk and mule deer wintering area. Since the shrub component was so depauperate on the sites consistently exposed to browsing, the trend was towards a Bluebunch wheatgrass/Arrowleaf balsamroot community. As evidence of antelope bitterbrush disappears, interpretation of the successional status in the absence of the exclosed site will become progressively more difficult.

The ridge above this exclosure site was burned in the Mortar Fire of 1981. On the most southerly exposed sites, cheatgrass and arrowleaf balsamroot predominated, and antelope bitterbrush plants were all dead. However, on other sites where Idaho fescue was present, we observed sprouting from the root collars of many burned antelope bitterbrush plants. The whole area was traditional mule deer winter range; it probably was grazed by livestock when the homesteads were occupied. Bud Hamilton, a long-time USDA Forest Service employee having extensive knowledge of this area, said that sheep, cattle and horses grazed the Thomas Creek area in the 1920s and 1930s. The Idaho Department of Fish and Game bought the Hood Ranch in the early

Table 14. Vegetative characteristics of the Hood Ranch exclosure site.

HERBACEOUS SPECIES (coverage > 5%)	INSIDE (CANOPY COVER ± S.D.)	OUTSIDE	Paired T-test T	P
Balsamorhiza sagittata	14.4±32.4	8.5±20.2	0.418	.6778
Bromus tectorum	44.3±31.5	52.4±32.9	0.669	.5071
Cerastium arvense	0	0.1±1.1		
Crucifera spp.	5.3±9.3	1.01±1.1	1.18	0.244
Lomatium foeniculaceum	0.3±1.1	0		
Phlox longifolia	2.3±3.8	0		
Pseudoroegneria spicata	15.5±29.3	17.0±27.8	0.9924	0.3498
Pseudoroegneria spicata seedstalk heights	75.7±7.9	69.2±9.6	2.973	0.0039
SHRUBS				
Artemisia tridentata				
No. plants	3	0		
Height (cm)	113.3±4.0	0		
No. dead	0	0		
Chrysothamnus viscidiflorus				
No. plants	2	1		
Height (cm)	57±12.7	17	one plant outside	
No. dead	0	2		
Ericameria nauseosa				
No. plants	15	28		
Height (cm)	65.1±18.7	57.6±18.4	1.739	0.0951
No. dead	5	14		
Purshia tridentata				
No. plants	47	3	7.68	0.0001
Height (cm)	143.4±42.9	200±	0.412	0.683
No. dead	43	63		

1940s to secure the mule deer winter range by removing the livestock. In 1966, hardly any elk wintered in the area, according to Hamilton. The Idaho Department of Fish and Game estimated the elk population for the Middle Fork hunting unit 27 at 4,753±204 in January 2002.

Pence Report

This report includes a sequence of photographs taken by Thomas Pence, Mackay, Idaho, in October 1925, and by Dan T. Pence, Salmon National Forest, in December 1968 (Figure 20). The area covered included Brush Creek

to Short Creek on the west side of the Middle Fork River in the vicinity of the "Flying B" and Bernard Guard Station. These sites were photographed again in June 1988. The original typewritten report by Dan Pence, then forester at Cobalt Ranger District, was on file at the supervisor's office, Salmon National Forest.

Repeated photographs of four sites suggest decreases in antelope bitterbrush and increases in heath goldenrod occurred from 1925 to 1968. Photographs taken in 1988 suggest both species further declined in the intervening 20 years.

The 1968 Pence report stated that the Wilson brothers owned the Mormon Ranch and the "Flying B" property in 1925. The brothers wintered cattle and horses in the area. The Wilsons were reported to have lost up to 500 head of cattle during the 1928 winter, a severe one in this area, after which they sold these properties.

Thomas Pence reported deer were abundant in 1925 but less abundant in 1968. He felt less antelope bitterbrush and grass cover existed in 1968 than in 1925.

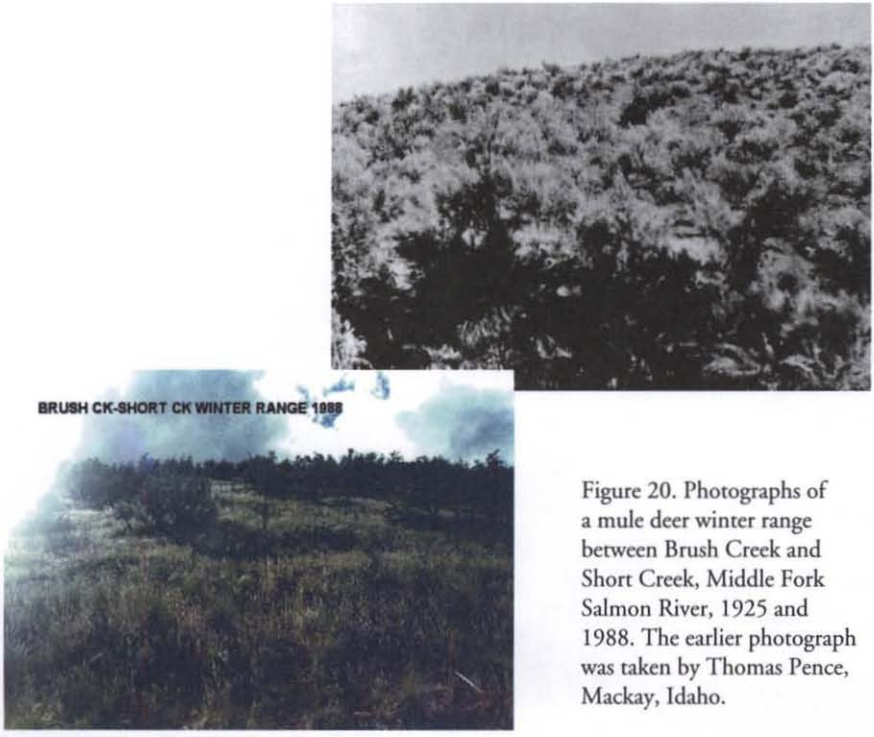

Figure 20. Photographs of a mule deer winter range between Brush Creek and Short Creek, Middle Fork Salmon River, 1925 and 1988. The earlier photograph was taken by Thomas Pence, Mackay, Idaho.

Discussion

Three attributes of the vegetation pattern stand out for the region, coinciding with the moisture gradient. First, Big sagebrush communities are common and well developed on the southern portions of the area. They became scarce and less well developed along the main Salmon River and in the South Fork. Second, more mesic communities tend to occur as understory in Douglas fir or Ponderosa pine communities. Thus, a Mountain big sagebrush/ Bluebunch wheatgrass community may be positioned next to a Douglas fir stand where the herbaceous union appears much the same as without the conifer component. Third, an increasingly larger component of forbs occurs in stands of the same community along the southeast to northwest gradient.

While sagebrush species are common in the more arid valleys such as Thomas Creek and Brush Creek in the Middle Fork, they gradually diminish in importance on the more northerly and westerly portions. Conversely, bunchgrass-dominated communities proliferate in the central portion of the mountain canyonlands. Bunchgrass stands characterize the slopes in Big Creek and much of the narrower portions of the Middle Fork. Finally, forested communities or their seral stages characterize the main Salmon Canyon and its South Fork. Cliffy areas in the Middle Fork and the main Salmon River have curlleaf mountain mahogany and little greenbush stands. Antelope bitterbrush communities exist throughout the region but are more abundant along the northern portions.

Tisdale (1986) considered the grassland types of the lower Salmon-Snake River region highly stable and not likely to change without a major climatic alteration. Exotics have invaded many of these communities since he made those observations. Tisdale (1986) considered shrub communities more responsive to shifts in fire and grazing regimes than the grasslands. Curlleaf mountain mahogany and common snowberry may have increased their range in the absence of fire, and short-term climatic variation also may have made the shrub complex more responsive when environmental conditions change. Johnson (1986) concluded from an examination of vegetative change across the western range that alterations in the sagebrush complex were site-specific and related to kind of use and site characteristics. Generally, no major shift in sagebrush distribution has occurred as a result of use, and the distribution of these species over a 115-year period has remained similar, although reduced in overall cover (Johnson 1986).

Gruell (1983), Houston (1973), Tisdale et al. (1965), and others provided evidence from undisturbed sites that a general increase in shrubs had occurred

across the west. Alterations in community structure require long periods with significant climatic change. An example from the Grays Lake, Idaho, area approximately 150 miles southeast of the central Idaho mountains shows dramatic change over a 70,000-year period (Beiswenger 1991). A cold, dry sage steppe occurred from 70,000-30,000 Before Present; a conifer woodland from 30,000-11,500 BP; a juniper-forb complex from 11,500-7100 BP. The more recent cooler, moist climate again caused increases in conifers and decreases in steppe plants. The hypothesis that changes in climate may first be noticed in shrubs seems tenable.

While longer term change may favor woody plants, on the shorter term, wildfires that remove woody plants from communities and favor grasses and forbs will encourage stands dominated by sagebrush species, antelope bitterbrush, and possibly mountain mahogany to appear as grassland dominated communities. While some woody plants typically remain alive following fire, stands designated as grassland without a shrub component might eventually revert to shrub-dominated communities as time following disturbance increases.

Our community descriptions are provisional, pending further examination of soils and of more stands. Our information is not adequate to identify communities dominated by needle-and-thread. Needle-and-thread is abundant in stands along the Middle Fork and in Big Creek, sometimes with a mountain big sagebrush overstory. These communities may be successional, either currently disturbed or recovering from past disturbance. Since communities dominated by needle-and-thread occur farther south, they may extend into the study area.

A problem in identifying the maximum potential vegetative expression for a site is not knowing the history for the site, and hence the degree of disturbance. A community may be located in an area where grazing and fire were likely major influences in vegetation composition. Many of the stands we examined probably were most influenced by wildfire and grazing pressures at some time in their history. Whether drought and climatic change have influenced their structure more than fire and grazing history is debatable. Native ungulates also may have influenced composition and structure of some communities.

The prevailing moisture regime is undoubtedly responsible for the reduced presence of sagebrush in the northwestern portions of these mountains. Big sagebrush does not reappear until the Blue Mountains and the eastern Washington scablands, farther north and west, in more arid

climates. Hironaka et al. (1983) speculated that the extensive cloudy periods characteristic of this region in winter prevent the nondeciduous sagebrush species from photosynthesizing sufficiently to persist, based on experimental evidence developed by Pearson (1975).

The change from shrub-steppe to forest in this region is subtle, and may be the major source of concern in designating communities. Bluebunch wheatgrass-dominated stands may be seral to sagebrush, antelope bitterbrush, curlleaf mountain mahogany, ponderosa pine, or Douglas fir. Factors that prevent the establishment of one of these woody species in these stands may or may not be related to the prevailing soil and climatic regimes; hence, some stands we consider Bluebunch wheatgrass/Sandberg bluegrass may eventually be recognized as successional. The same may be said for all provisional communities that have a counterpart with a taller shrub or conifer predominating. Some curlleaf mountain mahogany stands may succeed to Douglas fir, and some antelope bitterbrush to ponderosa pine.

We must expect some disturbance in the absence of anthropogenic influence and wildfire. Pocket gophers, ground squirrels, badgers, deer, elk, and bighorn may disturb local sites sufficiently in search of food, during breeding, or for bedsites, to maintain some species that otherwise would disappear or diminish. Those species may persist on a site long after the disturbance is not otherwise noticeable. It is perhaps significant that the old campsites used by Sheepeater Indians on lower Big Creek, now simply depressions on the ground, have the same vegetative composition as the surrounding area. However, the shallower sites excavated for archaeological purposes can be recognized by the different species composition 15 years after the disturbance. The Wyeth grave sites covered by a pure stand of needle-and-thread, while the adjacent grazed stand was dominated by big sagebrush, illustrate the long-term nature of influences on the vegetation complex in the region.

Another problem centers on the presence of cheatgrass, an introduced annual exotic, and other similar species in these stands. We did not use cheatgrass to define communities, but it must be considered a permanent part of the communities where it occurs, pending major climatic change or disturbance. We hypothesize that on more mesic sites desiccated by wildfire or grazing, the possibility exists cheatgrass will decrease and perhaps disappear as time since disturbance increases, coinciding with an increased moisture regime. On other more xeric sites it will likely persist and may increase following disturbance. Cheatgrass is ubiquitous, not confined to any one community. Hence, it does not appear to identify any particular

plant community. We follow the convention of excluding cheatgrass when describing communities.

Shrub-steppe vegetation on the East Fork and Middle Fork Salmon River drainages has been undergoing a transition from past disturbance. The areas have a relatively long history of use by humans and associated livestock. The area around the "Flying B" served as a winter range for up to 1,200 head of pack stock that supplied mining operations in the adjacent higher country. Farming and grazing these properties likely caused major changes in vegetation.

Parts or all of some exclosures were not within antelope bitterbrush-dominated communities, but were seral communities of which antelope bitterbrush was a part. The exclosures above the "Flying B" and at Cave Creek appear to represent this condition. These exclosures were established to demonstrate the adverse effects that game, mainly mule deer, or livestock grazing were having on antelope bitterbrush and other vegetation. Some 40 years after their establishment, the exclosures experienced considerable changes. Antelope bitterbrush plants became decadent; shifts in plant composition in the understory also were apparent. The exclosures were established not long after livestock grazing was reduced in the areas. The exclosures originally included vegetation that reflected the high mule deer and livestock grazing pressure. We suspect high mule deer populations had followed earlier livestock grazing, directed at grasses that allowed woody plants to survive. Although predator control and reduced harvest had some influence, the vegetation change, added to livestock grazing, has to be a major factor contributing to the high deer populations. Horse and cattle grazing likely favored invasion of big sagebrush, heath goldenrod, and antelope bitterbrush on adjacent sites at the expense of the more palatable grasses and forbs. An alternative explanation implicating fire suppression along with grazing in enhancing shrub communities is tenable, but this assumes fire suppression was effective in the 1910s and 1920s. In the late 1980s and early 1990s before the major fires, shrubs were becoming decadent, and thrifty stands of grass were appearing in the exclosures. Shifts in the understory composition were occurring from species that included cheatgrass and needle-and-thread to bluebunch wheatgrass and associated forbs. Mule deer populations are lower than in the middle decades of the 20th century, and the elk population has increased. The apparent transition from shrubs to grass probably will favor elk over mule deer. Current fire management policies should enhance that transition.

Climatic change, including the major drought of the 1930s, likely had a substantial effect on these plant communities. Shrubs would be expected to proliferate during those conditions, both on sites where individual species exist as seral dominants or codominants and on sites where they occur in the climax. Periods of high moisture would favor the associated bunchgrasses. Vegetation change would occur in response to natural climatic fluctuation in the absence of human interference, especially since climatic changes would affect fire frequencies. When climate predisposed higher fire frequencies, the vegetation condition would reflect the combined effects. The fluctuating climate predisposes change in the vegetation complex and, subsequently, the animal complex, that is very unlikely to be replicated in the future (Holling and Meffe 1996). This contrasts with the concept that change occurs as a long-term cyclic pattern, repeating conditions at an as-yet undefined long-term interval.

Conflicting trends occur in shrub-steppe species composition across the western rangelands. Burkhardt and Tisdale (1976), Gruell (1983), Hull and Hull (1974), Johnson (1986), Madany and West (1983), Martin and Turner (1977), Passey and Hugie (1962), Tisdale and others (1965), and Vale (1975), suggest that woody species, including the sagebrush species, have increased over this century, in some cases because of grazing, in other cases due to fire suppression, and in others where neither grazing nor fire were important. Grazing and fire prevention are generally held responsible for changes in plant composition in forest and shrub steppe across the arid West (Gruell 1983, Branson 1985). More recently, evidence has appeared that the increasingly higher concentrations of atmospheric carbon dioxide will alter community composition and function (Bazzaz 1990), with much uncertainty about results (Idso 1998, Vitousek 1994, Strain 1969, Marshall and Zhang 1994). However, Polley (1997) reported transition zones between grasslands and forest may be among the first areas to experience species change as CO_2 rises or climate changes, and trees and shrubs may increase at the expense of grasses.

Evidence of long-term increases also appeared in the herbaceous components in shrub steppe (Yeo et al. 1990, Austin and Urness 1998). These increases were attributed to changes in livestock and native ungulate grazing, deliberate efforts to reduce or eradicate woody plants to favor herbaceous forages for livestock. Prescribed burns and wildfires also favored change to herbaceous species over woody species.

If fire suppression and livestock grazing have been the major human

influences on these communities, current policy dramatically alters these influences. It provides substantial opportunity to investigate systems that detect natural change, climate-induced change, and variations related to the effects of rising atmospheric CO_2 as it affects photosynthesis, respiration, and plant growth. Lindroth et al. (1993) reported that elevated CO_2 atmospheres predicted for the next century will produce measurable changes in individual plant species and affect community structure and nutrient cycling on a broad level. Polley (1997) said transition zones between grasslands and forest may be among the initial areas experiencing species change as CO_2 rises or climate shifts. Trees and shrubs may increase at the expense of grasses. The long-term interactions between fire, climate, and herbivory continue to affect the shrub-steppe communities in this region.

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Back Cover: Big Lost River drainage illustrates the variation in shrub steppe as slope and aspect change. Herd Peak is in background.

University of Idaho

Idaho Forest, Wildlife and Range Experiment Station, Moscow, Idaho;
Steven Daley Laursen, Station Director and Dean

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