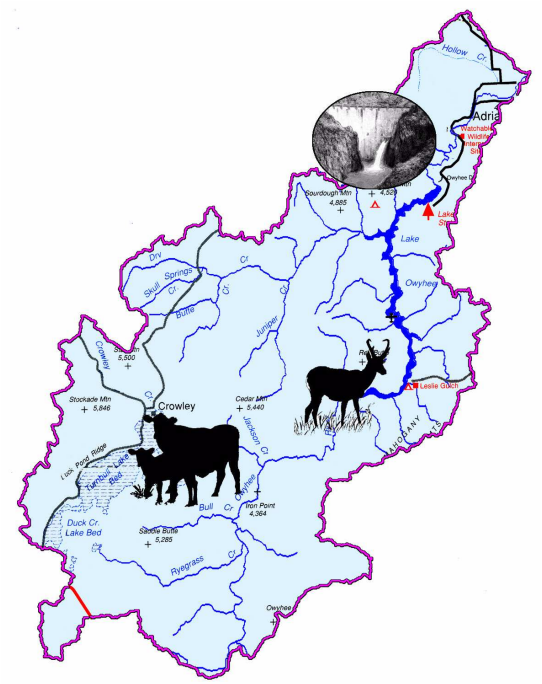

Lower Owyhee Watershed Assessment

IX. Rangeland

Contents

F. GMA
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H. Discussion
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J. Conclusions

IX. Rangeland

Appendix E contains a list of the common names and scientific names of plants in the lower Owyhee subbasin. Appendix F contains a list of the common names and scientific names of invasive species in the lower Owyhee subbasin.

A. Introduction

1. What is rangeland?

Rangeland is extensive, unforested land that is dominated by native plants. The term range was originally used to describe the wide open lands of the western half of the United States, probably because it was possible to "range" over large expanses.[35]

Land that is not towns or cities, farmland, dense forest, barren desert, "badlands", rock or glaciers is termed rangeland. Rangelands include open woodlands, grasslands, and shrublands. Since they exist worldwide, rangelands are known by many names: prairies, plains, grasslands, savannas, steppes, shrublands, deserts, semideserts, swards, tundra and alpines.[34,97]

Although rangelands occur on every continent and account for about 45 percent of the earth's land surface, they account for only 36 percent of the land surface of the United States. Most of these rangelands are in the western US where about 80 percent of the lands are rangelands.[35,98]

Rangelands are the dominant type of land in the arid and semiarid regions. In addition to having limited precipitation, they generally have sparse vegetation, sharp climatic extremes, and highly variable and frequent saline soils.[35,97,98] The dominant vegetation of western American rangelands is grasses, shrubs, and forbs (broadleaf plants like wildflowers).[34,98]

2. How is rangeland used?

Historically, the primary use of rangeland has been to provide forage for livestock and wildlife. Rangelands also provide wildlife habitat, habitat for a wide array of diverse native plant species, mineral resources, recreation, open space, and areas of natural beauty.[34,35,97,98]

Rangelands provide the varied habitats needed by a wide array of animal species including both game animals and non-game animals. Numerous species of mammals, birds, reptiles, amphibians, fish and insects live in the rangelands. Ruminants, animals such as deer, pronghorn antelope, and big horned sheep, can digest the cellulose in rangeland plants due to their specialized digestive systems. Small rangeland mammals have adapted to the arid environment and the forage provided by rangeland plants.[34,98]

Sheep, cattle, and goats are also ruminants and can utilize the cellulose in rangeland plants. Livestock production on rangeland supplies meat, leather, and wool. In the 19 western states, rangeland and associated pasturelands support 58% of all beef cattle in the United States, 79% of all stock sheep, and 88% of all goats.[34]

Outdoor recreational activities in rangelands include hiking, camping, river rafting, fishing, hunting, and photography.[98] The importance of rangeland for recreation and water production is growing.[34]

B. Historical condition of rangeland in the lower Owyhee subbasin

We have little written information on which to base an understanding of the condition of the rangeland before the introduction of livestock. The pioneers on the Oregon trail kept to limited routes, and after the first few years the conditions along those routes had been altered by the previous use. The descriptions of trappers and early explorers are sketchy, but give us some idea. (See the at contact section of the history component of this assessment).

The earliest trappers like Peter Skene Ogden and "pathfinders" like John Townsend noted sagebrush and greasewood with comments such as "wormwood [sagebrush] in abundance",[46] "abounding in wormwood",[83] and embarrassed with wormwood."[99] Fremont, a trained observer, talks about leaving the Owyhee River and crossing a sage plain of *Artemisia tridentata*.[78] These early Euro-Americans in the area also note the scarcity of grass in some areas.[46,83]

The first area overgrazed in the lower Owyhee subbasin was along the Oregon Trail crossed by numerous emigrants with their draft and dairy animals.[29]

1. Prior to significant livestock introduction

Before the miners had discovered gold in the Owyhees, a member of one of the first military expeditions to explore in the lower Owyhee subbasin, contrasts the green of the vegetation in the Jordan Valley area with the barren land which he had crossed until then coming up the Owyhee River.[71]

Before cattle or sheep were introduced in the area, Lieutenant Colonel Drew of the Oregon Cavalry crossed the rangelands near the southern border of the lower Owyhee subbasin in 1864 (see the early settlement section of the history component of this assessment). He describes a large stretch of the country as being "covered almost entirely with lava, sand and sage" and some greasewood.[18]

Cattle and sheep were introduced on the rangelands soon after the discovery of gold in 1863. In his memoirs, David Shirk describes the rangeland in 1867.

> "From the west slope of the Rocky mountains to the east slope of the Cascades . . . the valleys along the water courses are covered with a growth of browse, such as greasewood, thorny rabbit brush, salt brush and white sage. This grows to a height of from fourteen inches to four feet, and is excellent forage for horses, cattle, and sheep. I have driven cattle off the range, where white sage was abundant, in the month of January, as fat as I ever saw in the corn fed stalls of Illinois. On the

upland, or mountain ranges, there is little feed save the famous bunch grass, no browse growing worthy of mention. Horses will live indefinitely on the white sage, eating the snow for water. . . Cattle will perish after about six weeks. In the latter, after a period, the browse will become dry in the stomach and will not digest, and hence they will soon die."[74]

"Throughout the great valley of the Snake River, the first vegetation that appears in the spring is Larkspur, a rank poison. While the ground is yet soft, cattle in feeding will pull up some of the roots and if not attended to at once, will die. . . . Consequently, cattle have to be moved into the foothills of the mountains to feed upon bunch grass, and follow up the snow as it melts away."[74]

Although we have only sketchy means to visualize what the rangeland was like before the introduction of grazing, Harold Heady, "one of the most famous range scientists in history",[80] uses evidence from many sources to develop a description of the possible vegetation in Malheur County in 1863. (Some scientific names have since changed.)

One type was dominated by big sagebrush and bluebunch wheatgrass. Shrub cover remained less than 25 percent and may have been near zero following fires. We have no evidence that big sagebrush . . . covered as much area as grass did. Other species characterized the type according to elevation, soil, and rainfall. Sandberg bluegrass and squirreltail were in dry areas; low sage replaced big sage on shallow stony soils; Idaho fescue and bitterbrush reached codominance with bluebunch wheatgrass and big sagebrush at upper elevations. This combination composed the understory in juniper . . . Other minor species included Thurber needlegrass (*Stipa thurberiana*), prairie junegrass (*Koeleria cristata*), needle-and-thread (*Stipa comata*), and several shrubs. This grassland with shrubs scattered or in moderately thick stands, but always variable, extended over at least 90 percent of the district. At any one time, the landscape probably showed a mosaic of sagebrush densities, with low density following fire and a gradual increase until the next fire occurred.

The second major vegetation type grew on alkaline soils and was composed primarily of shrubs. Shadscale dominated; and others included spiny hopsage (*Grayia spinosa*), Winterfat or white sage, (*Eurotia lanata*), budsage, and greasewood. Bluebunch wheatgrass occurred in the type but larger amounts of squirreltail and Indian ricegrass (*Oryzopsis hymenoides*) characterized the landscape. The grass dominated if the soil was sandy. This type occupied about 6 percent of the district.

We offer several other descriptive points about the . . . vegetation. Grasses occurred between widely spaced shrubs as well as under their canopies.[29]

2. Following livestock introduction

(Further discussion in the end of the nineteenth century, early twentieth century component of this assessment).

In the early 1870s, changes in the lower Owyhee subbasin included the introduction of livestock to the rangelands. By 1876 David Shirk says they "began to realize the necessity of preparing food for winter, as the native grasses, mostly bunch grass, were slowly giving way, and prudence required preparations for winter."[74]

When livestock were first introduced, the grass on public lands was "free" and lured livestock growers to turn out herds of sheep, cattle, and, sometimes, horses to roam freely. There was a "winner take all" attitude that encouraged grazing.[25,31] Cattle outfits tended to graze different sections of rangelands so as not to compete with each other. In winter cattle were moved to areas with bunch grass and white sage.[33] The Desert Land Act of 1877 encouraged settlers to settle on arid lands and cattle outfits now faced competition. Competition between cattlemen, sheepmen, and settlers led to overstocking of the range.[31] Prior to 1890 cattle were sold by the head as much for the hide as for the meat. It was more important that cattle survive than the quality of the livestock.[103] After the act, livestock owners acquired lands with water resources to enable them to control the surrounding grazing lands.[26,31]

In 1894 and 1896 the Division of Botany of the Department of Agriculture sent botanists to survey the vegetation of eastern Oregon. The rangeland had been grazed to a greater or lesser extent for 20 years. Frederick Coville, one of those botanists recorded his general impressions for a National Geographic article.

> "The vegetation of the country consists primarily of sage brush, the well-known Artemisia tridentata of botanists, a shrub three to six feet high, closely related to the wormwood of Europe, and having in common with that plant a light gray color and a strongly aromatic odor. Away from stream beds and sinks and the shores of lakes, sage brush covers the whole country like a gray mantle and constitutes probably nine-tenths of the total vegetation. It is a plant the herbage of which is eaten by but few animals and by those only in starvation times, one that will grow with little moisture and will stand the widest range of temperature. Sage brush gives to the country its character. A level stretch is known as a sage plain; the grouse which live there are known as sage hens; the fuel of the region is sage brush; the odor upon the atmosphere is that of sage brush."[12]
>
> "A few other shrubs form an inconsiderable part of the woody vegetation, but these and the sage brush make up by no means all the plant life of the country. As the snow melts away in the spring, the well moistened soil between the Artemisia bushes becomes covered with the seedling of innumerable annuals. For a few weeks the ground is carpeted with these plants, which flower in the greatest profusion, but after about two months they ripen their seeds, dry up, die, and disappear. Growing with these annuals is another type of plants, tuberous-rooted perennials which have stored up during the preceding year's growth a large amount

of nourishment. They therefore bloom at the first break of spring, go through a brief period of rapid growth, lasting usually a little longer than that of the annuals, and then the newly formed bulbs, well protected by impervious coats against the desiccating influences of a long, dry summer, carry over a full supply of plant food for the next spring's blooming."[12]

3. Overgrazing

Already, Coville sees that the rangelands will not support uncontrolled grazing.

> "There is one phase of wastefulness of the natural resources of the United States which a trip across the plains of Oregon particularly impresses upon the traveler, namely, the careless destruction of our great natural wealth of forage . . . Continued over-grazing year after year, if sufficiently excessive, unquestionably kills out the native forage plants, which are then replaced largely by introduced weeds. The original nutritious grasses never regain their former luxuriance and sometimes are almost exterminated. Under moderate grazing the native species produce yearly a good crop, or if even slightly over-grazed will after a few years of rest regain their former abundance."[12]

Probably the first effect of overgrazing was reduced perennial bunch grasses in the spaces between the shrubs. Annuals may have invaded the bare ground, but Russian thistle and cheatgrass had not yet been introduced. The increasing species were probably unpalatable and included big sagebrush and rabbitbrush. In some places the sagebrush thickened and became a monoculture, the only plant growing at the site.

In 1902, when Theodore Roosevelt was in the White House, David Griffiths traveled from Winnemucca, Nevada to Ontario, Oregon on horseback. He was invited by the cattle producers who provided him with guides and services.[103] Griffiths, a USDA scientist, wrote that the "public ranges of the region are in many places badly depleted." He reported finding large areas of bare soil and traveling across deteriorated ranges which he says were "directly traceable to overstocking and it does not appear clear how matters will improve in the near future."[23]

As early as the 1860s the cattlemen had been trying to get grazing controls on the public lands. The railroads opposed the establishment of grazing rights that might compromise their plans for settlements.[103] In the early 1900s, both cattlemen and sheepmen in the lower Owyhee subbasin and adjacent areas who had a base property wanted to control the cattle and sheep operators who just used the land with no base property. Local ranchers approached congress and even President Theodore Roosevelt himself claiming the range was being destroyed by indiscriminate use. Nothing was done by the federal government to manage the use of lower elevation rangelands until the passage of the Taylor Grazing Act in 1934.[26]

Numbers of cattle, sheep and horses increased through the early twentieth century. In addition to causing immediate changes in vegetation, overgrazing by livestock during this period also set in motion long term changes in plant community structure. The reduction of fine fuels in the system interrupted the natural fire cycle. Coupled with the continual consumption of grass species, which reduced their competitive ability, a reduction in fires resulted in a rapid increase in sagebrush. More insidious, was the increase in juniper starts in the wetter sagebrush plant communities. This increase was only really apparent 40 years later when the juniper became large enough to dominate the landscape. Exotic plant species that were often contaminants of crop seed, found excellent seed beds on the overgrazed ranges and spread rapidly. Some members of the livestock industry in the West perceived the destruction going on and championed the Taylor Grazing Act.[81,91]

The number of animals on the range varied, but tended to increase until the Taylor Grazing Act of 1934 (Figure 9.1).[31]

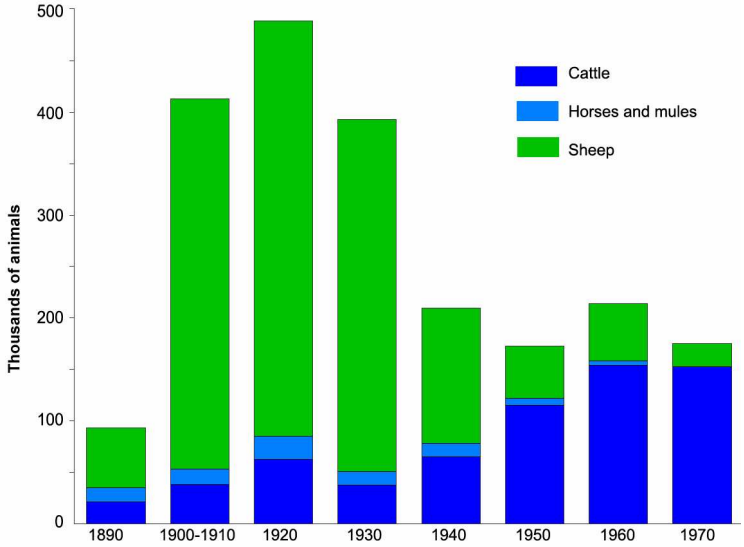

Figure 9.1. Total livestock numbers on the rangeland in Malheur County, 1890 to 1970.[22,29,31]

Russian thistle first began growing on rangeland about 1900, followed by mustard species. The cheatgrass which appeared about 1915 spread over large areas of rangeland during the 1920s. Cheatgrass tended to increase ground cover and although it provided scanty forage, it was more than had been produced by barren lands. Cheatgrass also provided a flash fuel and fires became common.[29]

By the end of the 1940s fire suppression on rangelands had begun to affect the plant communities of rangelands. During the 1950s there were intensive inputs into brush control, water developments including pipelines, seeding and reseeding, and adjustments in stocking rates and grazing periods. These changes were designed to improve the range resource for sustained livestock production. In the 1960s these changes were all incorporated by the Bureau of Land Management (BLM) into the Vale Project in the Owyhee basin, including parts of the lower Owyhee subbasin.[81,91] Prior to the Vale Project, very little land in the Owyhee basin had been sprayed for brush control, plowed or seeded.[29]

In the 1980s, reseeding of rangelands with crested wheatgrass, spraying sagebrush with herbicides, and mechanical control of woody species had mostly ended.[81,91]

C. Vale Project

1. Project proposal

The ranchers and BLM cooperatively started range rehabilitation efforts before the Vale Project in 1962. Although the 1950s were a time of inputs into brush control, water developments, seeding and reseeding, and adjustments in stocking rates and grazing periods, less than one tenth of a percent of the land in the Owyhee basin had been sprayed for brush control, plowed or seeded. There were no seasonal grazing plans established beyond stipulation of allotment boundaries and dates of grazing. There had been no erosion control nor construction of recreational sites.[29]

Within Malheur County, ranchers, either cooperatively with BLM or at their own expense, had developed approximately 582 livestock watering points or facilities and almost 500 miles of fence (water developments depicted in Figure 9.2 are grouped). Ranchers did the fence repairs and maintenance.[29]

In 1961 the range condition was poor and certainly not improving. The Vale district (Malheur County) was ready for a range rehabilitation program. Information on what to do had been developed at the Squaw Butte range research station near Burns, Oregon. Lacking funds, all parties turned to Congress for help.[29]

The project proposal to Congress offered a demonstration of "a solution to the national problem of depleted and deteriorating public rangelands" and proposed "to do so without seriously impairing the livestock industry." The eight specific objectives listed in the proposal were 1) to correct erosion and prevent further soil losses, 2) to increase the forage supply for wildlife and livestock, 3) to stabilize the livestock industry at the existing or increased level of production, 4) to facilitate fire control by replacing high hazard cheatgrass and sagebrush with low hazard perennial grasses, 5) to prevent the encroachment and spread of noxious and poisonous weeds, 6) to make necessary land tenure adjustments, 7) to prevent improper recreational use, and 8) to develop access and service roads to open "vast areas of untapped recreation potential."[29]

2. Project activities

a. Rangeland rehabilitation

The Vale Program selected sites for treatment based on their potential for improvement. Sites deemed to have the greatest potential for improvement were treated first. Most sites with high potential which required seeding, preceded by plowing or spraying, had been treated by 1968. Native perennial grasses on untreated sites recovered more quickly than expected, reducing the need for seeding. The areas seeded with crested wheatgrass were able to carry more livestock, reducing stress on the native rangelands that were in better condition. More projects after 1968 were treated with spray-only treatments to reduce brush. The criteria for site selection and type of treatment changed in 1969.[29]

The treated areas were distributed somewhat uniformly over the district with similar acres of seeded areas and of brush removal in the lower Owyhee subbasin

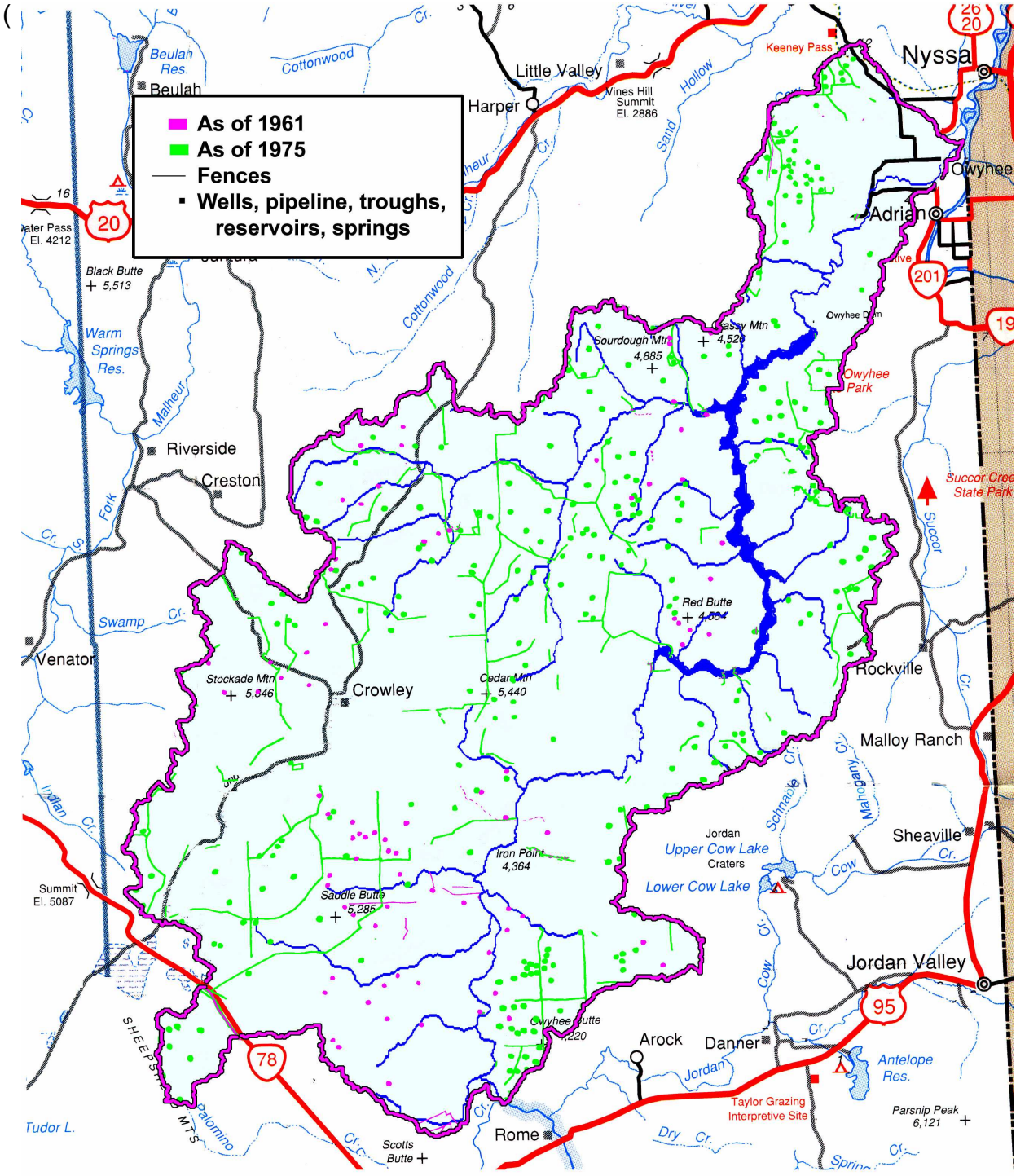

Figure 9.2. Fences and water developments in the lower Owyhee subbasin as of 1961 and 1975.[29]

Figure 9.3). By 1975, only 10 percent or less of the area had been rehabilitated, but there had been a rapid improvement in rangeland through the whole Vale district, not just in the areas plowed, seeded, and sprayed.[29]

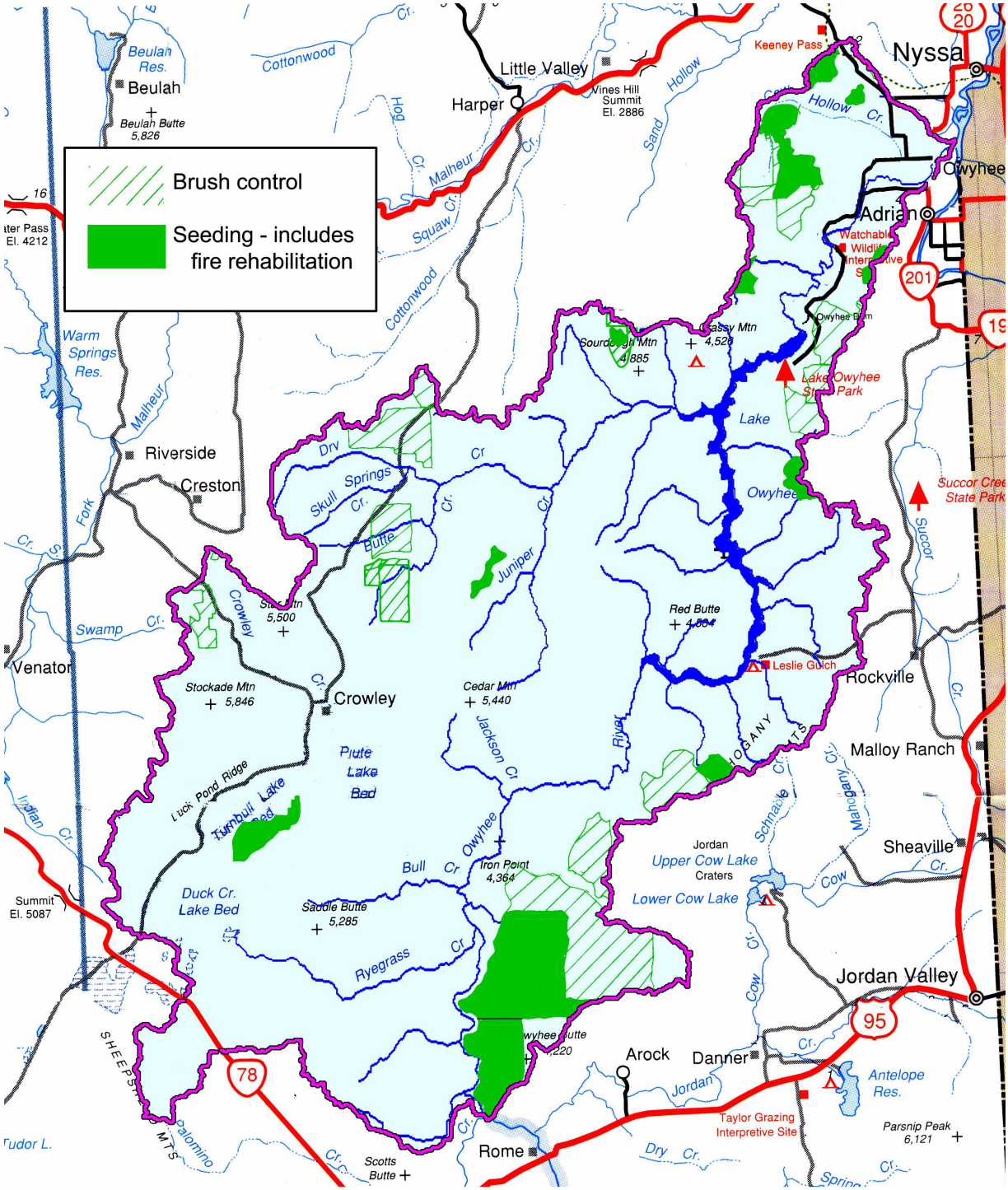

Figure 9.3. Areas in the lower Owyhee subbasin with brush control or seeding between 1961 and 1975.[29]

To reduce the density of shrub species, plowing, spraying 2,4-D herbicide, burning, or some combination of treatments was used. All land plowed for brush control and to reduce cheatgrass or other competitors was always seeded. Seeding usually followed wildfire and some of the sprayed areas were seeded. In 1975 the stands

appeared to have been seeded with a mix of Standard (*Agropyron desertorum*) and Fairway (*Agropyron cristatum*) crested wheatgrass.[29]

At the beginning of the Vale Project, fire in rangelands was considered harmful and dangerous. Fire control was to be increased by replacing highly flammable cheatgrass with less hazardous perennial grasses. Heady feels that the failure to use fire as a land treatment in the Vale project was a mistake since the burned and rehabilitated lands by 1975 produced as much forage as the more expensive, but acceptable, plowed and seeded areas.[29]

b. Infrastructure improvements

A total of 2,081 miles of fences were built in the Vale district by the BLM. These fences were built to standards which allowed antelope to go under the lowest wire, since antelope will seldom jump fences. Two basic types of water development were constructed. Six hundred and twenty four stock ponds were constructed at suitable locations within pastures, but they wouldn't normally hold water for the full grazing season. During the Vale Project, 28 systems with wells, pipelines, and troughs were developed as reliable sources of year-round water. There were 448 spring developments for a total of 1,600 watering points added in the district (Figure 9.2).[29]

The watering points worked well for livestock and large wildlife. However, smaller animals had difficulty getting water from troughs and where meadows disappeared, their foods provided by the meadows were also gone. A few of the water developments piped overflow water into fenced areas to create new meadows. Heady suggested that this procedure of using overflow water be expanded.[29]

3. Grazing management

The Vale Project was an integrated project, so the original grazing systems established were designed to protect and use the crested wheatgrass seedings, to rehabilitate the native ranges, and to preserve browse for wildlife. To meet these objectives, yearlong rest and little early grazing on native bunchgrass were effective practices.[29]

Modification in forage production requires effective provisions to control animal numbers and distribution. Water availability controls animal distribution more effectively than fencing. Heady felt that both these improvements installed during the Vale Project were not as effective as they could have been in controlling animal distribution. Herding was required in some allotments to influence animal movement to prevent concentration of livestock. "Herding does not substitute for the lack of properly placed fences and watering points."[29]

4. Conclusions in 1975

a. Vegetation

When he evaluated the Vale Project in 1975, Heady believed that at least 50 percent of the district was in good or excellent condition and that the trend of nearly all the district was either stable or improving. From a vegetational standpoint the Vale Project had been highly effective. Dense, nearly pure, stands of big sagebrush were

converted to grassland in about 8 percent of the district. The additional forage provided by the improvement of some range conditions gave flexibility in grazing use and further improvement in the untreated ranges.[29]

Just as the rangeland varies, the condition and trend of the untreated and treated areas in the Vale Project varied in 1975. Big sagebrush reestablished itself in all treatments. The degree of sagebrush increase depended on the effectiveness of the treatment with plowing, spraying, and burning all effective methods. Most of the increase of big sagebrush was actually the recovery of unkilled plants. Seedlings of big sagebrush established shortly after treatment in well-established stands of crested wheatgrass or native bunchgrass was very slow. Crested wheatgrass or native bunchgrass stands with up to 25% big sagebrush stands had almost the same forage potential as stands with no sagebrush.[29]

Stands with large perennial grasses between the bushes were expected to stabilize at a probable brush cover of less than 25 percent. Both crested wheatgrass and bluebunch wheatgrass appeared to be stable or increasing in density in seeded areas. There was evidence that bluebunch wheatgrass primarily increased by vegetative means rather than by seed and that moderate grazing helped this process.[29]

Seedings of crested wheatgrass with more than four plants per square yard rarely had significant amounts of cheatgrass. Where crested wheatgrass density was less than 1.5 plants per square yard, cheatgrass formed dense stands.[29]

Yearlong resting of pasture with good bunchgrasses may be a disadvantage. Dead material accumulates in their centers, increasing the fire hazard and reducing plant vigor. Some grazing each year promotes greater vigor than no grazing at all. Season-long use should be included in some systems on ranges in good to excellent condition, although deferred and rotational treatments must be maintained in some ranges.[29]

b. Wild horses

Horse counts in April 1975 by air showed that there were about 2,400 wild horses in the Vale District. Heady believed that the number needed to be reduced to 2,000 horses to maintain a balance with the range since it was impossible to attain even distribution of grazing with wild horses and some areas were becoming overgrazed and other areas not grazed at all.[29]

c. Cooperation

The Vale Project succeeded because the livestock interests and the BLM cooperated to achieve objectives of both groups. In 1975 there were already pressures being brought by other groups including recreationists and wild horse advocates. Heady saw achieving balance among these groups as becoming increasingly difficult as views about the Vale District from individuals outside the area were more intense than those from within the district.[29]

5. BLM legacy program

In 2002 a group of retired BLM personnel revisited some of the Vale Project areas. Two of these areas were in the lower Owyhee subbasin. Their conclusions and recommendations applied to the project as a whole. Although they saw some "neat successes", in general they judged the areas they viewed as not reflecting the long-term goals of the Vale Project. They felt that both the BLM and livestock grazers shared blame for the ecological problems which were evident. They recommended that many of the old land treatment areas be treated by a prescribed fire in the spring followed by two growing seasons of rest.[32]

They were surprised that so few Allotment Management Plans had been completed since they have been a part of BLM standard procedures since the late 1960s. Lands not in acceptable condition needed to be managed for ecological resource improvement.[32]

Project maintenance needed to be enforced and they questioned whether livestock operators had the equipment or time to do some of the spring, well and pipeline maintenance. They recommended that the BLM should maintain wildlife, riparian, etc. projects and supervise their use.[32]

To assure that the legacy of the Vale Project would be carried forward, they recommended that district training include information on the project and the subsequent years' activities. With personnel understanding the project, effective land management activities could be implemented or the Vale Project would be "lost forever".[32]

Crested wheatgrass seedings in the Vale Project suggest that some seedings persist for a long time (30-45 years). Big sagebrush repopulation of the crested wheatgrass area reached about 15% relative cover during a 20 year period following planting and seeding in the Vale Project. Over a 30-year period the crested wheatgrass plants were able to invade bluebunch wheatgrass stands in areas where bluebunch wheatgrass vigor was low (livestock concentration areas, areas recovering from drought, etc.). Big sagebrush and rabbitbrush were the only native species observed that would invade stands of crested wheatgrass. The severity of invasion was somewhat related to the vigor of the crested wheatgrass stand.[39] However, Bill Krueger has noticed substantial native grasses and forbs in crested wheatgrass seedings.[103]

D. Vegetation

1. Types of rangeland vegetation

The plants that grow on rangeland can be categorized into grasses, grass-like plants, forbs, shrubs, and trees.

Grasses have long narrow leaves and produce grain-like seeds. They do not have colored flowers. The leaves are on two sides of a hollow stem.

Forbs are herbaceous (non-woody), broad-leaved plants which usually have showy flowers. They have solid stems. The above ground growth dies back each year.

A few forbs, like wild onion, have leaves with parallel veins. Most forbs have leaves with a network of veins. Most wildflowers are forbs.[34,44,77]

Grass-like plants look like grass but aren't. They have solid stems which are often triangular. Sedges have leaves on three sides. Rushes have leaves on two sides.[44,77]

Shrubs and trees are plants with above-ground stems that do not die back from one year to the next. Shrubs grow from several main, solid woody stems that branch from near the base. Their leaves have a network of veins. Shrubs often produce berries.[34,44,77]

Trees have a definite main trunk which is woody. Usually trees are bigger than shrubs. Some species of shrubs can form either a tree or shrub depending upon the local conditions, but most shrubs never grow up to be trees.[34,44]

Browse is the part of a woody plant, usually a shrub, that is used for forage by wildlife and livestock. Browse usually includes leaves and young stems.[34,44]

2. Rangeland types

All rangeland is not the same. There are several broad types of rangeland that comprise a large part of the rangeland in Malheur County. There are areas of each of these types in the lower Owyhee subbasin. The type of rangeland may be related to the eco-region (see the background component of this assessment) but is a different way of looking at the landscape by examining principally the vegetation which grows in the area. Like ecoregions, the descriptions of rangeland types can vary.[91]

a. Salt-desert shrublands

Salt-desert shrublands, also known as salt desert scrub, are located in areas where there is no drainage and therefore a build-up of salts in the soil. The desolate looking plant community results from the soil salinity and cold temperatures. These shrublands receive very little precipitation each year. Shrubs generally grow better under these conditions than grasses or forbs.[37,90]

b. Sagebrush steppe

The sagebrush steppe is a broad category encompassing many diverse communities. Precipitation averages between six and fourteen inches a year and the winters are generally cold and the summers hot and dry. The natural vegetation consists of a shrub overstory with an understory of perennial grasses and forbs. Great variation exists in soil resources and therefore in the kind, cover, and amount of vegetation present.[38,89]

c. Sagebrush-grasslands

Sagebrush-grasslands are a mix of sagebrush and bunchgrasses. Big sagebrush is the main kind of sage in the lower Owyhee subbasin.

d. Other descriptions

The Oregon State University Rangeland Department uses an alternative description of rangeland types that includes herbaceous range, shrub and brush rangeland, and mixed rangeland.[103]

i. Herbaceous range

The herbaceous rangeland category is lands dominated by naturally occurring grasses and forbs as well as those areas of actual rangeland which have been modified to include grasses and forbs for rangeland purposes.[104]

ii. Shrub and brush rangeland

The brushlands found in arid and semiarid regions are characterized by xerophytic vegetation with woody stems such as big sagebrush, shadscale, greasewood, or creosotebush and also by the typical desert succulents such as cactus. Moister areas may have mountain mahogany.[104]

iii. Mixed rangeland

When more than one-third intermixture of either herbaceous or shrub and brush rangeland species occurs in a specific area, it is classified as mixed rangeland. [104]

3. Vegetation in the lower Owyhee subbasin.

a. 1963 to 1964 range reconnaissance survey

Shortly after the initiation of the Vale Project in 1963, range reconnaissance surveys were made. Figure 9.4 shows the locations of different types of vegetation at that time using the standard classifications of that survey.[29]

The desert shrub type was characterized by shadscale, budsage, and spiny hopsage in a mosaic with big sagebrush. Principal grasses were squirreltail and Sandberg bluegrass. This vegetation contained many palatable browse species and could constitute a desirable winter range.[29]

The area described as sagebrush-grass was complex, containing mixtures of several dominant plant species. Much of the area was a mosaic of sagebrush and native bunchgrasses. Forbs and annual cheatgrass were present in most of the area. At the start of the Vale Project, the mix of bunchgrasses and sagebrush frequently had a high brush density and few palatable bunchgrasses. In some locations there was almost no perennial grass with bare soil between the shrubs. Other shrubs in the sagebrush-grass type in addition to big sagebrush were low sagebrush, rabbitbrush, bitterbrush and mountain mahogany. On the areas judged to be good range the plants growing between and under the shrubs were mainly bluebunch wheatgrass, giant wildrye, and Idaho fescue. Common perennials, especially where the range was judged to be fair or poor, were less desirable grasses, squirreltail, and Sandberg bluegrass. In some areas cheatgrass was the only common plant under the shrubs.[29]

The grass type included areas which burned and where sagebrush was missing. Some of these areas were dominated by cheatgrass or Sandberg bluegrass.[29]

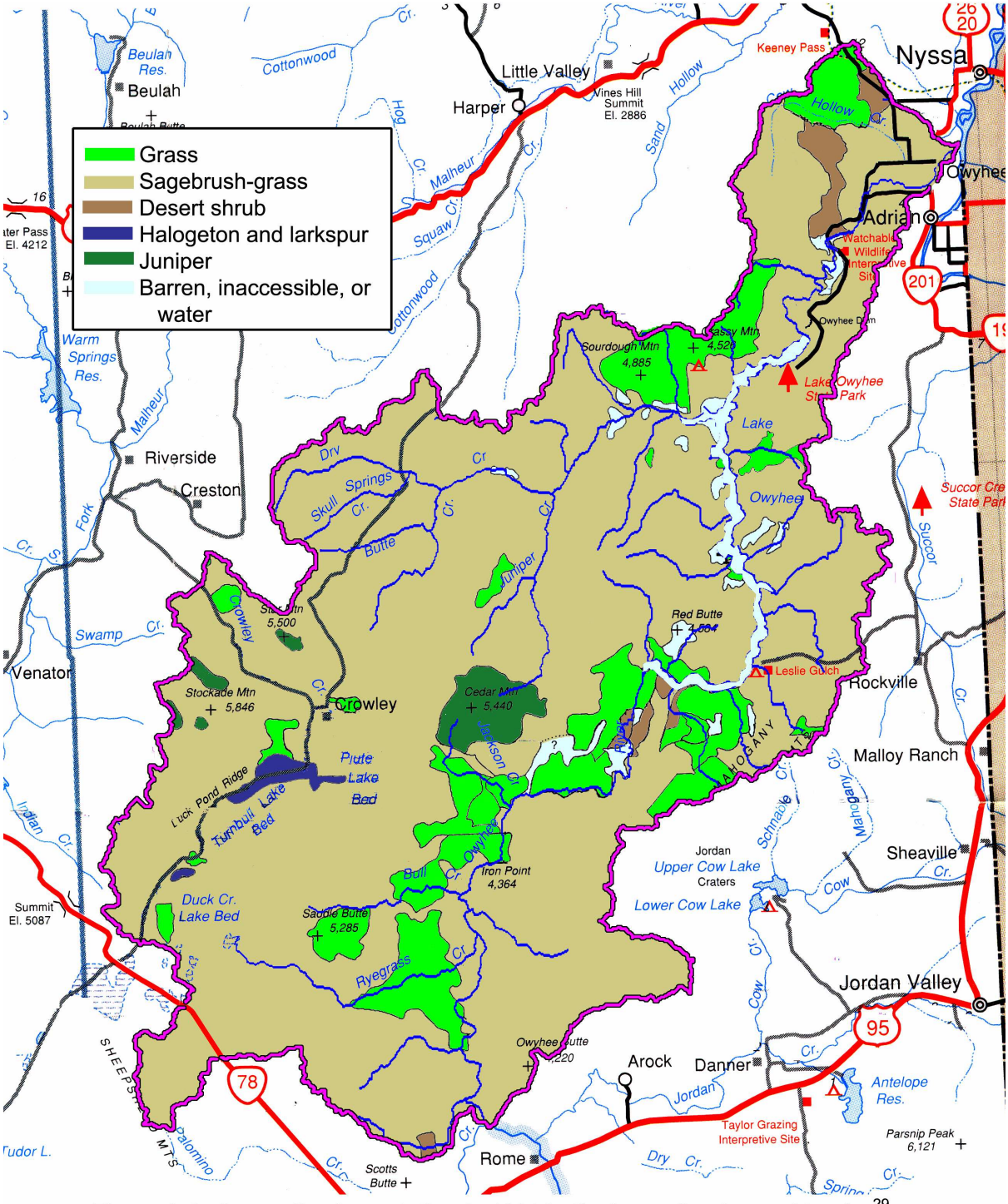

Figure 9.4. Generalized vegetation in 1961 in the lower Owyhee subbasin. 29

b. Plant communities

The 1963 - 1964 range reconnaissance surveys identified broad types of plant communities. Generally the plants living in association with each other, or the plant communities, are classified more narrowly. A classification system provides a set of

criteria for examining plant communities.[24] The National Vegetation Classification System (NVCS) was adopted by the Environmental Protection Agency and the US Geological Survey (USGS) in 1997[43] and is now used to classify rangeland sites based on plant associations.[33] Both the Natural Resources Conservation Service (NRCS) and

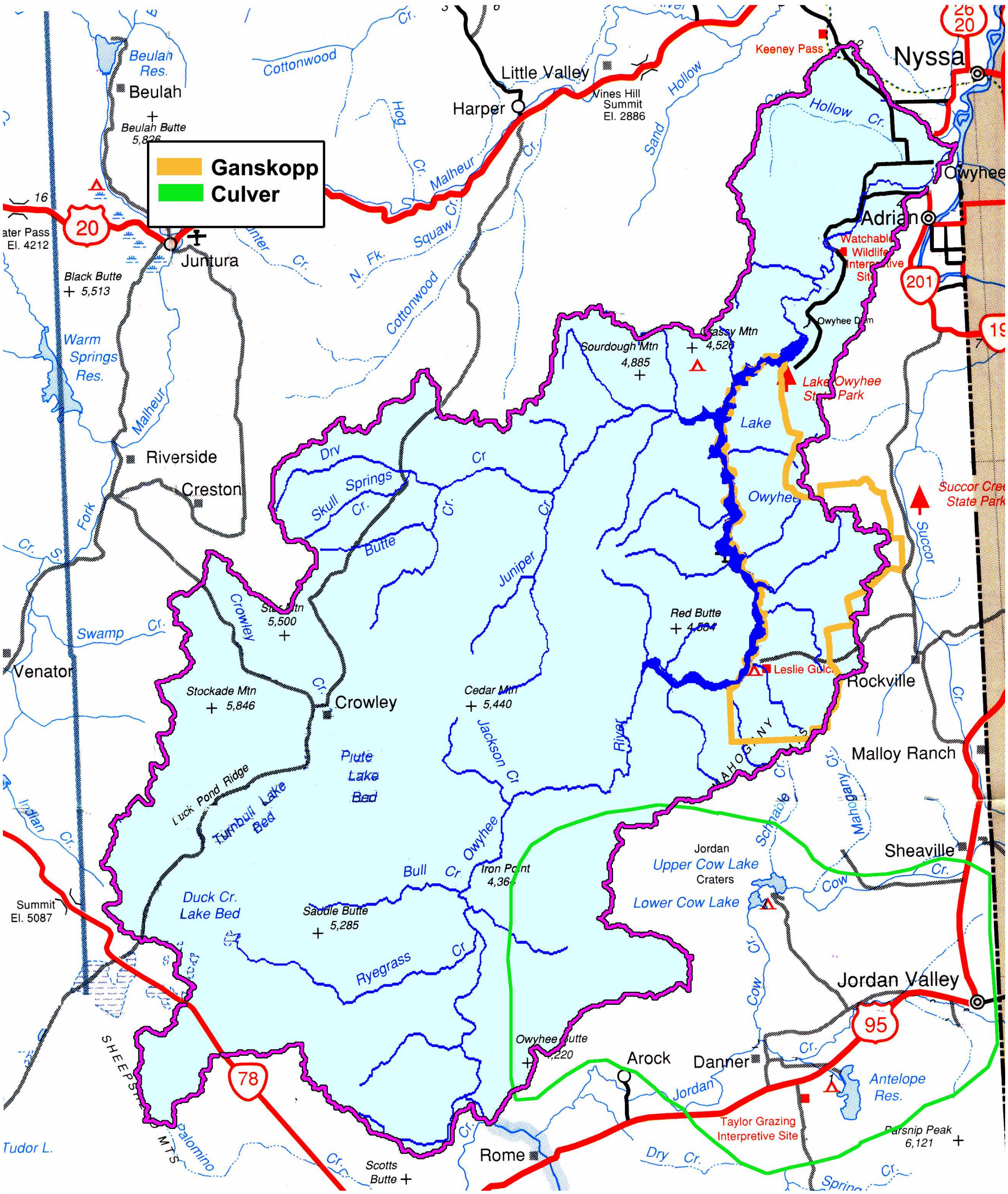

Figure 9.5. Boundaries of vegetation study areas in the lower Owyhee subbasin.[13,21]

the BLM use the ecological site description, correlated to soil surveys, from the NRCS land classification system (see the background component of this assessment). However, much of the past work used a non-standardized method of classifying plant communities.

The species in a plant community differ in kind or proportion from the species of a different plant community. Traditionally these communities, or associations, are named for two of the species in them. On rangelands this combination of names tends to be the dominant shrub followed by the most obvious grass. However, the community name may be that of two shrubs or include the name of a forb.

c. Surveys of vegetation

The few detailed studies of vegetation in the lower Owyhee subbasin have focused on a small sector of the subbasin.

i. Ganskopp's study

In 1979 and 1980 David Ganskopp mapped the vegetation in an area of the Owyhee Breaks east of Owyhee Reservoir (Figure 9.5). Although this is only a small section of the lower Owyhee subbasin, he identified fifteen plant communities (Appendix G). The five major plant communities covered 85 percent of the study area. The percent of ground covered by bare ground, moss, litter (dead plants), and rock was measured (Table1).[21]

Table 1. Major plant communities sampled in the Owyhee Breaks in 1979 and 1980.

Plant community	% of study area	% cover				
		Grasses	Forbs	Shrubs	Litter	Bare ground
Wyoming big sagebrush/ bluebunch wheatgrass	36.0	19	3	8	6	41
Wyoming big sagebrush/Sandberg's bluegrass	21.8	29	1	18	12	37
Wyoming big sagebrush/cheatgrass	16.8	63	2	18	11	8
Low sagebrush/Sandberg's bluegrass	8.5	17	6	30	15	26
Cheatgrass	2.2	44	4		11	30

Ganskopp describes some of the principal grass, forb, and shrub species which are found in each of the major plant communities.[21] A complete list of all the species he found in the area are included in Appendix E.

He calculated the productivity of herbaceous matter (and therefore potentially edible by wildlife or cattle) of the different components of each of the communities. These totals don't reflect nutritive value, the condition of the community studied, or potential season of use. The Wyoming big sagebrush/cheatgrass community had the highest potential total productivity, but the low sagebrush/Sandberg's bluegrass community had the most diverse and productive forb component (Table 2).[21] Cheatgrass productivity varies tremendously between years and Ganskopp’s sample included few years.

Table 2. Estimated productivity of the five major plant communities in the Owyhee Breaks for two years.

	_ _ lb/ac per year _ _			
Plant community	Grasses	Forbs	Shrubs	Total
Wyoming big sagebrush/ bluebunch wheatgrass	600	35	88	723
Wyoming big sagebrush/Sandberg's bluegrass	106	29	280	415
Wyoming big sagebrush/cheatgrass	730	16	213	959
Low sagebrush/Sandberg's bluegrass	71	67	340	478
Cheatgrass	733	18		751

ii. Culver's study

Another small section of the lower Owyhee subbasin was part of a larger study investigated in 1962 by Roger Culver (Figure 9.5).[13] He separated the vegetative communities into three major types based on the dominant shrub species: big sagebrush, stiff sagebrush, and low sagebrush. Each of these broad groups was broken down into specific associations to represent the habitat-types of the region (Appendix G).

Culver included a listing not only of every species found in the study area (Appendix E), but also a calculation of the percentage of stands of each plant community which contain that species.[13]

iii. Leslie Gulch

In 1979, J.W. Grimes studied the plants in Leslie Gulch. BLM botanists have added other species which they have located in the area (Appendix E). Jean Findley's description of the plant community in Leslie Gulch is a meeting of northern mesic flora with the xeric flora of salt desert species.[19]

iv. Dry Creek

In the evaluation of the Dry Creek management area, the BLM has identified 11 vegetative communities. Some of these communities are further described by other characteristics such as seeding with crested wheatgrass (Appendix G). In the narrative material on each pasture, some of the other species that are present are mentioned. The plant list included in the evaluation is for the whole southeast Oregon resource management area.[4]

From these studies, it is possible to see that a number of different rangeland communities exist in the lower Owyhee subbasin. However, the definition of these communities has varied significantly and we do not know which species can be expected within each community nor in what proportions they can be expected.

4. Invasive Species

Table 3. Range weeds of special importance to the Lower Owyhee Watershed.

E - These are weeds of economic importance to the land use indicated.
T - These weeds are considered by the State of Oregon as an economic threat[95]

Common name	Scientific name	In Malheur County	a		Land Use b	c	d	e	f
Buffalobur	*Solanum rostratum*	Limited	Y			E	E		E
Bull thistle	*Cirsium vulgare*	Abundant	Y			E	E		E
Burr buttercup	*Ranunculus testiculatus*	Ubiquitous	Y			E	E		E
Canada thistle	*Cirsium arvense*	Abundant	Y			E	E	E	E
Cheatgrass	*Bromus tectorum*	Ubiquitous	Y			E	E		E
Dalmatian toadflax	*Linaria dalmatica*	Limited	N						
Diffuse knapweed	*Centaurea diffusa*	Limited	Y			E			
Halogeton	*Halogeton glomeratus*	Limited	Y			E			E
Houndstongue	*Cynoglossum officinale*	Limited	Y		E				
Leafy spurge	*Euphorbia esula*	Limited		T		E	E		E
Mediterranean sage	*Salvia aethiopis*	Limited							
Medusahead rye	*Taeniatherum caput-medusae*	Abundant	Y			E			
Moth mullein	*Verbasum blattaria*	Limited	Y			E			
Musk thistle	*Carduus nutans*	Abundant	Y			E	E		E
Perennial pepperweed	*Lepidium latifolium*	Limited	Y		E	E	E		E
Poison hemlock	*Conium maculatum*		Y		E	E	E		E
Purple loosestrife	*Lythrum salicaria*	Abundant	Y	T	E				E
Rush skeletonweed	*Chondrilla juncea*	Limited	Y	T		E	E	E	E
Russian knapweed	*Acroptilon repens*	Limited	Y			E			
Saltcedar, tamarisk	*Tamarix ramosissima*	Abundant	Y		E	E	E		E
Scotch thistle	*Onopordum acanthium*	Abundant	Y			E	E		E
Spotted knapweed	*Centaurea maculosa*	Limited		T		E			
White top, Hoary cress	*Cardaria draba*	Abundant	Y		E	E	E		E
Yellow starthistle	*Centaurea solstitialis*	Limited	Y	T		E			E

a. Present in the subbasin
b. Riparian
c. Rangeland
d. Pasture
e. Crop land
f. Edges

a. Invasive species and noxious weeds

Noxious weeds are generally non-native plants. Noxious weeds appeared and spread with European settlement and new weeds continue to arrive today. A large number of the least desirable weeds are of Mediterranean, European, or Asian origin. Not all weeds are noxious weeds. Noxious weeds are plants considered to be serious pests because they cause economic loss and harm the environment. Noxious weeds can choke out crops, destroy range and pasture lands, clog waterways, threaten native plant communities or affect human and animal health.[51]

Invasive species are species which have the potential to expand or invade all or part of their U.S. range and degrade the landscape. Not all invasive species were introduced to the U.S. Some species are native but have managed to spread and

invade habitats such as rangelands or agricultural fields. Other species are native in part of the country but are serious pests in other parts.[85,86]

The introduction of invasive plants in the US has increased dramatically in the past decade due to the increased ease and speed of national and world travel and the expansion of global commerce. Local spread of noxious weeds can be natural by wind, water, and animals; but, human activities such as, recreation, vehicle travel, and the movement of contaminated equipment, products, and livestock often greatly increase the distance and rate of dispersal.[51]

Invasive plants affect the plant community composition and have profound negative consequences for native biotic diversity. In rangeland, the most significant invasive species for affecting the plant community composition are fire-adapted annual grasses, like cheatgrass and medusahead rye. The expansion of these grasses has resulted in annual grass-fire cycles that rapidly replace sagebrush-steppe and salt-desert shrubland systems.[3,11]

b. Invasive species in the lower Owyhee subbasin

The state of Oregon has listed the weeds in table 3 as being present in Malheur County. Appendix F describes each of these species. Most of these species are also known to be present in the lower Owyhee subbasin. Gary Page, the Malheur County weed inspector, considers eight of these species to present the greatest risk in the lower Owyhee subbasin: salt cedar, medusahead rye, rush skeletonweed, leafy spurge, bur buttercup, hoary cress, perennial pepperweed, and Scotch thistle.

i. Saltcedar, tamarisk (Tamarix ramosissima)

Tamarisk or saltcedar is a strong perennial shrub to small tree species that is invading riparian areas in the mid Snake River region, and throughout the Lower Owyhee subbasin (Figures 11.10 and 11.11). Tamarisk is known to use prolific amounts of water and dry out riparian areas. It has a habit of mining salts from the soil profile and exuding them on the surrounding soil, rendering those areas unable to support plant species that cannot tolerate saline conditions.[66,76]

Salt cedar is at or near the top of the list of noxious invasive weeds for all agencies. There are two to three hundred acres of tamarisk at the old Watson town site. It has become established along the Owyhee River, Dry Creek, and BLM's Areas of Critical Environmental Concern at Leslie Gulch, the Honeycombs, and in other associated wash bottoms. It has begun to show up at some remote (from the river corridor) springs and intermittent streams. This invasion is particularly troubling to the Oregon Department of Fish and Wildlife given the high probability that established salt cedar will limit the ground flow of water and affect fish and wildlife. Tamarisk has very prolific seed production and can out compete native riparian trees and shrubs.[66,76,105]

ii. Medusahead rye (Taeniatherum caput-medusae)

Medusahead rye demonstrates its negative qualities best on the east side of Oregon. Medusahead has the ability to outcompete other annual grasses and generally crowd out perennial grass seedlings by extracting the majority of moisture well before perennial grasses have begun to grow. Medusahead is almost worthless as forage for

cattle, sheep or wildlife as it becomes unpalatable in late spring as forage. The stiff awns and hard florets can injure eyes and mouths of grazing animals. Once land is invaded by medusahead, it becomes almost worthless, supporting neither native animals, birds nor livestock. Medusahead rye changes the temperature and moisture dynamics of the soil, greatly reducing seed germination of other species and creating fuel for wildfires The propensity of medusahead to support frequent fire cycles makes range restoration even more difficult.[44,55,66]

Medusahead rye is without question the noxious weed that is advancing most quickly in eastern Oregon. It has invaded and completely dominated large tracts of land in the mid-Snake River region. Certain areas of heavy soils in the lower and mid Owyhee subbasins are thoroughly infested. It can invade stands of bluebunch wheatgrass. Economically viable livestock production in Malheur County is in peril which will certainly have far reaching consequences. Medusahead has already had a serious impact on sage grouse habitat. It may also affect the movements of big game.[66,76]

iii. ***Rush skeletonweed (Chondrilla juncea)***

Rush skeletonweed is an aggressive plant in both rangeland and cropland. Rush skeletonweed has the capability to reduce or choke out native range species, decreasing range productivity and diversity.[60,76]

Rush skeletonweed continues to threaten the lower Owyhee subbasin, however it is currently confined to the north east corner, primarily below the dam. It has been found at sites contiguous to and intermingled with Malheur forget-me-not (*Hackelia cronquistii*), Mulford's milkvetch (*Astragalus mulfordae*), Owyhee clover (a*Trifolium owyheense*), and Malheur valley fiddleneck (*Amisinckia crinata*), all of which have been identified by the BLM as threatened or endangered.[66] Despite efforts to eradicate or contain outbreaks, new sites are being found each year in the eastern part of Oregon.[60]

Rush skeletonweed reaches new sites mainly by wind borne seed. However, increased occurrences at recreation sites in the lower Owyhee subbasin indicate that those seeds also arrive with recreationists and their vehicles.[66] It is hard to control because of the deep taproots, and tilling it under can spread the rootstock. Rush skeletonweed does well on road sides, rangelands, grain fields, grasslands, open forest, and pastures.[76]

iv. ***Leafy spurge (Euphorbia esula)***

Leafy spurge is one of the West's worst weed species because it reduces cattle carrying capacity of infested rangelands by 50 to 75%. Once established, control of even modest-sized infestations is difficult. This weed is most common under dry conditions where competition from native plants is reduced. It is capable of invading disturbed sites, including abandoned cropland, pastures, rangeland, woodland, roadsides and waste areas. A milky latex exists in all broken parts of the plant that can cause skin irritations in humans, cattle, and horses and may cause permanent blindness if rubbed into the eye.[54,76]

Leafy spurge exists in a small geographic area upstream of the lower Owyhee subbasin along Jordan Creek from the head waters to the Danner town site. It is poised to invade areas of the lower Owyhee subbasin from the Jordan Creek drainage. Leafy spurge is aggressive and takes over most other vegetation. Leafy spurge remains high on the priority list of both the BLM and Malheur County.[66,76]

v. ***Bur buttercup (Ranunculus testiculatus)***

Bur buttercup has rapidly colonized broad expanses of rangeland within the lower Owyhee subbasin. Because it begins growing early in the spring and has a short growing season, bur buttercup can use most of the available moisture before many of the annual native species have emerged. It spreads into bare, denuded sites subject to erosion. Because it is comparatively shallow rooted, produces scant biomass, and has a relatively short life span, the potential for soil erosion in areas where it is dominant continues to be very high. It is toxic to sheep and can be competitive with small grain crops. Bur buttercup seed heads are irritating to hands, knees, or bare feet and the seed and seed heads are also commonly known by their annoying habit of sticking to shoe laces, pants cuffs, etc. with tiny Velcro-like spines.[66,76]

vi. ***White top, hoary cress (Cardaria draba)***

White top forms dense patches that can completely dominate sites, restricting the growth of other species and degrading pastures. The species is not toxic to livestock but is only grazed in the absence of more desirable species.[64] White top had been mainly confined to riparian or seasonally wet areas for much of the time since its arrival in the county around 1930. However, white top has spread and is continuing to advance into many of the rangelands of Baker and Malheur Counties including the lower Owyhee subbasin. Whitetop spreads by seed and vegetatively under the soil and is very competitive with native vegetation on disturbed or alkaline sites.[66,76]

vii. ***Perennial pepperweed (Lepidium latifolium)***

Perennial pepperweed establishes and colonizes rapidly. It degrades riparian areas and nesting habitat for wildlife. It displaces desirable species in natural areas and hay meadows. It lowers digestibility and protein content of hay and inhibits grazing. It can grow in a large variety of habitats but grows best along streams and in other wet areas such as ditches, roadsides, and marshes. Perennial pepperweed had been mainly confined to riparian or seasonally wet areas in the lower Owyhee subbasin after its arrival about 1930. However, perennial pepperweed is appearing in some very remote seasonal streams and springs including the Areas of Critical Environmental Concern. Perennial pepperweed spreads through root fragmentation. The Vale BLM has been working to limit this expansion, concentrating on the various roadside outbreaks.[57,66,76]

viii. ***Scotch thistle (Onopordum acanthium)***

Scotch thistle is a wasteland weed that generally inhabits moist sites or drainages in dry locations. Scotch thistle can be found along roadsides, waste land areas, and lower range slopes, where there is more moisture than in surrounding range. Scotch thistle also invades grasslands and sagebrush communities, especially where

there is disturbed soil. If not controlled, it presses into farmland or forms dense canopies in any area overgrazed or not under intense cultivation. It is a major issue in rangeland management. There are considerable Scotch thistle infestations in Malheur County. The infestations are greatest near the Snake River drainage.[7,62,76]

ix. Halogeton (Halogeton glomeratus)

Halogeton is poisonous to cattle and sheep. The toxic substance is found in both fresh and dry plants. Halogeton is not highly competitive in vigorous range conditions, but thrives in disturbed sites or sites limited by alkaline soils. It produces two types of seeds: one has wings to blow in the wind and can germinate within one year and the other type can lie dormant for several years. Late in its growth stage it can break off and tumble across the landscape, spreading seeds as it rolls.[52,76]

Halogeton has gained a foothold along many of the roads in the lower Owyhee subbasin. From these sites it is expanding into neighboring rangelands since much of the lower Owyhee subbasin has alkaline soils.

x. Buffalobur (Solanum rostratum)

Buffalobur is not very competitive and survives in disturbed, dry areas. A native of the Great Plains, buffalobur is drought tolerant and grows most frequently on disturbed, sandy soils. The burs may cause damage and considerable loss in wool and fiber value for sheep and goats.[47,76]

xi. Bull thistle (Cirsium vulgare)

Bull thistle is a biennial found in waste lands, along road sides, in fields and pastures, and many other places where there is disturbed soil. It takes the place of forbs and grasses and if not controlled, presses into farmland. The seeds develop on top of the flowers, with fluffy white tops which can be picked up by the wind and spread all over, infesting more places with this noxious weed. Horses consider the flowers to be a delicacy because the heads are filled with sugary nectar.[48,76]

xii. Canada thistle (Cirsium arvense)

Canada thistle invades crop fields, pastures, rangeland, riparian areas, roadsides and waste lands. Individual plants easily grow into dense, persistent thistle patches. A lack of control will result in dramatic reductions in crop production in heavily infested ground. This strong, aggressive perennial is difficult to control. New infestations can be spread from seeds, but are more often caused by redistribution of roots by tillage practices.[49,76]

xiii. Diffuse knapweed (Centaurea diffusa)

Diffuse knapweed will form dense stands on any open ground, excluding more desirable forage species. It is very competitive with native range plants, growing from taproots. It is very aggressive, and invades roadsides, waste lands, grass lands, and dry rangelands. It spreads rapidly and quickly forms stands. Once established, the necessary extensive control measures are often more expensive than the income potential of the land. Diffuse knapweed grows under a wide range of conditions, such as

those of riparian areas, sandy river shores, gravel banks, rock outcrops, rangelands and roadsides.[50,76]

xiv. ***Houndstongue (Cynoglossum officinale)***

Houndstongue can be a serious problem in rangeland and pasture. The weed is highly invasive and can significantly reduce forage. The plant produces barbed seeds, or burrs, which allow the plant to readily adhere to hair, wool, and fur and can in turn reduce the value of sheep wool. In addition houndstongue contains large quantities of alkaloids which can cause liver problems in cattle and horses. Animals may survive six months or longer after they have consumed a lethal amount. Houndstongue is limited to riparian areas in the lower Owyhee subbasin.[53,76]

xv. ***Moth mullein (Verbasum blattaria****)*

Moth mullein is a sun-loving plant usually found on bare hillsides, in worn out fields, in closely grazed pastures, along fence rows that are not overgrown, and in other waste places. Livestock will not eat the hairy, felt-covered leaves. It cannot stand much competition, even by grass, but prospers on dry poor upland soils. Moth mullein is easily eradicated by cultivation. Moth mullein has started to appear as an invading species in rangeland outside of Ontario, Nyssa, and New Plymouth. It has the potential to displace native species.[20,56,76]

xvi. ***Musk thistle (Carduus nutans)***

Musk thistle is unpalatable to wildlife and livestock. Wildlife and livestock selective grazing on native plants leaves musk thistle, giving musk thistle a competitive edge. The spines can harm animals and hinder their movement through infested areas. Musk thistle may produce chemicals that handicap the growth of other plants. Musk thistle invades fields and pastures, especially under conditions of heavy grazing. It spreads by seeds, taking advantage of human disturbance and is also found on ditch banks, stream banks, roadsides, waste lands, and in grain fields.[53,76]

xvii. ***Poison hemlock (Cicuta douglasii)***

Poison hemlock is a highly toxic plant and commonly infests riparian areas. It is considered to be one of the most poisonous plants in North America. It has accidentally poisoned many who have mistaken it for water-parsnip or other edible plants such as celery, parsley, and sweet anise. Several deaths of livestock and humans are attributed each year to poison hemlock. Poison hemlock can be found in marshes, wet meadows and pastures, along stream banks and on roadsides. In the lower Owyhee subbasin it is primarily along the Owyhee River and the banks of Owyhee Reservoir.[58,66,76]

xviii. ***Purple loosestrife (Lythrum salicaria)***

Purple loosestrife is a vigorous noxious weed that crowds out marsh vegetation required by wildlife for food and shelter. It can eventually destroy marshes and choke waterways. Decreased waterfowl and songbird production has been well documented in heavily infested marshes. Purple loosestrife is an escaped former ornamental species and can be found along wetlands, stream banks, or farm ponds. One plant can

produce 300,000 seeds a year, as well as being able to reproduce by offshoots and cuttings.[59,76]

xix. ***Russian knapweed (Acroptilon repens)***

Russian knapweed can grow aggressively, eliminating most native plants. After invading rangelands or fields, it forms dense stands, spreading by rhizomes, horizontal plant stems with shoots above and roots below the ground, or by seed. Once established, it can overrun native grasslands as well as irrigated crops. It is bitter and not palatable to livestock. Its aggressive and deep spreading root system make it very difficult to control and it is drought tolerant.[61,76]

xx. ***Spotted knapweed (Centaurea maculosa)***

Spotted knapweed is one of the most dominant weed species in the western United States. It has seriously degraded millions of acres of prime range and native habitat throughout the northern Rocky Mountain states. It will form dense stands on any open ground, excluding more desirable forage species and native plants. On heavily infested range, the necessary control measures to recover the land are often more expensive than the income potential derived from grazing. It establishes on disturbed soil and is competitive for soil moisture and nutrients. Spotted knapweed plants can produce up to 1,000 seeds. Control success is hampered by seed longevity. It is still very limited in the lower Owyhee subbasin.[63,66,76]

xxi. ***Yellow starthistle (Centaurea solstitialis)***

Yellow starthistle is an aggressive, adaptable weed that inhibits the growth of desirable plants in pasture, rangeland, and wasteland. It will grow wherever cheatgrass grows, in addition to growing in canyon grasslands, rangelands, pastures, edges of cropland, roadsides, and disturbed areas. This plant may become a problem in ground where the grass stand is weak. Many large rangeland sites have become dominated by yellow starthistle. It will grow in any type of soil and intermountain environment. Yellow starthistle is toxic to horses causing “chewing disease”, equine spongiform encephalopathy, if they eat it.[65,76]

5. Cheatgrass, downy brome (*Bromus tectorum*)

Cheatgrass is considered as a desirable forage grass in many places and a valuable forage resource. It provides a substantial amount of forage for many livestock operations and some of the earliest green feed available to deer on some winter ranges.[67,82] Other rangeland scientists and ranchers consider it an undesirable exotic or noxious weed.[11,17,39]

Cheatgrass is vigorous, short lived, and widely distributed. Cheatgrass does provide forage, but can form dominate stands following repeated fire events. It grows rapidly and competes with and replaces native grasses. It is a widely adapted plant and has spread throughout the lower Owyhee subbasin.[66,76]

a. Why it spread

Uncontrolled livestock grazing had depleted and permanently altered vegetative composition of rangelands as early as the turn of the century. Although an exotic

species, cheatgrass was well adapted to the climate and soils in much of Idaho, Nevada, Oregon, and Utah. Cheatgrass filled the void left vacant by the reduction of native herbaceous vegetation by legacy livestock grazing.[39,67,80]

b. Competitive advantage

Cheatgrass competes strongly with native grasses and seeded crested wheatgrass. It not only is a prolific seed producer, but the seed is highly viable. The seed is capable of germinating in either the spring or autumn, giving it a competitive advantage over native plants. Viable cheatgrass seeds can survive in the soil for up to five years, enabling cheatgrass to survive periodic drought.[39,67]

Cheatgrass germinates early in the season or in the fall and overwinters. It grows rapidly following emergence. It has rapid and extensive root penetration into the soil and extensive root development. Cheatgrass has been shown to reduce the growth of seedlings of bluebunch wheatgrass and crested wheatgrass. By extending its roots during the winter, it gains control of a site before bluebunch wheatgrass seedlings become established. Cheatgrass is capable of producing twice as many roots as bluebunch wheatgrass during the first 45 days of growth. Its roots also move down into the soil faster than those of bluebunch wheatgrass.[39,67,106,107,108]

Cheatgrass has a short growth period relative to native plants. It can out compete native plants for water and nutrients in the early spring since it is actively growing when many natives are initiating growth. It matures four to six weeks earlier than bluebunch wheatgrass and utilizes the limited moisture supply prior to use by bluebunch. Cheatgrass is tolerant of grazing and increases with frequent fire.[39,67]

c. Fire danger

Cheatgrass ranges burn frequently. Wildfire return intervals are now less than five years on some rangelands heavily infested with cheatgrass. The short growth period of cheatgrass relative to native plants increases the likelihood that wildfires will start and spread. Cheatgrass becomes flammable four to six weeks earlier and remains highly flammable for one to two months later than native perennials. Cheatgrass is usually dry by mid-July when perennial plants may contain 65% moisture. Standing dead cheatgrass and litter are extremely flammable resulting in shorter wildfire return intervals. As cheatgrass ranges burn frequently, there is a limited availability of native plants so that natural reseeding of the site doesn't occur.[11,39,67]

As fire cycles increase, cheatgrass abundance increases until the rangeland is essentially a cheatgrass range. Some federal land managers call this a "locked in" range. The name "locked in" refers to the never ending cycle of fire with more cheatgrass filling in the interspaces until perennial plants such as Wyoming sagebrush and bluebunch wheatgrass become replaced.[39]

d. Removal of livestock

Some cheatgrass communities have maintained a steady state that would not return to native vegetation after livestock removal. Some researchers have speculated that the removal of livestock from rangeland could increase the rate of conversion of the

range to cheatgrass because of the increased fuel accumulations which would result in more frequent wildfires.[67]

e. Other considerations

Cheatgrass normally provides adequate cover for watershed protection. Cheatgrass litter effectively reduces raindrop energy and promotes infiltration. However in drought years and after a wildfire this protection is reduced and the potential for erosion is increased.[67]

Forage quality and digestibility also affect cheatgrass use by livestock. The period that cheatgrass is palatable and nutritious for herbivore consumption is considerably shorter than for most native herbaceous plants. Forage quality declines as cheatgrass matures, therefore early spring to early summer grazing provides the greatest nutritional benefits to livestock.[67]

f. Research, solutions, and unknowns

i. Greenstrips to reduce fire danger

Strips of fire resistant vegetation, greenstrips, can be used to manage the fuels on rangeland. These strips are designed to slow or stop wildfires. As early as 1946, Platt and Jackman proposed planting fire resistant species in strips in cheatgrass areas.[68,70]

Wildland fires burn differently depending on the type of vegetation, the amount of fuel, the proximity of fuel sources to each other, the water content and the fuel volatility. Greenstrips slow fires by separating volatile fuels and disrupting fuel continuity, reducing the amount of accumulated burnable material, and increasing the proportion of plants with a higher moisture content. Fine fuels that readily ignite and carry fire are replaced with perennial, less flammable vegetation.[28,68]

Reports suggest that forage kochia is a very effective greenstrip species to decrease fire frequency by successfully competing with and decreasing cheatgrass density. Forage kochia has four times the moisture content of crested wheatgrass and ten times the moisture content of cheatgrass. Fires have burned up to a forage kochia greenstrip and stopped because of the green biomass and sparsity of contiguous fine fuels. When fires burn in forage kochia the flame length and intensity are both reduced, aiding fire fighting.[28,68]

There have only been a few burning trials of forage kochia and there is a lack of published data on its fire suppressant qualities. The most efficient greenstrip width, best establishment practices, and potential combinations with other greenstrip species are unknown.[28]

ii. Competitive native vegetation

There have been promising initial studies that show that squirreltail can invade both cheatgrass and medusahead stands.[39] Is it a more promising native plant to seed in cheatgrass infested areas?[39]

iii. Management to increase native vegetation

A five-year research project is being conducted that will explore ways to improve the health of sagebrush rangelands across the Great Basin in the western United States. The purpose of the project is to conduct research to be able to provide land managers with improved information about sustaining and restoring sagebrush rangelands. The project is a collaboration among the USGS, Oregon State University, University of Idaho, University of Reno-Nevada, Brigham Young University, US Department of Agriculture (USDA) Forest Service, USDA Agriculture Research Service, and BLM.[1,79,88]

One of the two experiments of this project is focused on sagebrush communities threatened by cheatgrass invasion. Four primary land-management treatment options will be studied including prescribed fire, mechanical thinning of shrubs and trees by mowing, herbicide applications, and a control with no management action. Some sections within the treated areas will have an additional herbicide application applied to control cheatgrass. One objective is to discover how much native perennial bunchgrass needs to be present to create a community that will be more resistant and resilient to fire and weed invasion without having to conduct expensive restoration.[1,88]

In cheatgrass infested rangelands, could livestock grazing management practices be used to improve the vigor and quantity of native perennial vegetation by reducing the competition from cheatgrass.[67]

iv. Understanding conditions favoring and retarding cheatgrass dominance

Dominance by cheatgrass varies depending on the elevation. At higher elevations it is closely related to temperature. At lower elevations it is related to soil water.[87] Can we use these relationships to anticipate which areas are most subject to cheatgrass dominance?

The USGS has begun an investigation of factors including climate, sources and forms of soil nutrients, soil characteristics, underlying geology, and topologic location.[3]

6. Western juniper (*Juniperus occidentalis*)

a. Juniper expansion

Since the settlement of Euro-Americans, juniper has been spreading throughout the Great Basin including the Owyhee uplands and the lower Owyhee subbasin (Figure 9.6). Although the data on expansion are not specific to the lower Owyhee subbasin, anecdotal information indicates that the trends documented in adjacent areas apply to the subbasin. In southwestern Owyhee County of Idaho, the area occupied by western juniper has more than doubled from what was occupied in 1860.[41]

The invasion of juniper into sagebrush steppe communities over the last 120 years has been documented by various methods including determining the age of trees, studies of juniper pollen increases, and comparisons of aerial photographs. The expansion of juniper in southeastern Oregon began in the late 1860s and accelerated in the 1880s. In the state of Oregon the estimated area of juniper forest and savanna is over four times the acreage of 1930.[2,27,40,41,87,96]

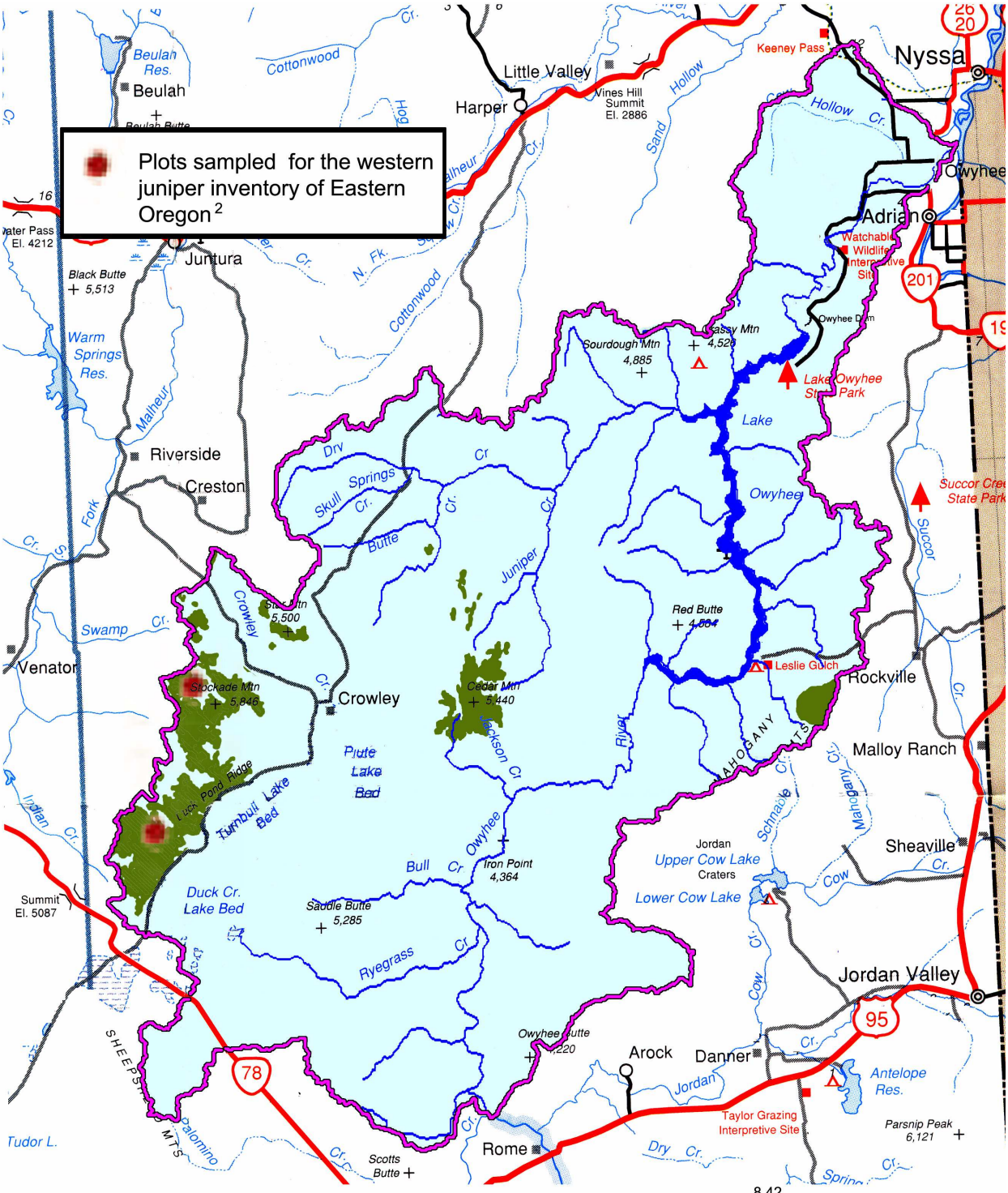

Figure 9.6. Juniper stands in the lower Owyhee subbasin. 8,42

b. Problems of juniper expansion

Juniper expansion into sagebrush communities results in many negative consequences. These changes result primarily from the fact that juniper hogs water.

i. Changes in plant community

Juniper invasion results in major changes in the plant community composition. Increasingly abundant juniper outcompetes other native vegetation for water. Biomass production is significantly affected and there can be a serious loss of forage. The diversity of plants in the community is reduced and desirable understory vegetation can disappear. The amount of ground covered by herbaceous (non-woody) plants is diminished. The grass clumps are smaller and more widely spaced so there is an increase in bare ground. As juniper utilizes more of the water and nutrients at a site, other plants lose vigor and die.[2,41,42,96]

ii. Wildlife

A change in the plants growing in an area alters the wildlife habitat and impacts the wildlife species. Increasing dominance by juniper results in a decline in wildlife abundance and diversity. Much of the food for large herbivores like mule deer, pronghorn antelope, and elk disappears. Fawning habitat for deer is reduced by replacement of big sagebrush with juniper. Some of the shrub-steppe communities which pronghorn antelope prefer in winter and spring disappears. The small mammal population is affected by both decreases in food and cover.[2,40,42,96]

With juniper encroachment, there are fewer shrub-steppe birds. How much the population of a species decreases with increasing western juniper varies. Species which require sagebrush, including the sage grouse, are very sensitive to juniper invasion into sagebrush communities. Nesting habitats for birds such as the sage grouse disappear.[2,40,42,96]

iii. Changed hydrology

Juniper roots extend over a wide area and deep into the soil, depleting water from the soil. In addition, the juniper canopy intercepts a large amount of precipitation, reducing the amount of moisture actually reaching the soil. Measurements below juniper show a reduction in precipitation of 20% near the canopy edge to 75% under the canopy by the trunk.[2,40,42,96]

The structure of the changed plant community can affect infiltration rates and overland flow of water. Where plant cover has changed from more evenly dispersed to clumped plants, there is increased soil erosion. Hillsides with juniper had runoff in a thunderstorm with an intensity that occurs about every two years. Similar hillsides with no juniper only had runoff from the type of thunderstorm that occurs every 50 years.[101] With a 50-year thunderstorm, the hillside without juniper lost no sediment, but the hillside with juniper lost 275 lb/acre of sediment. The loss of nutrients off site in sediment will ultimately change soil fertility and cause a reduction in community productivity.[40,41,42]

Juniper expansion may lead to the loss of stream flows. There is ample anecdotal evidence that streams, springs, and meadows have dried up due to increased juniper. Where juniper has been removed the flows have returned. Juniper expansion may be a substantial factor in the loss of stream function.[15,42,111,112,113]

c. Previous range

A characteristic of the location of older juniper stands is that the sites where they are growing are mostly naturally shielded from fire. Old-growth juniper typically occupy rock outcrops, rocky ridges, or rimrock. Junipers could grow in fractured bedrock in these spots .[9,10,41,42,81,96]

A small minority of juniper stands are ancient with trees that are 1,000 years old or older. One juniper tree growing east of Bend has been determined to be 1600 years old. Old juniper growth is a relative term. Younger juniper trees are between 80 and 130 years old and typically are an inverted cone shape. Older trees have a round-topped crown and become unsymmetrical in appearance with spreading canopies that may be sparse.[41,42,96]

About 10 percent of the existing western junipers were established before the 1870s. Stands of these older trees have long achieved a steady state. The other 90 percent of areas occupied by juniper are still in transition.[42,96]

d. Reasons for juniper expansion

i. Previous fire intervals

Fire has been an important natural factor in the environment of southwestern Idaho and southeastern Oregon for "at least several centuries preceding white settlement."[9] Native Americans also deliberately set fires to improve forage for game, maintain or increase the yield of certain wild edible plants, or increase seed production. In the 1820s Peter Skene Ogden noted abundant evidence of fires caused by Native Americans. These fires had probably been set throughout the 1700s, if not earlier, to add to the number of fires started naturally. Following a fire ignited naturally or by man, there would be a new flush of grasses and wildflowers. Young juniper would be killed.[40,96]

Young juniper is much more severely affected by fire than older trees. Just scorching of the crown and stem can kill young juniper, especially seedlings and saplings. In some recent burns nearly all the juniper less than 50 years old was killed. Fires were probably more frequent than this. The plant species comprising sagebrush communities are a product of an environment which included relatively frequent fires and are adapted to survive periodic burning. Although big sagebrush is readily killed by fire, the stands generally regenerate quickly from seed. Juniper, especially young juniper is not adapted to survive burning. Juniper became established in areas which fires would not completely burn.[9,10,92]

In big sagebrush plant communities with Idaho fescue the fire return intervals typically ranged between 10 and 25 years. Large fires occurred about every 40 years. However, in the more arid areas with big sagebrush, fire return intervals could range up to 50 to 100 years. In Eastern Oregon large fires in sagebrush-steppe communities were preceded by at least one year with above-average precipitation. A series of wet years would allow greater quantities of fuels to accumulate and carry fire. When fire return intervals become greater than 70 years, the probability that juniper will establish and successfully mature greatly increases.[9,41,42]

ii. Juniper encroachment

Invasion of juniper and its phenomenal expansion is attributed to the reduced occurrence of fire. Fire return intervals now exceed 100 years and there has been a reduced role of fire since the 1870s with a large decline in the occurrence of fires since 1910.[9,41]

Livestock have grazed on the Owyhee Plateau since the late 1860s. When Griffiths crossed from Nevada to Ontario, Oregon in 1902, he commented that "no open-range lowland was seen on the whole trip which had much feed upon it excepting that consisting of the tough and persistent salt grass."[23] Overgrazing by domestic livestock reduced not only the supply of feed but also the supply of fine fuel available to carry fire. Fire was less effective and did not spread far. Fire suppression did not become a major factor in range management until after World War II.[2,9,40,41,42]

Overgrazing at the close of the 19th and beginning of the 20th centuries and fire suppression by state and federal agencies during the last 60 years have reduced the occurrence of fires that would have killed smaller juniper. Juniper expansion in eastern Oregon occurred at the same time fire return intervals increased.[2,9,11,15,40,41] Most of the lower Owyhee subbasin is part of the Owyhee Plateau where "A cause and effect relationship between the decline in periodic fires and the initiation and rate of juniper invasion on the Owyhee Plateau is suggested by the data."[9]

e. Progression of invasion

Overgrazing is not the direct cause of juniper invasion, but indirectly affects juniper expansion through decreasing fire frequency and intensity. Most older trees grew on ridges or rimrocks and juniper seedlings establish downslope from the old juniper. Most juniper seed is spread close to the parent plant, about 4½ feet downhill and two feet uphill. Seeds are apparently spread by small mammals as the seeds are found in the droppings of cottontail rabbits and ground squirrels. Although mule deer will eat juniper when other food is not available, this is generally after most juniper seeds have dropped to the ground. Birds also spread juniper seed. Seed buried in the soil can germinate a number of years later.[9,41,96]

Seedlings establish in the protected areas under the crown of shrubs, usually big sagebrush, possibly because this is a bird perch. The density of seedlings is negatively related to bare ground and positively related to the presence of shrubs and trees. In an unusually dry year in the Owyhee uplands, 1967, 71% of seedlings survived the first year and 60% survived for two years.[2,9,103]

When juniper is first established the trees are widely scattered and the community is dominated by sagebrush and grasses. The understory of grasses and shrubs begins to decline when the trees reach 45 to 50 years old. Juniper begins to exclude other species through moisture competition and halting juniper expansion becomes more difficult. Eventually juniper outcompetes other native vegetation including smaller junipers, sagebrush, and grasses. By the time the trees are around 100 years old the juniper has become so dominant that it is unlikely that there is enough native understory community left to reestablish itself even if the trees are removed.[2,42,96]

Much of the sagebrush-steppe in eastern Oregon with juniper trees already growing on it is still developing into juniper stands. Seedlings on these lands indicate that juniper is still in an establishment stage, and that the probability juniper on these lands will continue to increase in density is greater than for areas with a single old juniper.[2]

f. What to do

Without treatment, areas of range that have been invaded will continue to decline due to the effect of young trees already present. The problems created by juniper invasion can not be solved by grazing manipulation alone. There is no reason to believe that competition from other vegetation will either crowd out existing juniper or prevent the establishment of new juniper plants. In the early and middle stages of development, juniper invasion can be successfully treated by various methods, particularly fire. Where native grasses, forbs, and shrubs were present in southeastern Oregon, they increased following juniper removal and there was a good chance they would regain dominance.[9,41,42,96]

The ability to predict the outcome of juniper removal decreases when juniper becomes more dominant. Several reburns might be required to destroy all the residual seed in the soil in established juniper. The composition of the understory prior to juniper removal affects the chance of re-establishment of desirable species. Instead of reverting to native grasses and shrubs, the range can achieve a new steady state with invasive species such as cheatgrass or medusahead and leave the site in poorer shape than before.[11,40,41,42,96]

The current juniper increase is aided considerably by human activity. Continued increase can affect the ecological functioning of the natural communities of juniper, sage, and bunchgrass. It's important to maintain functioning hydrological and nutrient cycles and healthy understory communities to provide habitat for sage grouse and food and shelter to a rich diversity of wildlife.

7. Invasive weed control

a. Fire

Periodic fire has been mentioned above as a means to keep juniper from invading rangelands. However in some areas fires have become more frequent and severe. Overgrazing followed by vigorous fire suppression reduced the number of fires. Reduction in fires meant that sagebrush and juniper cover increased. With removal of overgrazing, fine fuels, especially cheatgrass filled the interspaces between the shrubs allowing fires to spread. Increases in the continuous proximity of fuels allows rapid spread of fires. These fires can be very destructive to existing perennial vegetation and extremely difficult to control. Cheatgrass may become the dominate species following fire in some areas. Dominance by cheatgrass then promotes frequent burns to the detriment of existing or reestablishing shrubs and perennial grasses.[14,30,92]

Fire can have a place in range management. Another grass which is invading large areas of the lower Owyhee subbasin is medusahead rye. Although medusahead rye supports frequent fire cycles, prescribed burning has shown great success in the

management of medusahead. Timing is critical. Medusahead needs to be in the milk or soft dough stage. The fire is best set when the relative humidity is about 30% to 50% and it will burn slowly into a light breeze. A complete burn is necessary. There is no germination of medusahead seeds which are completely burnt. Uncharred seeds may still have 87% germination. Under wildfire conditions only 50% of the seed is usually destroyed.[16,66]

Controlled burns are also effective on yellow starthistle. Unfortunately the proper timing, early to mid-summer, is when the risk of escaped fires is very high. Also the seeds can survive three or more years in the soil and three consecutive years of burning are needed.[16]

Studies show that few non-target plants respond negatively to prescribed summer burning. Those that do respond negatively are generally non-native species. The most important positive impact of prescribed burning for invasive weed control is the potential increase in native perennial grasses. In general controlled burns increase the plant diversity, particularly of native plants. Most studies show that this is due to an increase in forbs. The amount of land covered by summer native legumes can increase. Although most species benefiting from burns are desirable, in some cases invasive perennials can increase following a prescribed fire.[16]

Controlled fires or wildfires have some effect on diffuse knapweed if the seeds are exposed to the direct heat from the flames of the burn. Prescribed burns don't control spotted knapweed, leafy spurge, or dalmatian toadflax regardless of the timing. Saltcedar is favored by fire. It readily resprouts from the base following fire or mechanical damage. In most cases, successful control of invasive perennial forbs involves integration of other control options.[16]

b. Integrated management

Noxious rangeland weeds are highly competitive and persistent and control requires an integrated approach. Fire, herbicides, and grazing management plans can all be part of weed control. An integral part of any control program is mapping where weeds exist.[14,16]

The most effective method for managing noxious weeds is to prevent their invasion into new areas. Possible methods to limit noxious weed encroachment include detecting and eradicating weed introductions early, limiting weed seed dispersal, containing neighboring weed infestations, minimizing soil disturbances, and establishing competitive species.[72,73]

Successful species have seed adapted to spread. Wildlife and livestock can ingest seeds which pass through unaffected and are introduced to new areas. Timing of livestock grazing on infested areas can minimize both the amount of seed which matures and the amount of mature seed which is carried to other areas. A vehicle driven through spotted knapweed can pick up 2000 seeds and still be carrying 10% of them 10 miles from the infestation. Flowers picked by hikers, campers, and recreationists can produce viable seed after they are discarded. Seed can stick to the coats of wildlife or livestock and to the clothing of people.[72,73]

Weed infestation can be contained to existing areas to protect neighboring uninfested rangeland. Spraying borders of infested areas may contain the weeds although it doesn't eliminate the infestation and is a long-term commitment to weed control. It also enhances the future success of eradication efforts.[72,73]

Eradication of existing weed species depends on using control techniques appropriate for the site and weed species. This includes the effectiveness of the technique, the availability of control agents including labeled uses of herbicides, the presence of grazing animals, and environmental considerations. Some control measures may need to be repeatedly applied until the weed seed bank and root reserves are exhausted.[16,72]

Herbicides with short half-lives need to be available for use whenever herbicides are part of the management program.

Re-establishment of native species can prevent reinfestation with noxious weeds. Replanting in the lower Owyhee subbasin needs to be with species that are competitive with cheatgrass and medusahead.

c. Special considerations

Rush skeletonweed is hard to control with herbicides because of the deep taproots and spreading roots, and tilling it under can spread the rootstock.

Whitetop spreads by seed and vegetatively under the soil and is very competitive with native vegetation on disturbed or alkaline sites. It has also been found that one time tilling of the soil will spread this noxious weed, and that it takes 3 consecutive years of tilling to destroy the root system.

Russian knapweed can be successfully controlled with combinations of grazing and herbicides but control programs must persist for several years.[61]

There is a special fruit fly that has been introduced as a partial biological control of spotted knapweed. It lays its eggs on the flower heads. Larvae eat the developing seeds, leaving only 5-20 seeds instead of 30.

E. Fire suppression

Prescribed burns in the spring when the vegetation is not tinder dry are different from wildfires. The BLM actively fights most wildfires on BLM land.

The lower Owyhee subbasin is part of the Vale district of the BLM which includes Baker, Wallowa, Union, and Umatilla Counties in addition to Malheur County. The north half of Malheur County is the Malheur resource area and the south half is the Jordan resource area.

In 2006, the Vale BLM fought 80 wild fires in Malheur County, 45 in the Malheur resource area and 26 in the Jordan resource area. Nine of these fires were caused by humans and 71 were sparked by lightning. Of the 169,283 acres burnt, only 850 acres were destroyed due to fires caused by people.[101] The number of acres burned by wildfires in 2006 in the complete Vale district of the BLM greatly exceeded the number burnt in any of the last ten years (Figure 9.7)

Following a fire, the cattle are removed from that section of range for at least two grazing seasons to allow the area to recuperate.[8]

Of the acres burnt in 2006, 15,400 acres were reseeded, 800 acres were scheduled for bitterbrush plantings, and 26 acres were to be inventoried and treated for weeds. In May 2007 about 6 of these acres had been treated.[101]

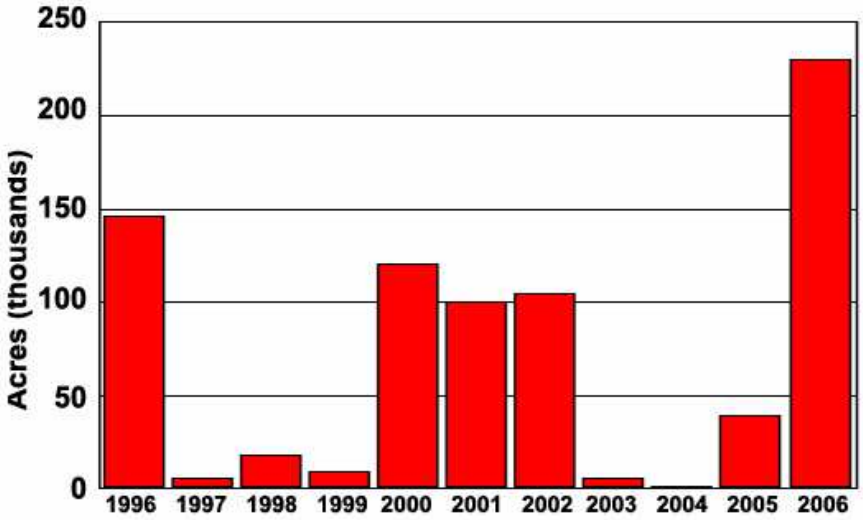

Figure 9.7. Acres burnt by wildfires in the BLM Vale district.

F. GMA

The Vale BLM recently completed an evaluation/assessment of the Dry Creek geographic management area (GMA). Part of this GMA lies within the lower Owyhee subbasin while the remainder is in the Malheur River watershed (Figure 9.8).[4]

Five primary characteristics of rangeland health were evaluated: upland watershed function; riparian/wetland areas watershed function; ecological processes; water quality; and native, threatened and endangered, and locally important species. The criteria for considering each of these items, other than water quality, states that they be "appropriate to soil, climate, and landform."[4] The manual for interpreting indicators of rangeland health states that the approach "requires a good understanding of . . . soils for each of the sites to which it is applied."[69] As one of the few remaining areas of the continental US with no soil mapping completed, there is a large gap in knowledge which severely limits any such assessment in Malheur County.

The manual for interpreting indicators of rangeland health also specifically states that these assessments are to be used to provide a preliminary evaluation of the soil/site stability, hydrologic function, and integrity of the biological community for the ecological site. The purpose is to help land managers identify areas that are potentially at risk of degradation. The approach is not to be used to identify the cause(s) of resource problems, make grazing and other management decisions, monitor land, or determine trend.[69]

G. Areas of critical environmental concern and wilderness study areas.

On federal land, there are a series of wilderness study areas (WSAs) along both sides of the Owyhee River corridor. BLM wilderness study areas constitute 30% of the lower Owyhee subbasin (Figure 9.9). A number of these wilderness study areas have been recommended as suitable for wilderness designation by the BLM (Figure 9.10).[8]

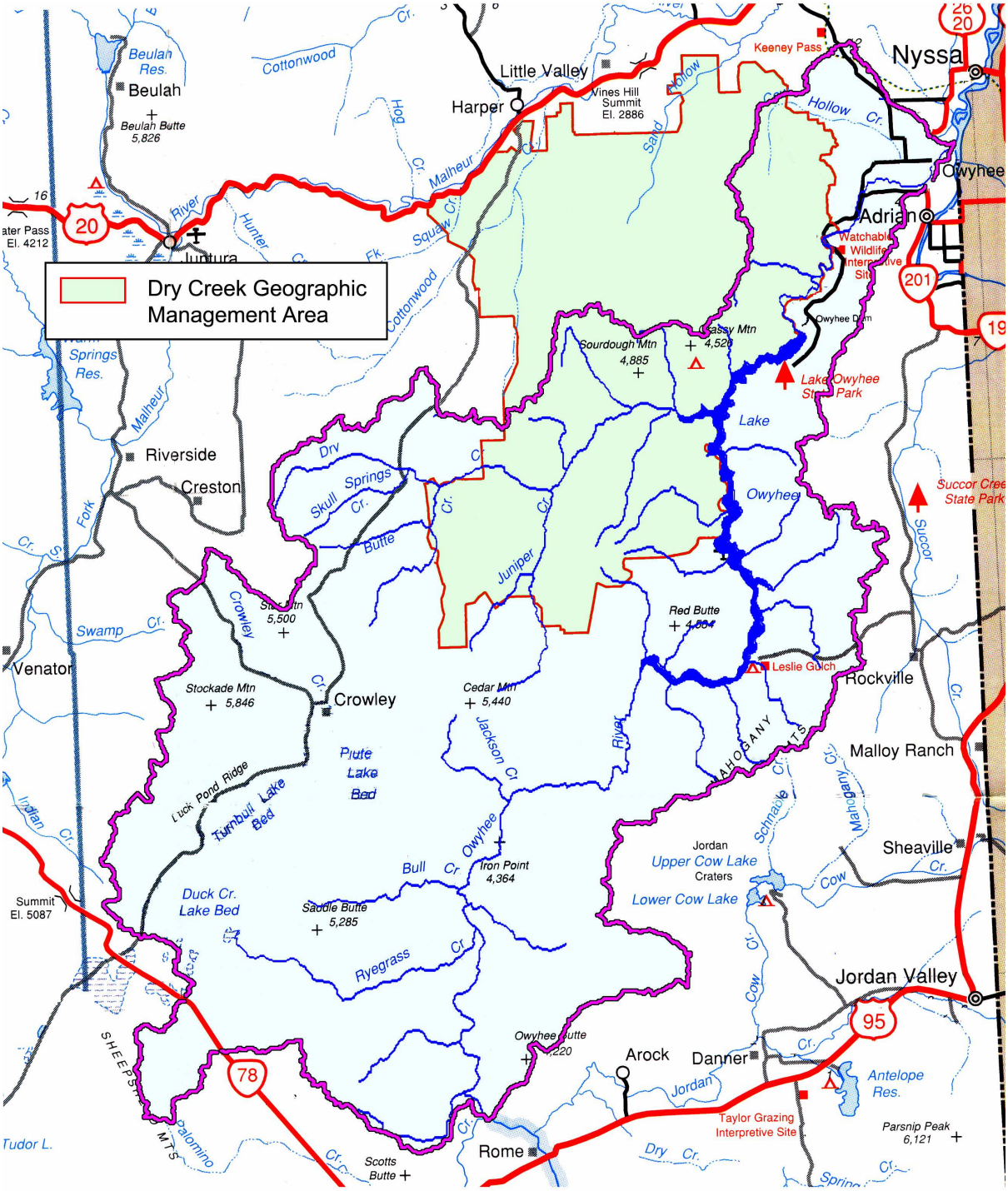

Figure 9.8. Location of the Dry Creek Geographic Management Area. A section of is in the lower Owyhee subbasin.[4]

Some cattlemen's groups support either the designation of these areas as wilderness or the areas being released instead of remaining wilderness study areas.[94] In addition to the WSAs, there are designated areas of critical environmental concern (ACECs) (Figure 9.11).[8]

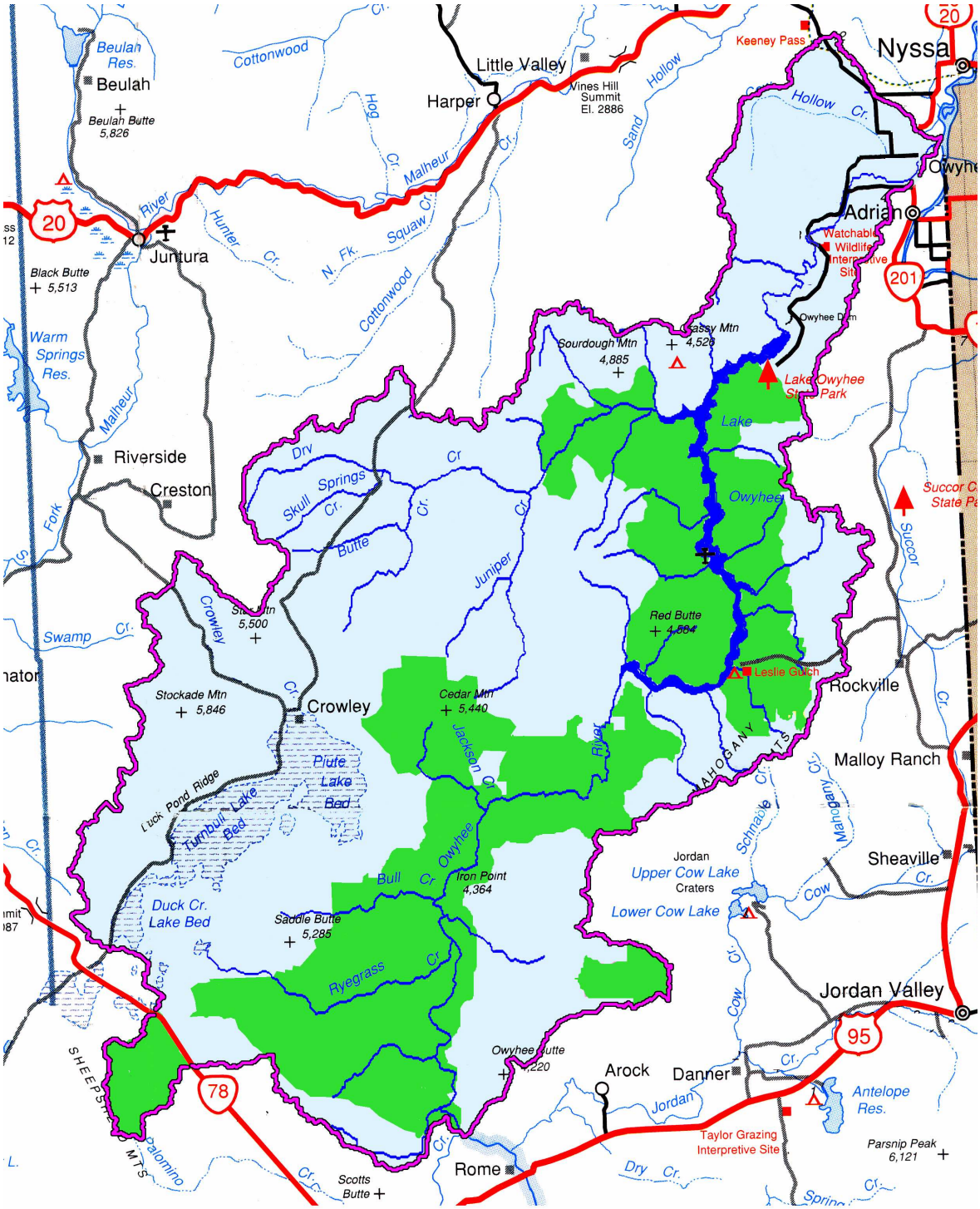

Figure 9.9. Bureau of Land Management wilderness study areas in the lower Owyhee subbasin.[8]

In February 2004, the Vale District of the BLM received a request from the Oregon Natural Desert Association (ONDA) to amend the Southeast Oregon Resource Management Plan to include new wilderness study areas. Since the Department of the Interior has instructed BLM that it can no longer establish new wilderness study areas, ONDA requested that their proposed WSAs be reviewed as wilderness ACECs. ONDA

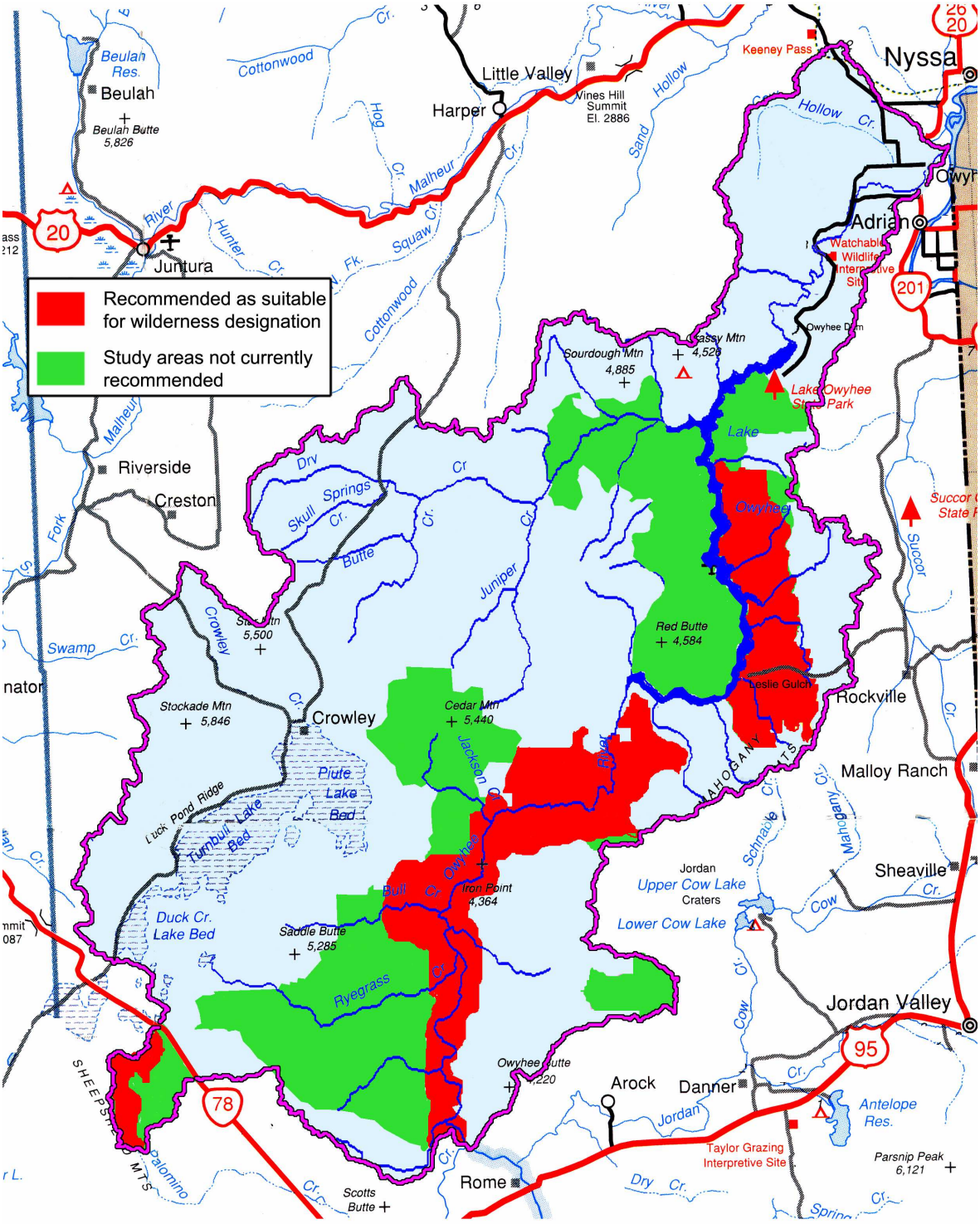

Figure 9.10. Bureau of Land Management wilderness study areas in the lower Owyhee subbasin recommended as suitable for wilderness designation by the BLM.[8]

mmended 42 new wilderness ACECs totaling more than 1.3 million acres, either wholly or partially within the Vale District. The existing WSAs and ACECs in the lower Owyhee subbasin section of the Dry Creek GMA, along with ONDA's recommended additions are shown in Figure 9.12.

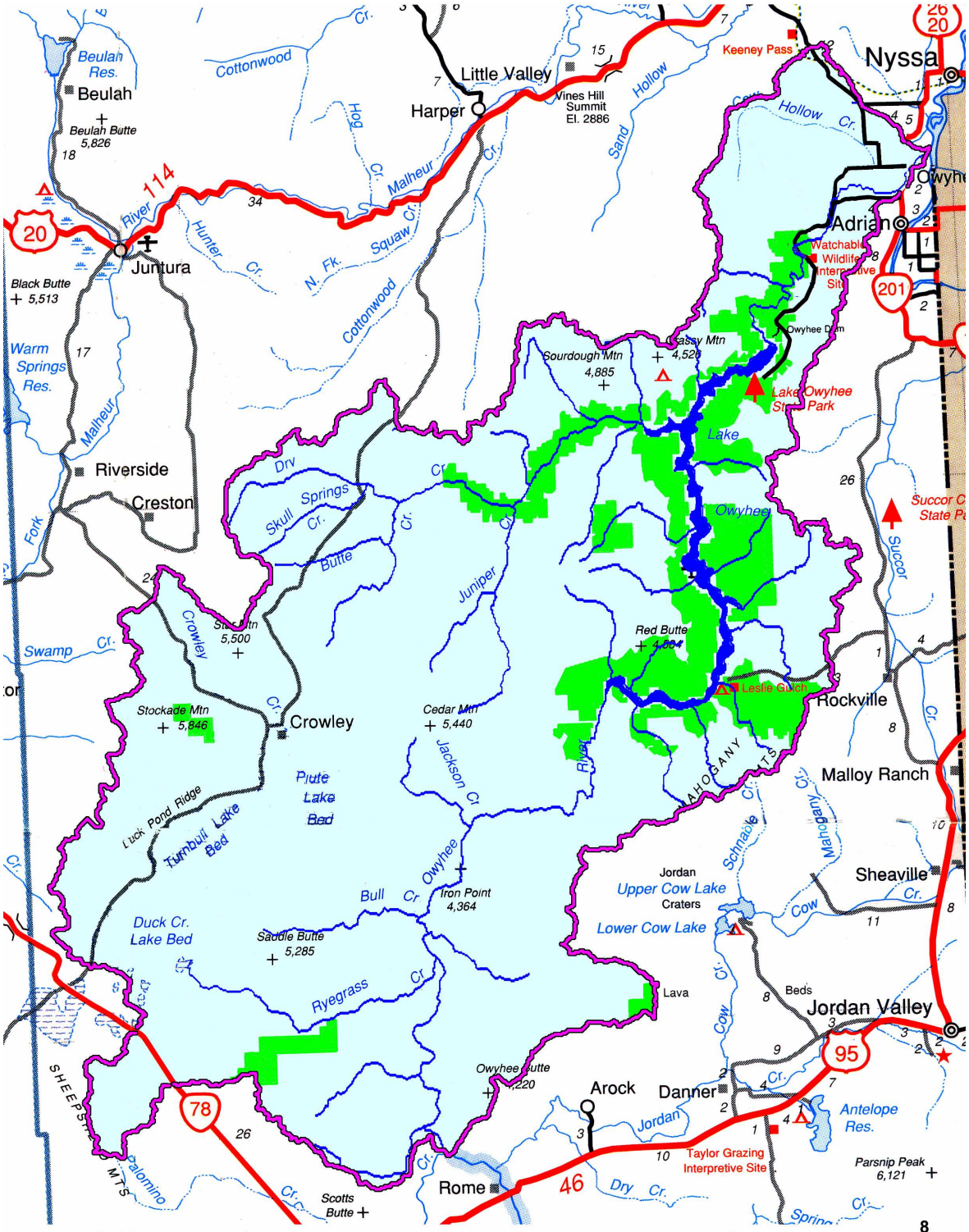

Figure 9.11. Areas of critical environmental concern in the lower Owyhee subbasin.[8]

ONDA has also recommended other large areas in the lower Owyhee subbasin be designated as wilderness ACECs. It is of utmost importance that consideration of any such designation by BLM be completely transparent to the public, including letting

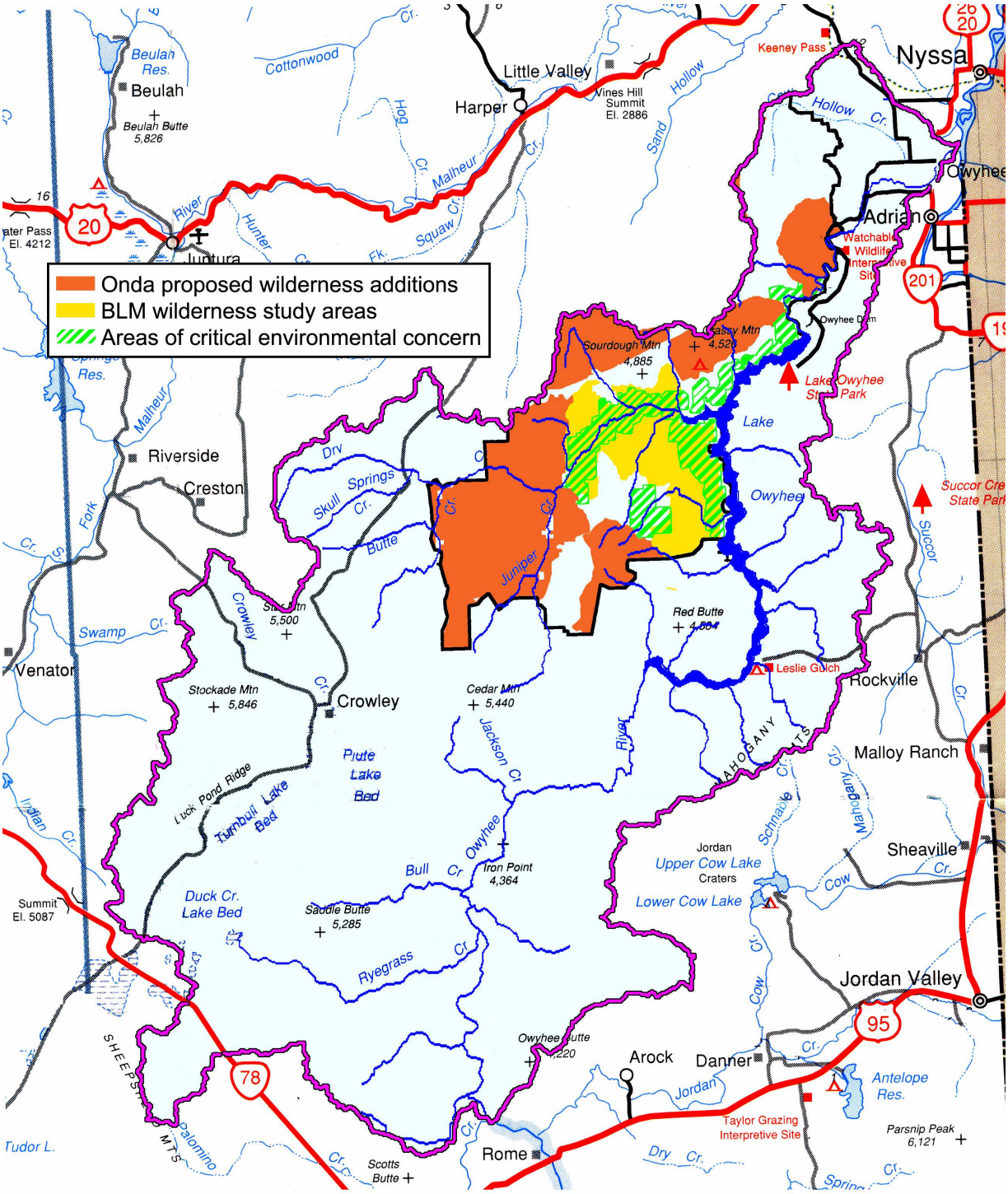

Figure 9.12. ONDA proposed wilderness additions, BLM wilderness study areas, and areas of critical environmental concern in the sector of the Dry Creek Geographic Management Area in the lower Owyhee subbasin.[4]

the public know that the recommendations are being considered, having all the data supporting the recommendation available, having advertised open meetings for commenting on the recommendation, and only making a decision after seriously weighing all of the input.

H. Discussion

The BLM is handicapped in combating noxious weeds by courts injunctions which do not allow for the use of newer, safer herbicides. In 1984 the Northwest Citizens Against Pesticides, Oregon Environmental Council, and Portland Audubon Society sued to stop all herbicide programs on federal forest lands. The US District court issued an injunction prohibiting the use of all herbicides. The BLM returned to court in 1987 and received a partial lifting of the injunction that allowed the use of herbicides containing dicamba (Banville), glyphosate, picloram (tordon), and 2,4-D. Since then, the BLM has been limited to these old chemistries. Newer chemicals are available that are safer environmentally and have shorter half lives.[5,6,45,66]

The native vegetation of the lower Owyhee subbasin was greatly changed at the end of the 19th and beginning of the 20th centuries. We have descriptions of what the area was like at the time of Euro-American settlement, but we don't really know the composition of the native species. Following the abusive livestock grazing which ended between the passage of the Taylor Grazing Act of 1934 and World War II, the rangeland has improved. Vegetation cover of the landscape has increased. The ecoregion is recovering. However the plant communities undoubtedly remain altered. There has been a public shift in the perception of the role of range. The idea of maintaining a sustainable long-term output of livestock products has been replaced by one of continuing to produce livestock products while maintaining ecological functions and multiple uses.

Major challenges continue on the rangelands of the lower Owyhee subbasin. Large areas of the subbasin have been invaded by medusahead rye and it has become dominant. Areas dominated by medusahead rye are expanding at a phenomenal rate. These areas no longer provide forage for wildlife or livestock and habitat for species such as the sage grouse disappears. Little is being done to stop the spread.

New noxious weeds are gaining a strong foothold in the lower Owyhee subbasin, like tamarisk along the waterways.

Some of the existing areas of critical environmental concern have greatly increased noxious weed infestations that are not being controlled or eliminated.

Grazing has been eliminated in some allotments with ACECs (Figure 12). Special status plants that have survived until now in Leslie Gulch under grazing are being squeezed out in the ACEC by competitive plants which were kept in check by grazing.

Wildlife, as well as livestock, is endangered by a perception that water which is currently stored in stock ponds could instead increase the flows into the river.

Current knowledge should provide for continued improvement in ecological conditions. Throughout the Great Basin ecoregion, the reintroduction of fire as a management tool is having a very positive effect in reducing the amount of late successional sagebrush and invasive juniper dominance that has occurred with past fire suppression practices. Livestock management for riparian zone enhancement is in its

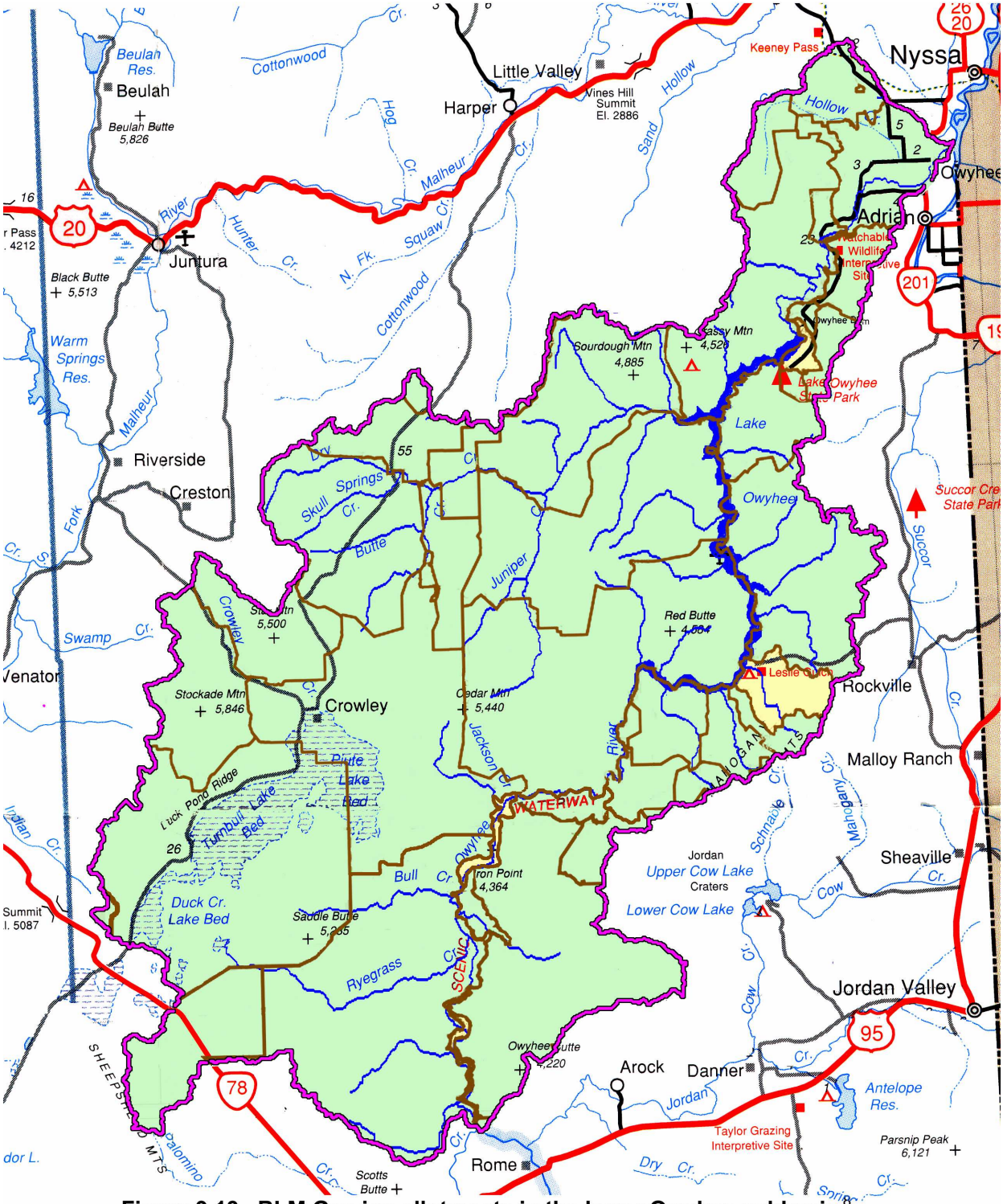

Figure 9.13. BLM Grazing allotments in the lower Owyhee subbasin.

Boundary Area with livestock grazing discontinued

infancy, but where practiced significant positive results are occurring. However, any management activities on public land require an extensive paper trail and public scrutiny before implementation.[81]

I. Unknowns and data gaps

There is no good mapping of current vegetative coverage in the lower Owyhee subbasin.

1. Plant composition

a. Juniper

Much of what is unknown about western juniper expansion impacts on rangelands is basic science. How does juniper expansion impact watershed function and water resources? How does it affect the water balance? Does it increase surface runoff and erosion? Is stream flow and spring flow affected? Does water extraction by juniper reduce aquifer recharge and stream flow?

There has been no work on snowfall accumulation dynamics. How does the hydrology change if juniper is removed?

What are the nutrient dynamics of western juniper in rangelands? How is the expansion of juniper distributed across landscapes? What is the interrelationship between juniper and elk?

b. Invasive plants and noxious weeds

An integral part of any control program is first mapping where weeds exist in the lower Owyhee subbasin.

What are the effects of conversion to invasive annuals on watershed function and water resources?

What are the factors that make sagebrush ecosystems susceptible/resistant to invasion by nonnative species? What are the rates of expansion of invasive plant species, the types of activities that increase invasion rates, and the types of ecosystems where expansion is occurring most rapidly? Can changes in current management activities be used to decrease the rates of invasion?

What are the most appropriate scales and stages of invasion of noxious weeds to target control activities? What are the longer-term impacts of using herbicides to control invasive species? What are the long term impacts of failing to use herbicide to control invasive weeds, especially when they first appear?

c. Cheatgrass

The interaction effects between cheatgrass and crested wheatgrass are unknown. Cheatgrass doesn't seem to expand in areas of crested wheatgrass. Relatively low densities of cheatgrass affect the establishment of seedlings of crested wheatgrass.[67] Native grasses generally have poorer seedling vigor than the introduced grasses so what affect does cheatgrass have of native grass establishment?

A major problem in the management of cheatgrass infested rangelands is using livestock grazing management practices to improve the vigor and quantity of native perennial vegetation by reducing the competition of cheatgrass.

Is there an acceptable ratio of cheatgrass to native plants where the ecological processes still function?

What treatments can restore perennial vegetation in cheatgrass infested rangelands. How do the treatments change depending on the degree of cheatgrass dominance?

Experience indicates cheatgrass seed production is limited by early spring cattle grazing.[103]

Does the removal of livestock accelerate conversion of rangeland to cheatgrass because of increased fuel accumulations and more frequent wildfires?

What happens to plant communities with the removal of livestock for rangeland dominated by cheatgrass? From rangeland dominated by crested wheatgrass? From rangeland dominated by native grasses? From rangeland dominated by sagebrush? There are long term exclosure studies at Squaw Butte.[103]

Dominance by cheatgrass varies depending on the elevation. At higher elevations it is closely related to temperature. At lower elevations it is related to soil water.[87] Can we use these relationships to anticipate which areas are most subject to cheatgrass dominance?

Do wildfires favor cheatgrass? Could early grazing following wildfires be used to favor native vegetation?

d. Ecosystem factors

There are currently researchers studying some of the following questions. The problem is then to apply the knowledge to day to day operations and decisions.

How will climate change influence water resources in sagebrush ecosystems? How will climate change influence fire regimes and expansion of invasive species? Tony Svejcar at Burns ARS has been studying this for a long time.[109]

What fire regimes are required to maintain the diverse sagebrush ecosystems? What are the effects of fire and prescribed fire on vegetation, soils, animals and hydrology of sagebrush ecosystems? Rick Miller has written a number of publications.

What are the factors, abiotic and biotic, that determine the capacity of the diverse sagebrush ecosystems to recover following disturbance or management treatments? How can we discover and define these factors? Tamzen Stringham has worked on this.[110]

What are the habitat requirements, spatial structures of populations, and population biology of the endemic plant and animal species?

What are the cause and effect relationships between and uses and population responses of species at risk? Are threatened species actually favored by grazing? Will the exclusion of grazing in ACECs place them at risk by the uncontrolled growth of other vegetation?

How will ACECs impact other species?

How does crested wheatgrass affect native perennial vegetation? Is there a density of crested wheatgrass that maintains perennial vegetation? One study showed three crested wheatgrass plants in ten square feet maintained perennial vegetation.[67]

2. Methodology

Effective management of sagebrush ecosystems requires basic resource information for developing effective management strategies. This information needs to be collected at appropriate scales. GIS and local measurements can be supplemented with remote sensing if there are ground-based observations to verify the validity of the conclusions.

• Methods are needed for assessing current ecological conditions and species status across the region. Information on the current ecological status (intact, at risk, threshold crossed) of sagebrush ecosystems and on the status of individual species is necessary for developing strategic plans and implementing management and restoration programs.[11]

• Methods are needed for monitoring the types and rates of change occurring in sagebrush ecosystems. Information on the changes in vegetation, soils, and animals, as well as in climate, fire regimes, and invasive species is needed for effective adaptive management.[11]

• Methods/tools are needed for predicting future effects of ecosystem stressors on sagebrush ecosystems. Predictive information is needed on the future effects of increases in human populations, climate change, fire and invasives that can be used to develop alternative futures and guide research and management programs.[11]

• Methods/tools are needed for prioritizing management activities and restoration treatments at site, watershed and landscape scales. Prioritization requires information not only on the ecological status of sagebrush ecosystems and individual species, but also on the habitat and range requirements for species of concern, and the abiotic and biotic conditions that cause threshold crossings for both plants and animals.[11]

• Methods/tools are needed for maintaining intact ecosystems and restoring ecosystems at risk or that have crossed thresholds. Although many studies have been conducted on managing and restoring sagebrush ecosystems, information/tools are still lacking in several areas including: 1) economic analysis tools to compare the current situation to the restored site and assess the benefits to local communities that participate in restoration activities; 2) seed supplies and establishment methods for native species; 3) methods for controlling invasive species while reestablishing sagebrush communities.[11]

• Education programs are needed that can be used to build consensus for implementing necessary changes in management.[11]

3. Research and Management Questions

There are numerous research and management questions that remain to be answered.

"What are the consequences of doing nothing? That's just as much of a management decision as doing something. What will the site look like in 20 years if we don't treat it?" Managers can greatly increase their success rate by asking the right questions: What is the goal? What is the problem? What plants or soils are on the site now? What course of treatment will be both affordable and effective? What follow-up will be needed?[96]

There is still little data on the results of prescribed burning on many important invasive species. The impact of prescribed burning on native vegetation has only been studied for a few perennial grasses and legume species. What is the seedbank longevity of target and non-target species. How do differences in timing, topography, fire extent or size, community structure, fuel loads and properties, or intensity affect native plants?

The effectiveness of establishing green strips for controlling fire in cheatgrass invested rangelands should be tested.

There have only been a few burning trials of forage kochia and there is a lack of published data on its fire suppressant qualities. The most efficient greenstrip width, best establishment practices, and potential combinations with other greenstrip species are unknown.[28]

There have been promising initial studies that show that squirreltail can invade both cheatgrass and medusahead stands.[39] Is it a more promising native plant to seed in cheatgrass infested areas?[39]

We don't really know what happens to plant communities with the removal of livestock. Will the removal of grazing place special status plants at risk by increasing competition?

There are no systematic allotment monitoring studies (trend, actual use, utilization and weather). These could be made and kept current with summaries posted in each allotment file for use by range staff.

There could be follow up studies on the same area that was well surveyed in 1979-80 in the Owyhee Breaks to see what obvious changes have occurred.

J. Conclusions

The use of the important resources of the rangelands of the lower Owyhee subbasin affects all of us. Therefore, proper use and management is vitally important.

"Thou shalt inherit the holy earth as a faithful steward, conserving its resources and productivity from generation to generation. Thou shalt safeguard thy fields from soil erosion, thy living waters from drying up, thy forests from desolation, and protect thy hills from overgrazing by thy herds, that thy descendants may have abundance forever. If any shall fail in this stewardship of the land thy fruitful fields shall become sterile stony ground and wasting gullies, and thy descendants shall decrease and live in poverty or perish from off the face of the earth". W.C. Lowdermilk [36]

Bibliography

1. About the Project: SageSTEP Research Overview. Retrieved 3/5/2007. http://www.sagestep.org/research_overview.html
2. Azuma, David L., Bruce A. Hiserote, Paul A. Dunham. 2005. The western juniper resource of eastern Oregon. Resour. Bull. PNW-RB-249. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.
3. Belnap, Jayne, Marith Reheis, and Rich Reynolds. Conditions favoring and retarding cheatgrass invasion of arid lands in the southwestern U.S. USGS, SW climate impacts project. Retrieved 3/5/2007. http://esp.cr.usgs.gov/info/sw/cheatgrass/
4. Bureau of Land Management. 2007. *Dry Creek Geographic Management Area Evaluation/Assessment*: Malheur resource area, Vale district. U.S Department of the Interior, BLM, Vale District Office, Vale, OR. Retrieved 2/19/2007. http://www.blm.gov/or/districts/vale/plans/files/vdo_plan_drycreek080306.pdf
5. Bureau of Land Management. 2003. Herbicides approved for use on BLM lands under the listed EIS/ROD documents and court injunction. Retrieved 3/13/2007. http://www.blm.gov/nhp/efoia/wo/fy03/ib2003-102attach3.pdf
6. Bureau of Land Management. 2006. Record of decision: Integrated pest management program, BLM Provolt Seed Orchard, Grants Pass, Josephine and Jackson Counties, Oregon and BLM Sprague Seed Orchard, Merlin, Josephine County, Oregon. Retrieved 3/13/2007. http://www.blm.gov/or/districts/medford/plans/files/Provolt-Sprague_eis_ROD_acc.pdf
7. Bureau of Land Management. Selected noxious weeds of Oregon. BLM publication BLM/OR/WA/PT-00/26+1792.
8. Bureau of Land Management. 2001. *Southeastern Oregon Resource Management Plan*. U.S Department of the Interior, BLM, Vale District Office, Vale, OR. BLM publication BLM/OR/WA/PL-01/016+1792.
9. Burkhardt, J. Wayne and E.W. Tisdale. 1976. Causes of juniper invasion in southwestern Idaho. Ecology 57: 472-484.
10. Burkhardt, J. Wayne and E.W. Tisdale. 1969. Nature and successional status of western juniper vegetation in Idaho. J. Range Management 22:264-270.
11. Chambers, Jeanne. 2006. Draft Great Basin Issues Papers. Collaborative Watershed Research and Management Conference, Reno, NV. Retrieved 3/5/2007. http://www.cabnr.unr.edu/GreatBasinWatershed/Issues_Papers.pdf
12. Coville, Frederick V. 1896. The Sage Plains of Oregon. National Geographic.
13. Culver, Roger N. 1964. An ecological reconnaissance of the *Artemisia* steppe on the east cental Owyhee uplands of Oregon. Master of Science thesis in range management, Oregon State University.
14. Davison, Jason. 1996. Livestock grazing in wildland fuel management programs. Rangelands 18(6). December 1996.
15. Deboodt, Tim and John Buckhouse. Personal communication.
16. Di Tomaso, Joseph M. and Douglas W. Johnson, eds. 2006. The use of fire as a tool for controlling invasive palnts. Cal-IPC Publication 2006-01. California Invasive Plant Council, Berkeley, CA.
17. Dodson, Sherry. Origin of the species: native versus non-native Rangeland Plants. Retrieved 3/4/2007. http://www.cnr.uidaho.edu/range456/hot-topics/native-plants-debate.htm
18. Drew, C.S. 1865. *Official Report of the Owyhee Reconnoissance made by Lieut. Colonel C.S. Drew, 1st Oregon Cavalry, in the summer of 1864.* Oregon Sentinel Printing Office, Jacksonville, Oregon.
19. Findley, Jean. 2004. Leslie Gulch. Kalmiopsis Volume 11, 2004.
20. Forest Preserve District of Cook County (Illinois). 1972. Newton ask a scientist. Retrieved 3/4/2007. http://www.newton.dep.anl.gov/natbltn/400-499/nb466.htm

21. Ganskopp, David C. 1984. Habitat use and spatial interactions of cattle, wild horses, mule deer, and California bighorn sheep in the Owyhee Breaks of southeast Oregon. Doctor of Philosophy thesis, Oregon State University.
22. Gregg, Jacob Ray. 1950. *Pioneer Days in Malheur County*. Lorrin L. Morrison, Los Angeles.
23. Griffiths, David. 1902. Forage conditions on the northern border of the Great Basin, being a report on investigations made during July and August, 1901, in the region between Winnemucca, Nevada and Ontario, Oregon. U.S. Department of Agriculture, Bur. Plant Industry Bulletin No. 15, Washington DC.
24. Grossman, D. H., D. Faber-Langendoen, A. S. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K. D. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. International classification of ecological communities: terrestrial vegetation of the United States. Volume I. The National Vegetation Classification System: development, status, and applications. The Nature Conservancy, Arlington, Virginia, USA.
25. Hanley, Mike. 1988. *Tales of the I.O.N. Country*. Jordan Valley, Oregon.
26. Hanley, Mike with Ellis Lucia. 1988. *Owyhee Trails, The West's Forgotten Corner*. The Caaxton Printers, Ltd., Caldwell, Idaho.
27. Harris, Tyson. 2005. Juniper woodlands. *What is Range?* Rangeland Ecology and Management, University of Idaho. Retrieved 3/8/2007. http://www.cnrhome.uidaho.edu/default.aspx?pid=85877
28. Harrison, R. Deane, Blair L. Waldron, Kevin B. Jensen, Richard Page, Thomas A. Monaco, W. Howard Horton, and Antonio J. Palazzo. Forage kochia helps fight range fires. Rangelands 24(5). Retrieved 3/5/2007. http://kochiaseed.com/rangelands.pdf
29. Heady, Harold F. and James Bartolome. The Vale rangeland rehabilitation program: The desert repaired in southeastern Oregon. USDA Forest Service Resource Bulletin PNW-70. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.
30. Hughes, Lee E. 1985. Is wildfire really bad? Rangelands 7(3). June 1985.
31. Jones, Ilea and Eunice Guerrant eds. 1988. *Malheur County History*. Taylor Publishing Company, Dallas, Texas.
32. Kindschy, Bob, Al Logosz, Chad McBurney, Roger Mertens, Ed Spang. 2002. Eastern Oregon: the Vale Project. BLM Legacy Program.
33. Kudray, Gary and Steve V. Cooper. 2005. Linking the national vegetation classification system to NRCS ecological sites in southeastern Montana. Report to the Bureau of Land Management. Montana Natural Heritage Program, Helena, MT.
34. Launchbaugh, Karen. A short course on rangelands. Rangeland Ecology & Management, University of Idaho. Retrieved 2/21/2007. http://www.cnr.uidaho.edu/what-is-range/files/short_course.pdf
35. Launchbaugh, Karen. 2004. Introduction to Rangelands. Retrieved 2/21/2007. http://www.cnr.uidaho.edu/west/introrange.html
36. Lowdermilk, W.C. 1942 (revised, 1950). Conquest of the land through seven thousand years. Miscellaneous Publication 32. United States Department of Agriculture, Soil Conservation Service, Washington, D.C.
37. Martin, Jacob. 2005. Salt-desert shrublands. *What is Range?* Rangeland Ecology and Management, University of Idaho. Retrieved 2/21/2007. http://www.cnrhome.uidaho.edu/default.aspx?pid=75115
38. Melissa Yzquierdo . 2005. Sagebrush steppe. *What is Range?* Rangeland Ecology and Management, University of Idaho. Retrieved 2/21/2007. http://www.cnrhome.uidaho.edu/default.aspx?pid=85874
39. Miles, Thomas G. and Michael G. "Sherm" Karl. 1995. Introduced forage grasses in the interior Columbia Basin: science assessment. Interior Columbia Basin Ecosystem Management Project, science integration team, terrestrial staff range task group. Retrieved 3/4/2007. http://www.icbemp.gov/science/miles.pdf

40. Miller, Richard F. and Peter E. Wigand. 1994. Holocene changes in semiarid pinyon-juniper woodlands: response to climate, fire, and human activities in the US great basin. BioScience 44(7):465-474.
41. Miller, Richard F. and Robin J. Tausch. 2001. The role of fire in pinyon and juniper woodlands: a descriptive analysis. *In* K.E.M. Galley and T.P. Wilson (eds.). *Proceedings of the Invasive Species Workshop: the Role of Fire in the Control and Spread of Invasive Species.* Fire Conference 2000: the First Nation Congress on Fire Ecology, Prevention, and Management. Miscellaneous Publication No. 11, Tall Timbers Reserach Station, Tallahassee, FL.
42. Miller, Richard F., Jon D. Bates, Tony J. Svejcar, Fred B. Pierson, and Lee E. Eddleman. 2005. *Biology, Ecology, and Management of Western Juniper.* Technical Bull. 152, Oregon State University, Agricultural Experiment Station, Corvallis, OR.
43. Montana State Library. National Vegetation Classification System. Accessed 2/28/2007. http://nhp.nris.state.mt.us/community/NVCS.asp
44. Nichols, J.T., P.N. Jensen, and J. Stubbendieck. 1987. Range Judging Handbook for Nebraska. Experiment Station Bull # EC 1-37-78.
45. Northwest Citizens for Alternatives to Pesticides. 1992. Beyond Herbicide Wars: Trees, Weeds, and the U.S. Forest Service in the Pacific Northwest. Journal of Pesticide Reform Vol. 12, No. 2.
46. Ogden, Peter Skeen. Rich, E.E. ed. 1950. *Peter Skene Ogden's Snake Country Journals 1824-25 and 1825-26*. The Hudson's Bay Record Society, London.
47. Oregon Department of Agriculture. Buffalobur. ODA plant division, noxious weed control. Retrieved 3/4/2007. http://www.oregon.gov/ODA/PLANT/WEEDS/profile_buffalobur.shtml
48. Oregon Department of Agriculture. Bull thistle. ODA plant division, noxious weed control. Retrieved 3/4/2007. http://www.oregon.gov/ODA/PLANT/WEEDS/profile_bullthistle.shtml
49. Oregon Department of Agriculture. Bull thistle. ODA plant division, noxious weed control. Retrieved 3/4/2007. http://www.oregon.gov/ODA/PLANT/WEEDS/profile_canadathistle.shtml
50. Oregon Department of Agriculture. Diffuse knapweed. ODA plant division, noxious weed control. Retrieved 3/4/2007. http://www.oregon.gov/ODA/PLANT/WEEDS/profile_diffuseknapweed.shtml
51. Oregon Department of Agriculture. Frequently asked questions. ODA plant division, noxious weed control. Retrieved 3/3/2007. http://www.oregon.gov/ODA/PLANT/WEEDS/faqs.shtml
52. Oregon Department of Agriculture. Halogeton. ODA plant division, noxious weed control. Retrieved 3/4/2007. http://www.oregon.gov/ODA/PLANT/WEEDS/profile_halogeton.shtml
53. Oregon Department of Agriculture. Houndstongue. ODA plant division, noxious weed control. Retrieved 3/4/2007. http://www.oregon.gov/ODA/PLANT/WEEDS/profile_houndstongue.shtml
54 Oregon Department of Agriculture. Leafy spurge. ODA plant division, noxious weed control. Retrieved 3/3/2007. http://www.oregon.gov/ODA/PLANT/WEEDS/profile_leafyspurge.shtml
55. Oregon Department of Agriculture. Medusahead rye. ODA plant division, noxious weed control. Retrieved 3/3/2007. http://www.oregon.gov/ODA/PLANT/WEEDS/profile_medusaheadrye.shtml
56. Oregon Department of Agriculture. Musk thistle. ODA plant division, noxious weed control. Retrieved 3/4/2007. http://www.oregon.gov/ODA/PLANT/WEEDS/profile_muskthistle.shtml
57. Oregon Department of Agriculture. Perennial pepperweed. ODA plant division, noxious weed control. Retrieved 3/3/2007. http://www.oregon.gov/ODA/PLANT/WEEDS/profile_perennialpepperweed.shtml
58. Oregon Department of Agriculture. Poison hemlock. ODA plant division, noxious weed control. Retrieved 3/5/2007. http://www.oregon.gov/ODA/PLANT/WEEDS/profile_poisonhemlock.shtml
59. Oregon Department of Agriculture. Purple loosestrife. ODA plant division, noxious weed control. Retrieved 3/5/2007. http://www.oregon.gov/ODA/PLANT/WEEDS/profile_purpleloosestrife.shtml
60. Oregon Department of Agriculture. Rush skeletonweed. ODA plant division, noxious weed control. Retrieved 3/3/2007. http://www.oregon.gov/ODA/PLANT/WEEDS/profile_rushskeletonweed.shtml

61. Oregon Department of Agriculture. Russian knapweed. ODA plant division, noxious weed control. Retrieved 3/5/2007. http://www.oregon.gov/ODA/PLANT/WEEDS/profile_russianknapweed.shtml
62. Oregon Department of Agriculture. Scotch thistle. ODA plant division, noxious weed control. Retrieved 3/3/2007. http://www.oregon.gov/ODA/PLANT/WEEDS/profile_scotchthistle.shtml
63. Oregon Department of Agriculture. Spotted knapweed. ODA plant division, noxious weed control. Retrieved 3/5/2007. http://www.oregon.gov/ODA/PLANT/WEEDS/profile_spottedknapweed.shtml
64. Oregon Department of Agriculture. White top. ODA plant division, noxious weed control. Retrieved 3/3/2007. http://www.oregon.gov/ODA/PLANT/WEEDS/profile_whitetop.shtml
65. Oregon Department of Agriculture. Yellow starthistle. ODA plant division, noxious weed control. Retrieved 3/5/2007. http://www.oregon.gov/ODA/PLANT/WEEDS/profile_yellowstarthistle.shtml
66. Page, Gary. 2007. Personal communication.
67. Pellent, Mike. 1996. Cheatgrass: The invader that won the West. Bureau of Land Management, Idaho State Office, Boise, Idaho Retrieved 3/5/2007. http://www.icbemp.gov/science/pellant.pdf
68. Pellent, Mike. Greenstrips - a tool to reduce wildfire impacts. Retrieved 3/5/2007. http://www.wy.blm.gov/cheatgrass/2003/pdfs/greenstrips-mpellant.pdf
69. Pellant, Mike, Patrick Shaver, David A. Pyke, and Jeffrey E. Herrick with BLM and NRCS Contributors. 2000. Interpreting Indicators of Rangeland Health, version 3. Bureau of Land Management, Denver, Colorado. Technical Reference 1734-6. BLM publication BLM/WO/ST-00/001+1734.
70. Platt, K. and E. R. Jackman. 1946. The cheatgrass problem in Oregon. Bull. 668. Oregon Agricultural Experiment Station, Corvallis, OR.
71. Scholl, Lewis. 1859. Mr. Scholl to General Harney. In: Report of the Secretary of war, communicating. . . the report of Captain H.D. Wallen of his expedition, in 1859, from Dalles City to Great Salt Lake, and back. United States. Army. Dept. of the Columbia, Washington. 1860
72. Sheley, Roger. 1995. Integrated rangeland weed management. Rangelands 17(6). December 1995.
73. Sheley, Roger, Mark Manoukian, and Gerald Marks. 1996. Preventing noxious weed invasion. Rangelands 18(3). June 1996.
74. Shirk, David L. 1956. *The Cattle Drives of David Shirk from Texas to the Idaho Mines, 1871 and 1873*. Martin F. Schmitt, ed. Champoeg Press.
75. Shock, Clinton C. 2007. Mid-Snake River Watershed Vegetation Database. Retrieved 2/18/ 2007. http://www.malag.aes.oregonstate.edu/wildflowers/
76. Shock, Clinton. 2007. Weeds of Malheur County. Unpublished brochure.
77. Smith, Liz. 2005. How to identify range plants. *What is Range?* Rangeland Ecology and Management, University of Idaho. Retrieved 2/21/2007. http://www.cnr.uidaho.edu/what-is-range/identify.htm
78. Smucker, Samuel M. 1856. *The life of Col. John Charles Fremont, and his narrative of explorations and adventures, in Kansas, Nebraska, Oregon and California: The memoir by Samuel M. Smucker*. Miller, Orton & Mulligan, New York & Auburn.
79. State and Federal Partnership forms to Restore Great Basin Rangelands . 2005. The Westerner. Retrieved 3/5/2007. http://thewesterner.blogspot.com/archives/2005_11_06_thewesterner_archive.html
80. Sundquist, Bruce. The earth's carrying capacity: some literature reviews. Retrieved 2/26/2007. http://home.alltel.net/bsundquist1/index.html
81. Sutton, N. Lynnae. 1999. The northern great basin ecoregion: Introduction. *Oregon State of the Environment Report*. Retrieved 2/23/07. http://www.bap.pdx.edu/greatbasinintro.html
82. Swanson, Sherman, Wayne Burkhardt, James A. Young. Living with cheatgrass in the great basin annual rangeland. University of Nevada Cooperative Extension Fact Sheet 87-45. Retrieved 3/3/2007. http://www.livingwithfire.info/pdf/WEB-Living_With_Cheatgrass.pdf

83. Townsend, John Kirk. 1839. *Narrative of a Journey across the Rocky Mountains to the Columbia River*. Oregon State University Press. *1834*

84. USDA, NRCS. 2007. The plants database. National Plant Data Center, Baton Rouge, LA 70874-4490 USA. Retrieved 2/17/2007. http://plants.usda.gov/index.html.

85. USDA, NRCS. 2007. Invasive and noxious weeds. The plants database. National Plant Data Center, Baton Rouge, LA 70874-4490 USA. Retrieved 3/4/2007. http://plants.usda.gov/java/noxiousDriver

86. USDA, NRCS. 2007. Invasive and noxious weeds. The plants database. National Plant Data Center, Baton Rouge, LA 70874-4490 USA. Retrieved 3/4/2007. http://plants.usda.gov/about_invasive.html

87. USDA Forest Service, Rocky Mountain Research Station. 2006. Research Accomplishments. Retrieved 3/5/2007. http://www.fs.fed.us/rmrs/docs/research-accomplishments/research-accomplishments-2006.pdf

88. USGS. 2005. State and Federal Partnership forms to Restore Great Basin Rangelands. Retrieved 3/5/2007. http://www.usgs.gov/newsroom/article.asp?ID=1412

89. Vavra, Marty. Sagebrush steppe. Retrieved 3/3/2007. http://www.bap.pdx.edu/sagebrushsteppe.html

90. Vavra, Marty. Salt desert scrub. Retrieved 3/3/2007. http://www.bap.pdx.edu/saltdesertscrub.html

91. Vavra, Marty. The northern Great Basin ecoregion. Retrieved 3/3/2007. http://www.bap.pdx.edu/greatbasinintro.html

92. Vavra, Marty. Summary of current status and health of Oregon's rangelands. In *Health of Natural Systems and Resources, Oregon State of the Environment Report.* Retrieved 3/5/2007. http://egov.oregon.gov/DAS/OPB/docs/SOER2000/Ch3_8.pdf

94. Water for Life. 2000. Owyhee ranchers request wilderness designation. In *Return Flows*. Retrieved 3/12/2007. http://www.waterforlife.net/inc/NewsSummer00.htm

95. WeedMapper Team. 2004. Weed information. *weedmapper.org*. Dept. of Rangeland Ecology & Management, Oregon State University. Retrieved 2/17/2007. http://www.weedmapper.org/facts.html

96. Wells, Gail. 2006. High desert dominator. Oregon's Agricultural Progress, Spring 2006. Retrieved 3/7/2007. http://extension.oregonstate.edu/oap/story.php?S_No=163&storyType=oap&page=1

97. What is range? 2005. Rangeland Ecology and Management, University of Idaho. Retrieved 2/21/2007. http://www.cnr.uidaho.edu/what-is-range/

98. What are Rangelands? *Rangelands West.* Retrieved 2/21/2007. http://rangelandswest.org/whatarerangelands.html

99. Work, John. Elliott, T.C. ed. Journal of John Work's Snake country expedition of 1830-31: second half. Retrieved 3/3/06. http://www.xmission.com/~drudy/mtman/html/jwork/work09.html

100. NRCS. 2006. *Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin*. United States Depart of Agriculture Handbook 296. Accessed on line 7/26/06. ftp://ftp-fc.sc.egov.usda.gov/NSSC/Ag_Handbook_296/Handbook_296_high.pdf.

101. Eyre, Randy. 2007. Wildland fire suppression. Presentation to the Ontario Chamber of Commerce agriculture committee meeting.

102. Pierson, F.B., J.D. Bates, T.J. Svejcar, and S.P. Hardegree. 2007. Runoff and erosion after cutting western juniper. Rangeland Ecology and Management 60:285-292.

103. Krueger, W.C. 2007. Personal communication.

104. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964. US Government Printing Office, Washinton D.C. Accessed 8/30/2007. http://landcover.usgs.gov/pdf/anderson.pdf

105. McDaniel, Kirk. Salt cedar project. New Mexico State University, Animal and Range Sciences. Accessed 8/30/2007. http://cahe.nmsu.edu/academics/anrs/saltceder-.html

106. Harris, Grant A. 1977. Root phenology as a factor of competition among grass seedlings. Journal of Range Management. 30(3): 172-177.

107. Harris, Grant A. 1990. Cheat grass: invasion of potential and managerial implications. In: Roche, Ben F.; Roche, Cindy Talbott, eds. Range weeds revisted: Proceedings of a symposium: a 1989 Pacific Northwest range management short course; 1989 January 24-26; Spokane, WA. Pullman, WA: Washington State University, Department of Natural Resource Sciences, Cooperative Extension: 5-9.

108. Harris, Grant and ,A. M Wilson. 1970. Competition for moisture among seedlings of annual and perennial grasses as influenced by root elongation at low temperature. Ecology. 51(3): 530-534.

109. Svejcar, A.J. 2007. Climate Change and Rangelands: What are the Management Implications? [abstract]. Society for Range Management Meeting Abstracts. Paper No. 420.

110. Stringham, T.K., W.C. Krueger, and P.L. Shaver. 2003. State and transition modeling: an ecological process approach. Journal of Range Management. 56:106 -113 March 2003.

111. Baker, Malchus. 1984. Changes in streamflow in a herbicide-treated pinyon-juniper watershed in Arizona. *Water Resources Research* 20:1639-1642.

112. Hibbert, Alden. 1983. Water yield improvement potential by vegetation management on western rangelands. *Water Resources Bulletin* 19:375-381.

113. Sturges, David. 1994. High-elevation watershed response to sagebrush control in southcentral Wyoming. Res. Pap. RM-318. US Dept. of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.