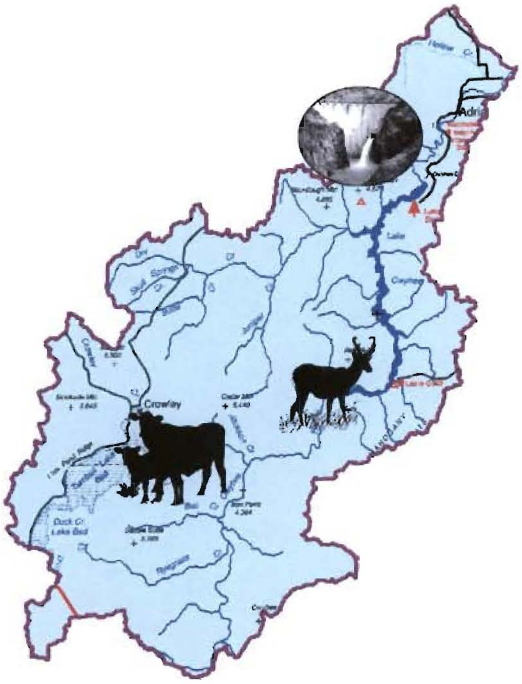


Appendix F. Weeds of special importance to the lower Owyhee subbasin

Appendix F. Weeds of special importance to the lower Owyhee subbasin

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

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

Range Weeds

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

Common name	Scientific name		a		b	c	d	e	f
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

(Land Use: b–f)

Some Selected Important Crop Weeds

Cheese weed, common mallow	Malva parviflora	Abundant	Y
Dodder	Cuscuta spp.	Abundant	Y
Field bindweed	Convolvulus arvensis	Abundant	Y
Jointed goatgrass	Aegilops cylindrica	Limited	
Puncturevine	Tribulus terrestris	Abundant	Y
Yellow nutsedge	Cyperus esculentus	Abundant	Y

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

a. *Buffalobur (Solanum rostratum)*

Buffalobur is a weed in the mid Snake region but is not currently a known problem in the Lower Owyhee Subbasin but is common in North America. Buffalobur is a yellow flowered annual that grows most frequently on disturbed, sandy soils. The yellow flowers have 5 petals as other Solanaceae and are about an inch across. The plant grows to about 2 feet tall and has deeply cut leaves 2 to 5 inches long.

b. *Bull thistle (Cirsium vulgare)*

This is a native plant to Eurasia; it has established itself throughout North America. It is a biennial, which has short, fleshy taproot. The first year the plant makes a small rosette near the ground. During the second season the plant puts up a stem 2-5 feet or more tall, with green, hairy leaves, that are prickly and have deep woven hairs on the upper side; on the bottom they feel cottony. The flowers are in big clusters at the end of the branches. The seeds then develop on top of the flower, with fluffy white on top of them, which are then picked up by the wind and spread all over; infesting more places with this noxious weed. This plant has reddish-purple flowers which appear between July and September. Horses consider this to be a delicacy, because the heads to the flowers are filled with sugary nectar. Some birds use the seeds as food. Bull thistle can be found in waste lands, along road sides, in fields and pastures, and many other places where there is disturbed soil.

c. *Bur buttercup (Ranunculus testiculatus)*

Bur buttercup or hornseed buttercup is a common low growing annual weed in the north western states. It is native to southeastern Europe. The plant grows 1 to 5 inches tall and has gray green leaves 1 to 4 inches long. Because of its short stature and short growing season, it is often overlooked. Seeds germinate with the melting of snow or thawing of the soil in late winter to early spring, depending on elevation. Bur buttercup is very common, especially on disturbed soils. It can be competitive with small grain crops and is toxic to sheep. 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 Velcro-like spines.

d. Canada thistle (Cirsium arvense)

This is an aggressive perennial, which spreads by seeds blowing in the wind, or plowing the seeds and rhizomes into the soil, or the rhizomes of established plants growing horizontal and increasing the number of stems. Individual plants easily grow into a dense, persistent thistle patches. It can grow from 1.5 to 5 feet tall, but typically are 2 to 3 feet tall. This is a unisexual plant, with male flowers producing pollen and the female flowers producing seeds on separate plants. It has flower colors from rose to purple and even white, and blooms from June through August. The leaves have woolly hairs on their under side. It was introduced from Eurasia into Canada in the hay for the horses in Burgoine's army. It invades fields, pastures, and waste lands. This strong, aggressive perennial is difficult to control.

e. Cheatgrass, downy brome (Bromus tectorum)

Cheatgrass is a vigorous, short lived, and widely distributed annual grass that has replaced many native species. Cheatgrass does provide forage. Following repeated fire events it may become dominate, replacing most native species. Cheat-grass was introduced from the Mediterranean region. Cheatgrass has a finely divided, fibrous root system with an average of 7 main roots that grow rapidly, spreading laterally and vertically. It also grows rapidly and the amount of growth varies from year to year depending upon the amount of moisture that it receives, perennial plant competition, and soil fertility. It is a widely adapted plant and can be a nuisance. Heavy cheatgrass stands can make the re-establishment of native vegetation very difficult.

f. Dalmatian toadflax (Linaria dalmatica)

Dalmatian toadflax usually first appears on disturbed soil along roadways and can crowd out desirable native range species. Dalmatian toadflax is a 2 to 4 foot tall perennial with bright yellow flowers. It was introduced from southeastern Europe, and is not current widely distributed in Malheur County.

g. Diffuse knapweed (Centaurea diffusa)

Diffuse knapweed was introduced from Eurasia; it is native to southeastern Europe and western Asia. Diffuse knapweed is a problem for dry Pacific northwestern areas, being very competitive with native range plants. It is very aggressive, and invades roadsides, waste lands, grass lands, and dry range lands. It spreads rapidly and stands in dense groups. The flowers are white and occasionally purple. It flowers July through September. The flower heads are numerous and narrow. This is a bushy annual, biennial, or short lived perennial. It can grow 1-2 feet tall. When the stems mature and become brittle they break off, then become a tumble weed, which then blow in the wind spreading seeds all over becoming a threat to pastures and rangelands. It is very competitive growing from taproots.

h. Halogeton (Halogeton glomeratus)

Halogeton is an annual plant native of Asia that has invaded millions of acres of alkaline soils in the semi arid west. Halogeton is not highly competitive in vigorous range conditions, but thrives in over grazed sites or sites limited by alkaline soils. Halogeton grows horizontally, then the branches curve upwards from just a few inches to 1.5 feet tall. The stems are red, while the leaves are greenish- blue with sharp needle like tips, with small yellow flowers. It can grow 1 to 2 feet tall. It produces two types of seeds; there is a black, shiny one with wings to blow in the wind that can germinate within one year. Then there are brown seeds that can lie dormant for several years. This plant is found in concentrated areas along roadsides, sheep trails, and near where livestock congregate. It is especially lethal to sheep and occasionally lethal to cattle because it contains sodium oxalate.

i. Houndstongue (Cynoglossum officinale)

j. Leafy spurge (Euphorbia esula)

Leafy spurge is aggressive and takes over most other vegetation, and is poised to invade large areas from strongholds in Council and Cambridge ID and from the Jordan Creek drainage in the Owyhees. Leafy spurge is a 3 foot tall perennial that spreads by rootstocks as well as by seed. Because of its deep roots and large seed count it is hard to control. The flowers are yellowish- green; the leaves vary in size and shape. Leafy spurge can be distinguished by the white sap that oozes out when cut or broken. Leafy spurge starts blooming in mid June. This plant is toxic to cattle and horses. It is from European or Eurasia. It can be found in abandoned cropland, pastures, rangeland, woodland, roadsides and waste areas.

k. Mediterranean sage (Salvia aethiopis)

l. Medusahead rye (Taeniatherum caput-medusae)

Medusahead rye 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 and subbasins are thoroughly infested.

m. Moth mullein (Verbasum blattaria)

Moth mullein has started to appear as an invading species in rangeland outside of Ontario, Nyssa, and New Plymouth. It has the potential to become a serious range-land weed, displacing native species.

n. Musk thistle (Carduus nutans)

Musk thistle invades fields, and pastures, especially under conditions of heavy grazing; also forest lands, roadsides, waste lands, ditch banks, stream banks, and grain fields. Musk thistle is a vigorous biennial or sometimes annual, growing up to 6 feet or more. Musk thistle was introduced to North America in the early part of the twentieth century and is native to southern Europe and western Asia. It is spreading rapidly through the mid Snake River region. The leaves are dark green, and light green on the midribs, leaves extend onto the stem giving it winged appearance. The purple flower heads range from 1½ to 4 inch in diameter, and are slightly bent over. The flowers can vary from pink to violet and purple. It begins flowering in early June in Malheur County. This weed will only reproduce through seeds, so one way to control it is to cut young plants off just below ground level before seed set.

o. Perennial pepperweed (Lepidium latifolium)

Perennial pepperweed is a risk to the degradation of riparian areas. Perennial pepperweed is native to southern Europe and Western Asia and was found in North America in the 1940's. It can grow in a large variety of habitats but grows best in along streams and other wet areas such as ditches, roadsides, and marshes. Perennial pepperweed is a very common weed in the western states, and is difficult to control. Biocontrol agents have not been established, seed production is prolific, selective weed control is difficult, and deep seated rootstocks make the plant strongly perennial. The main way that pepperweed spreads is through root fragmentation. Perennial pepperweed flowers from early summer to fall, and the flowers appear in dense clusters.

p. Poison hemlock (Cicuta douglasii)

Poison hemlock is a highly toxic plant and commonly infests riparian areas. Poison hemlock can be mistaken for other useful and poisonous plants such as celery, parsley, sweet anise, water hemlock, and water parsnip. All parts of the plant are toxic including the large white tap root. It is a biennial native of Europe that grows 1 to 7 or more feet tall, and can be found in marshes, wet meadows and pastures, along stream banks and on roadsides. This plant has smooth stems that are swollen at the base, and are hollow with purple stripes or spots. The flowers are white, are in clusters at the top of the stem, and they look like an umbrella. The seeds are tiny and readily shatter when dried and hard.

q. Puncturevine (Tribulus terrestris)

r. Purple loosestrife (Lythrum salicaria)

Purple loosestrife is a noxious weed because it crowds out native plants and it can eventually destroy marshes and choke waterways. This beautiful noxious weed is native to Europe and was accidentally introduced to North America in the 1800s. It is a perennial wetland herb that grows along streams, farm ponds and other wet areas that have been disturbed. It can grow to 5 feet or more and blooms in June to late August with each flower having 5-7 petals. One plant can produce 300,000 seeds a year, as well as being able to reproduce by offshoots and cuttings.

s. Rush skeletonweed (Chondrilla juncea)

Rush skeletonweed has the capability to choke out native range species, decreasing range productivity and diversity. Rush skeletonweed is perennial that grows from 1 to 4 feet tall, has branching stems with dense clusters of flowers on the ends of them. It has a stiff and bare appearance looking like a skeleton, which is where it got its name. It has bright yellow flowers in mid- July, when the flowers start growing the leaves wither. On the bottom of the stem there are thin dense sharp hairs pointing down ward, and the upper stem is smooth. The plant bleeds white sap if cut, or broken. Rush skeletonweed is native to Eurasia and has invaded millions of acres in California, Idaho, eastern Washington, and Oregon. It is hard to control with herbicides because of the deep taproots, and tilling it under can spread the rootstock. It likes to grow in lighter, well drained soils and completely dominates some sites along the Boise River, choking out native vegetation. Rush skeletonweed does well on road sides, rangelands, grain fields, grasslands, open forest, and pastures.

t. Russian knapweed (Acroptilon repens)

Russian knapweed can grow aggressively, eliminating most native plants. Russian knapweed is an aggressive perennial that grows 1 to 3 feet tall, and has deep root systems, spreading rhizomes to form dense populations. This plant is native to Eurasia and was introduced near the end of the 19th century. It reproduces by root stocks and seeds, and its aggressive and deep spreading root system make it very difficult to control. It is bitter and not palatable to livestock. It flowers June through September with pink to purple or white blooms. It tolerates drought and invades hay fields, pastures, roadsides, and rangelands.

u. 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. Tamarisk has very prolific seed production and can out-compete native riparian trees and shrubs. 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.

Tamarisk was introduced to the US from Eurasia. The leaves are small and scale-like on slender stems. Stems are smooth and brown to reddish brown in color. Flowers are very small and are pink to white and have five petals. Tamarisk can develop into nearly pure stands, restricting biodiversity. Tamarisk is known to use prolific amounts of water and dry out riparian areas.

v. Scotch thistle – Onopordum acanthium

Scotch thistle is native to Europe and eastern Asia and is now naturalized in North America. Current Scotch thistle infestations in Oregon are concentrated in the eastern counties, with considerable infestation in Malheur County. It is most troublesome near the Snake River drainage. Scotch thistle can be found along roadsides, waste land areas, and lower range slopes, where there is more moisture than in surrounding range sites. Scotch thistle also invades grasslands and sagebrush communities, especially where there is disturbed soil. Scotch thistle is a biennial herb, the flowers are a pale purple to violet and sometimes reddish color. Scotch thistle flowers in mid- June through July. Leaves can occasionally get up to 2 feet long, and the plant can be from 2-10 feet tall. The leaves have tiny fine dense hairs giving it a grayish appearance.

w. *Spotted knapweed (Centaurea maculosa)*

Spotted knapweed was introduced from Eurasia as a contaminant of alfalfa and clover seed, and is native to Europe and Western Asia. It has seriously degraded much of the rangeland in western Montana. This is a biennial or short lived perennial. It can grow from 1 to 3 feet in height. Spotted knapweed plants can produce up to 1,000 seeds. It has light purple to pink flowers and blooms between June and October. It has stiff branches and resembles diffuse knapweed, although it has to have a higher level of moisture and does not spread as fast. It can be found along roadsides, waste lands and range lands. Spotted knapweed likes to establish in disturbed soil, is competitive for soil moisture and nutrients. There is a special fruit fly that has been introduced as a partial biological control, laying its eggs on the flower heads. Larvae eat the developing seeds leaving only 5-20 seeds instead of 30.

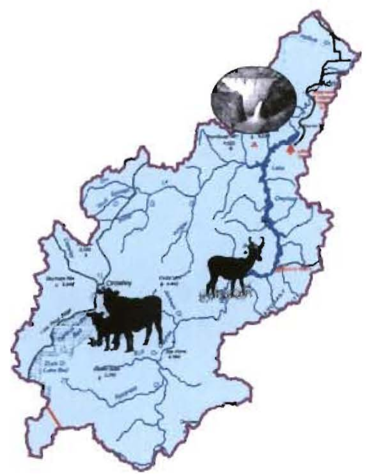
x. *Squarrose knapweed (Centaurea virgata)*

y. *White top, Hoary cress (Cardaria draba)*

Hoary cress or whitetop (Cardaria draba) is native to the Balkans, Georgia, Armenia, Azerbaijan, Turkey, Israel, Syria, Iraq and Iran. Whitetop was introduced to the U.S. by early European explorers in North America. It has since spread throughout almost the entire country. Whitetop has spread and is spreading into many of the rangelands of Malheur and Baker Counties of Oregon. 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 tillings of the soil will spread this noxious weed, and that it takes 3 consecutive years of tiling to destroy the root system. Whitetop emerges in early spring, then blooms and sets seed by mid-summer.

z. *Yellow starthistle (Centaurea solstitialis)*

Yellow starthistle is native to the Mediterranean region of Europe, but was introduced from Europe. It is wide spread in California and occurs in parts of Idaho and Washington. Many large rangeland sites have become dominated by yellow starthistle. It will grow in any type of soil and intermountain environment. It starts as a rosette and becomes a bushy annual or sometimes a biennial. Yellow starthistle can grow from 1 to 3 feet tall, and leaves and stems become covered in white cotton wool. Yellow starthistle has brilliant yellow flowers between July and September. It has rigid branches and the upper leaves are sharply pointed. The flower head can get up to 1 inch wide and is covered in needle sharp thorns. Yellow starthistle can be deadly to horses, where they contract "chewings disease", equine spongiform encephalopathy, if they are forced to eat it.



Lower Owyhee Watershed Assessment

Appendix G. Plant communities identified by different studies in the lower Owyhee subbasin.

Table 1. Plant communities or habitats found in the Owyhee Breaks in 1979 and 1980.[3]

Plant community	Approximate percentage of study area
Wyoming big sagebrush/ bluebunch wheatgrass	36
Wyoming big sagebrush/cheatgrass	16.8
Wyoming big sagebrush/Sandberg's bluegrass	21.8
Low sagebrush/bluebunch wheatgrass	4.6
Low sagebrush/Sandberg's bluegrass	8.5
Bluebunch wheatgrass	0.8
Cheatgrass	2.2
Alfalfa	0.1
Cliffrock	0.6
Gravel slopes	0.4
Low sagebrush/cheatgrass	< 0.1
Shrub scabland	6.2
Bitterbrush/grass	0.2
Stiff safebrush/Sandberg's bluegrass	0.1
Mountain mahogany/grass	1.4
Silver sagebrush	<0.1
Juniper scabland	0.3

Table 2. Plant associations found in the sagebrush steppe in the southeast portion of the lower Owyhee subbasin and adjacent area in 1962.[2]

big sagebrush/bluebunch wheatgrass
big sagebrush/bluebunch wheatgrass - Idaho fescue
big sagebrush/Idaho fescue
big sagebrush/green rabbit-brush -Thurber's needlegrass
big sagebrush/great basin wildrye
stiff sagebrush/Sandberg's bluegrass
low sagebrush/Idaho fescue
low sagebrush/bluebunch wheatgrass

Table 3. Plant associations recorded in the Dry Creek GMA of the lower Owyhee subbasin in 2006.[1]

native Wyoming big sagebrush/bluebunch wheatgrass	Wyoming big sagebrush/Sandberg bluegrass
native Wyoming big sagebrush/bunchgrass	greasewood
Wyoming big sagebrush/bluebunch wheatgrass	greasewood/cheatgrass
Wyoming big sagebrush/bunchgrass	salt desert shrub
Wyoming big sagebrush/cheatgrass	mixed shrub
Wyoming big sagebrush/native bunchgrass	

Table 4. Plant communities mentioned in the Dry Creek GMA evaluation / assessment. Bold type items are specifically mentioned as vegetation community types, the other names are referred to that way in the narrative.[1]

Native Wyoming big sagebrush/bluebunch wheatgrass range site
Native Wyoming big sagebrush/bluebunch wheatgrass range site burned in 2000
Native Wyoming big sagebrush/bluebunch wheatgrass range site dominated by annual species
Native Wyoming big sagebrush/bluebunch wheatgrass range site lacking shrubs
Native Wyoming big sagebrush/bluebunch wheatgrass range site with needle-and-thread grass
Native Wyoming big sagebrush/bluebunch wheatgrass range site with potential shrubs
- Native Wyoming big sagebrush/bunchgrass vegetation communities
- Wyoming big sagebrush/bluebunch wheatgrass

Wyoming big sagebrush/bluebunch wheatgrass range site seeded to crested wheatgrass
- Wyoming big sagebrush/bluebunch wheatgrass range site seeded to crested wheatgrass and dominated by cheatgrass and other annual species with little or no shrub overstory
- Wyoming big sagebrush/bluebunch wheatgrass range site with little loss of native species
- Wyoming big sagebrush/bluebunch wheatgrass range site with little loss of native species and near potential shrub composition
- Wyoming big sagebrush/bluebunch wheatgrass range site seeded to crested wheatgrass and dominated by cheatgrass and other annual species with little or no shrub overstory
- Wyoming big sagebrush/bluebunch wheatgrass range site with a loss of native species

Wyoming big sagebrush/bunchgrass community
Wyoming big sagebrush/bunchgrass community with cheatgrass
Wyoming big sagebrush/bunchgrass range site dominated by cheatgrass
Wyoming big sagebrush/bunchgrass range site seeded to crested wheatgrass
- Wyoming big sagebrush/bunchgrass and the annual rangeland vegetation communities
- Wyoming big sagebrush/bunchgrass range site dominated by cheatgrass and other annual species with some or no sagebrush component in the overstory

- Wyoming big sagebrush/bunchgrass vegetation communities
- Wyoming big sagebrush/bunchgrass range site, with a high occurrence of annual species including cheatgrass

Wyoming big sagebrush/cheatgrass vegetation communities

Wyoming big sagebrush/native bunchgrass community

Wyoming big sagebrush/native bunchgrass community dominated by annual species

Wyoming big sagebrush/Sandberg bluegrass vegetation communities

- Wyoming big sagebrush community
- Big sagebrush/bunchgrass community

Greasewood community

Greasewood/cheatgrass vegetation communities

Salt Desert Shrub Communities

Mixed shrub community

- Community dominated by native perennial species
- Native upland vegetation communities
- Upland rangeland vegetation communities
- Rich forb community associated with healthy perennial grasses

1. Bureau of Land Management. 2007. Dry Creek geographic management area evaluation/assessment: Malheur resource area, Vale district. Retrieved 2/19/2007. http://www.blm.gov/or/districts/vale/plans/files/vdo_plan_drycreek080306.pdf
2. 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.
3. 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.

Lower Owyhee Watershed Assessment

Appendix H. Descriptions of channel habitat types in the lower Owyhee subbasin

(From Watershed Professionals Network. 1999. Appendix III-A: descriptions of channel habitat types. *Oregon Watershed Assessment Manual.* Prepared for the Governor's Watershed Enhancement Board, Salem, Oregon)

A. Low Gradient Confined Channel (LC)

LC channels are incised or contained within adjacent, gentle landforms or incised in volcanic flows or uplifted coastal landforms. Lateral channel migration is controlled by frequent bedrock outcrops, high terraces, or hill slopes along stream banks. They may be bound on one bank by hill slopes and lowlands on the other, and may have a narrow floodplain in places, particularly on the inside of meander bends. Stream-bank terraces are often present, but they are generally above the current floodplain. The channels are often stable, with those confined by hill slopes or bedrock less likely to display bank erosion or scour than those confined by alluvial terraces.

High-flow events are well-contained by the upper banks. High flows in these well-contained channels tend to move all but the most stable wood accumulations downstream or push debris to the channel margins. Stream banks can be susceptible to landslides in areas where steep hill slopes of weathered bedrock, glacial till, or volcanic-ash parent materials abut the channel.

1 Channel attributes

Stream gradient: <2%
Valley shape: Low- to moderate-gradient hill slopes with limited floodplain
Channel pattern: Single channel, variable sinuosity
Channel confinement: Confined by hill slopes or high terraces
Oregon stream size: Variable, usually medium to large
Position in drainage: Variable, generally mid to lower in the larger drainage basin
Dominant substrate: Boulder, cobble, bedrock with pockets of sand / gravel / cobble

2 Channel responsiveness

The presence of confining terraces or hill slopes and control elements such as bedrock limit the type and magnitude of channel response to changes in input factors. Adjustment of channel features is usually localized and of a modest magnitude.

a. Large woody debris: low to moderate

In larger forested basins, wood numbers are often low in this channel type. This may be in part due to land management activities, but these channels usually display sufficient energy to route wood downstream. Also, limited lateral movement of the channel reduces the recruitment of wood from bank erosion. Wood is often present in jams or as large single pieces capable of withstanding high energy flows. Even in streams of this channel type that are smaller and display less energy, wood may be routed or retained above the elevation of the bankfull channel, where it has limited impact on aquatic habitat.

b. Fine sediment: low

The confining nature of the landforms that define this channel type tends to focus enough stream energy to route most introduced fine sediment downstream. In basins with high background sediment levels, such as sand and siltstone-bedded channels in the Coast Range, supply may approach or surpass transport capacity, resulting in pool filling and **bed fining**.

c. Coarse sediment: moderate

These channels can be depositional areas for coarse sediment. When the supply of coarse sediment surpasses the transport capabilities of the stream, pools are filled, and the influence of large boulders, wood, and bedrock control structures is lessened. If significant amounts of large sediment are added, the channel is particularly vulnerable to widening, lateral movement, sidechannel development, or scour.

d. Peak flows: low to moderate

These channels have limited floodplain, and are capable of passing most high flows without adjustments to the overall dimensions of the channel. Development of point or medial bars is likely in basins with high sediment loads. Localized bed or bank scour is possible on bends in the main channel.

3 Riparian enhancement opportunities

These channels are not highly responsive, and in channel enhancements may not yield intended results. In basins where water-temperature problems exist, the confined nature of these channels lends itself to establishment of riparian vegetation. In nonforested land, these channels may be deeply incised and prone to bank erosion from livestock. As such, these channels may benefit from livestock access control measures.

B. Low Gradient Moderately Confined Channel (LM)

These channels consist of low-gradient reaches that display variable confinement by low terraces or hill slopes. A narrow floodplain approximately two to four times the width of the active channel is common, although it may not run continuously along the channel. Often low terraces accessible by flood flows occupy one or both sides of the channel. The channels tend to be of medium to large size, with substrate varying from bedrock to gravel and sand. They tend to be slightly to moderately sinuous, and will occasionally possess islands and side-channels. Because of the difficulty in assessing the degree of confinement and the height of stream-bank terraces from maps or air photos, these channels are often misidentified as LC channels unless field-checked.

1 Channel attributes

Stream gradient: <2%
Valley shape: Broad, generally much wider than channel
Channel pattern: Single with occasional multiple channels
Channel confinement: Variable
Oregon stream size: Variable, usually medium to large
Position in drainage: Variable, often main-stem and lower end of main tributaries
Dominant substrate: Fine gravel to bedrock

2 Channel responsiveness

The unique combination of an active floodplain and hillslope or terrace controls acts to produce channels that can be among the most responsive in the basin. Multiple roughness elements are common, with bedrock, large boulders, or wood generating a variety of aquatic habitat within the stream network.

a. Large woody debris: moderate to high

In forested basins, wood alone or in combination with other elements is associated with pool formation and maintenance, bar formation, and, occasionally, side-channel development. These channels may have relatively low wood numbers due to past management activities.

b. Fine sediment: moderate to high

The location of these channels often dictates a high sediment input to the stream. These channels can be sediment deposition zones for larger particles, although a significant portion of the fine sediment may be transported, particularly in bedrock channels. Increases in fine-sediment supply will likely result in filling of margin pool and bed-fining of side-channels and low-velocity areas. Decreases in sediment supply may induce scour in nonbedrock channels or localized bank erosion.

c. Coarse sediment: moderate to high

These channels are depositional areas for coarse sediment. When the supply of coarse sediment surpasses the transport capabilities of the stream, pools are filled, and the influence of large boulders, wood, and bedrock control structures is lessened. If significant amounts of large sediment are added, the channel is particularly vulnerable to widening, lateral movement, side-channel development, and localized scour.

d. Peak flows: moderate

These channels are capable of passing most high flows without adjustments to the overall dimensions of the channel. Development of point or **medial bars** is likely in basins with high sediment loads, as is side-channel development. Localized bed or bank scour is possible on bends in the main channel.

3 Riparian enhancement opportunities

Like floodplain channels, these channels can be among the most responsive of channel types. Unlike floodplain channels, however, the presence of confining landform features often improves the accuracy of predicting channel response to activities that may affect channel form. Additionally, these controls help limit the destruction of enhancement efforts common to floodplain channels. Because of this, LM channels are often good candidates for enhancement efforts.

In forested basins, habitat diversity can often be enhanced by the addition of roughness elements such as wood or boulders. Pool frequency and depth may increase, and side-channel development may result from these efforts. Channels of this type in nonforested basins are often responsive to bank stabilization efforts such as riparian planting and fencing. Beavers are often present in the smaller streams of this channel type, and fish habitat in some channels may benefit from beaver introduction through side-channel and scour pool development. Introduction of beavers, however, may have significant implications for overall channel form and function, and should be thoroughly evaluated by land managers as well as biologists as a possible enhancement activity.

C. Low Gradient Large Floodplain Channel (FP1)

FP1 channels are lowland and valley bottom channels of large watersheds. They may also occupy uplifted estuaries along the coast. Normally, these channels have extensive valley floodplains and river terraces. Sloughs, **oxbows**, wetlands, and abandoned channels are common in large river corridors. Smaller tributary streams may flow through channels abandoned by the main river. Numerous overflow **side-channels**, extensive gravel bars, avulsions, and log jams in forested basins are characteristic. They may be bordered on one bank by steep bluffs, marine terraces, or gentle slopes.

These channels function as sediment deposition systems, with short-term storage of fine sediment. Fines are typically mobilized during most high-flow events. Small side-channels dissecting the floodplain are common. In-channel wood accumulations are less stable than in smaller floodplain channels due to higher flood flows and greater channel width. Historically, many of these channels that drained forested areas contained significantly more wood than observed today.

1 Channel attributes

Stream gradient: $\leq 1\%$

Valley shape: Broad valley, floodplain
Channel pattern: Sinuous, single to multiple channels
Channel confinement: Unconstrained
Oregon stream size: Large
Position in drainage: Bottom, low in drainage
Dominant substrate: Sand to cobble

2 Channel responsiveness

Floodplain channels can be among the most responsive in the basin. The limited influence of confining terrain features and fine substrate allows the stream to move both laterally and vertically. Although often considered low energy systems, these larger channels can mobilize large amounts of sediment during high flows. This often results in channel migration and new channel formation.

a. Large woody debris: moderate to high

Because of the great stream power, only large pieces or accumulations of pieces are likely to impact overall channel conditions. The role of wood and the amount and distribution of pieces is highly variable over time, as high flows regularly change conditions. Single pieces are likely to be associated with pools in sidechannels and localized sediment depositions. Accumulations of wood are often responsible for the creation of midchannel bars and sidechannel development.

b. Fine sediment: moderate

Fine sediment is easily mobilized by most of these channels. Increases in the supply of fines may cause temporary storage and pool filling, but moderate to high flows will mobilize the majority of the sediment. Deposition may be more permanent in smaller side-channels, and pool filling and minor shifts in side-channel location could occur.

c. Coarse sediment: high

Floodplain channels are generally depositional areas for coarse sediment. When the supply of coarse sediment surpasses the transport capabilities of the stream, the channel is particularly vulnerable to widening, lateral movement, side-channel development, and **braiding**. Overall aquatic habitat complexity is reduced as pools are filled and obstructions such as large boulders or bedrock outcrops are buried.

d. Peak flows: low to moderate

Large floodplain channels are usually capable of transporting high flows with a minimum of alteration to the primary physical characteristics of the channel. Flows tend to spread out across the valley rather than cause streambed scour. Localized bank erosion is expected as new channels are developed.

3 Riparian enhancement opportunities

Due to the unstable nature of these channels, the success of many enhancement efforts is questionable. Opportunities for enhancement do occur, however, especially in channels where lateral movement is slow. Lateral channel migration is common, and efforts to restrict this natural pattern will often result in undesirable alteration of channel conditions downstream. Smaller sidechannels may be candidates for efforts that improve shade and bank stability, but it is likely that these efforts may be more beneficial and longer-lived elsewhere in the basin.

D. Moderately Steep Narrow Valley Channel (MV)

MV channels are moderately steep and confined by adjacent moderate to steep hill slopes. High flows are generally contained within the channel banks. A narrow floodplain, one channel width or narrower, may develop locally. MV channels efficiently transport both coarse bedload and fine sediment. Bedrock steps, boulder cascades, and chutes may be common features. The large amount of bedrock and boulders create stable streambanks; however, steep side slopes may be unstable. Large woody debris is found commonly in jams that trap sediment in locally low-gradient steps.

1 Channel attributes

Stream gradient: 4-8%, may vary between 3 to 10%
Valley shape: Narrow, V-shaped valley
Channel pattern: Single channel, relatively straight similar to valley
Channel confinement: Confined
Oregon stream size: Small to medium
Position in drainage: Mid to upper
Dominant substrate: Small cobble to bedrock

2 Channel responsiveness

The gradient and presence of confining terraces or hill slopes and control elements such as bedrock substrates limit the type and magnitude of channel response to changes in input factors. Adjustment of channel features is localized and of a minor magnitude.

a. Large woody debris: moderate

In larger forested basins, wood numbers are often high in this channel type. Wood is present in jams or as single pieces capable of withstanding high-energy flows. Large woody debris may be the primary element responsible for pool formation and development. In bedrock systems, wood has less influence, and is often transported downstream.

b. Fine sediment: low

The confining nature of the landforms and the higher gradients combine to produce enough stream energy to route most introduced fine sediment downstream. Filling of lateral pools and lower energy areas may result from increases in the sediment supply.

c. Coarse sediment: moderate

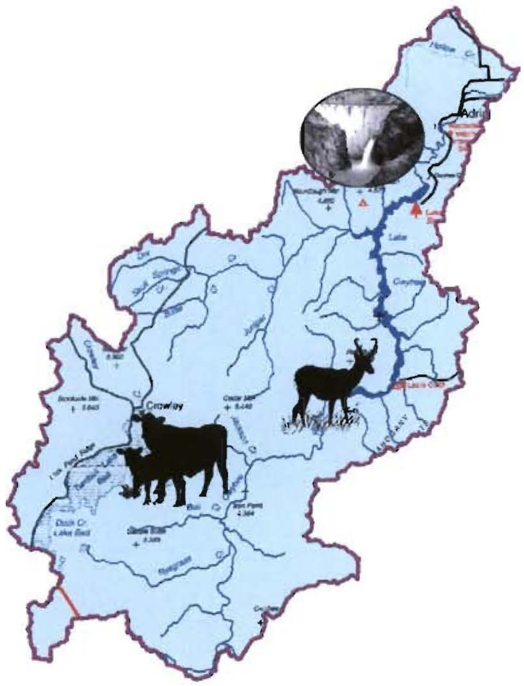
These channels are usually transport reaches for coarse sediment, although lower-energy sections can retain sediment and adjust channel dimensions. When the supply of coarse sediment surpasses the transport capabilities of the stream, pools are filled, and the influence of large boulders, wood, and bedrock control structures is lessened.

d. Peak Flows: Moderate

These channels have limited floodplain, and are capable of passing most high flows without adjustments to the overall dimensions of the channel. Development of point or medial bars is likely in basins with high sediment loads. Localized bed or bank scour is possible on bends in the main channel.

3 Riparian enhancement opportunities

These channels are not highly responsive, and in channel enhancements may not yield intended results. Although channels are subject to relatively high energy, they are often stable. In basins where water-temperature problems exist, the stable banks generally found in these channels lend themselves to establishment of riparian vegetation. In nonforested land, these channels may be deeply incised and prone to bank erosion from livestock. As such, these channels may benefit from livestock access control measures.



Lower Owyhee Watershed Assessment

Appendix J. Data Gaps and Unknowns

Appendix J. Data gaps and unknowns

Many of the currently identified unknowns, or data gaps, have been enumerated in the other sections of this assessment. Some of them are reiterated or summarized below.

A. Hydrology

There is data missing for the lower Owyhee subbasin which is available for most of the United States. There are no soil studies except for the irrigated lowlands, no mapping of groundwater aquifers, and no data for water infiltration rates, key variables for hydrology.

The mapping of vegetative coverage is basic: it is mixed sagebrush shrubland and grass.

There has been no ground verification of which streams are ephemeral, intermittent or perennial. The three types can not be looked at in the same fashion when considering if any remediation is feasible.

What were the natural patterns of flows in the lower Owyhee River before construction of the dam?

The specific figures for the percentages that evapotranspiration, runoff, groundwater recharge, and change in soil water contribute to the fate of precipitation in the lower Owyhee subbasin are not available.

There is no data for the lower Owyhee subbasin on how much runoff will occur with rain events of different intensities and on the different soil types.

Although figures for the percentage of precipitation intercepted by different types of canopy covers are available for other areas, interception data has not been developed for the local region.

The soils for most of Malheur county have not been mapped. Without knowing the types of soils in the lower Owyhee subbasin, it is difficult to estimate the maximum infiltration rate and the percentage of rain that could be infiltrated.

There has been no mapping of groundwater reserves or calculation of groundwater recharge for the lower Owyhee subbasin.

How do different land uses in the lower Owyhee subbasin affect spring flows, runoff, and aquifer recharge? The mapping of vegetative coverage is basic: it is mixed sagebrush shrubland and grass.

How does juniper expansion impact watershed function and water resources? How does it affect the water balance? Does it increase surface runoff and erosion? Are stream flow and spring flow affected? Does water extraction by juniper reduce aquifer recharge and stream flow?

What are the real flood risks in the lower Owyhee subbasin? How often will the Owyhee River upstream from the dam scour the banks of all vegetation including trees?

What are potential peak flows and low flows in the Owyhee River? What have they been over the last 1000 years? The typical condition for this ecoregion is that the maximum peak flow in each drainage is vastly greater than the average flows and average flows are much larger than the minimum flows.

What is the frequency of large rainfall or rainfall on snow events which would fill Owyhee Reservoir and then exceed the capacity of the Owyhee Dam glory hole?

Rainfall estimates only model rainfall between one point in the subbasin and stations surrounding it. These models are probably only somewhat accurate and give no idea of any local conditions that differ.

Are there locations within the lower Owyhee subbasin where precipitation exceeds or is much lower than that predicted by models?

B. Irrigated Agriculture

1. Future uncertainties

a. Water availability and competition for water

Water is the grower's second most important resource behind the land itself. Some years there is a serious irrigation water shortage due to nature's unpredictable ways. However, the growers in the lower Owyhee subbasin also face increasing pressure to restrict their water use so that it can be used for other purposes.

With the current power crises, there may be more and more pressure applied to use the water for power generation. Increased demands for water in the cities of the deserts of Nevada may place pressure upstream to divert water from the upper reaches of the Owyhee to uses in Nevada. There may be pressure to release water for endangered species such as salmon.

A Bureau of Reclamation (BOR) study concluded that "based on the historical period of record (1939-1992), the Owyhee River basin above Owyhee Reservoir would yield no additional water for storage in over 50 percent of the years." Although the study was conducted to see if increased storage in Owyhee Reservoir would be a potential source of water for flow augmentation in the lower Snake River for salmon, the conclusion that extra "water would be available . . . only in good water years," means that any allocation for other purposes would remove water from that available to irrigated agriculture in the lower Owyhee subbasin and other areas benefiting from this irrigation water.

Growers have made and are making many changes to conserve water. These changes will help cushion the effect on irrigated agriculture from drought years. These changes can not generate a reliable source of water for allocation to other uses. Any allocation for other purposes would be detrimental to the health of irrigated agriculture in Malheur County.

b. Population growth

Reallocation of land in Malheur County to residential and industrial purposes will have a concomitant reallocation of water away from agriculture.

c. Regulations

Since the water which growers use contains more nutrients and has a higher temperature than is allowed by the Total Maximum Daily Load (TMDL) to return to the Snake River, once this water is used of farms it will continue to exceed TMDL parameters for the Snake River. To reduce or eliminate water run off from farm ground, vast capital investments in irrigation are being required by the Oregon Department of Environmental Quality and the Environmental Protection Agency.

d. World economy

US policy is global free trade without consideration of whether trade ferms are fair. Other trading partners often establish non-tariff barriers that greatly restrict the movement of US products to other countries. It is not known if the US will continue these practices that are unfair to US producers.

The US allows the importation of goods produced with low standards of environmental protection, of labor protection and benefits, of permitted pesticide use, etc. to compete freely with US goods conforming to all US regulations. It is not known if the US will continue these practices which place US producers at an unfair disadvantage.

C. Recreation

The real costs of recreational use of the lower Owyhee subbasin to local governmental bodies is unknown. What are the costs associated with recreational use by individuals from outside the county to the Malheur County sheriff's office? To the Nyssa Road District?

How will the increasing population of the Boise metropolitan area affect the level of use of the lower Owyhee subbasin?

Is there adequate monitoring of the wild and scenic river corridor to ensure that improper use of some areas will not result in those areas becoming off limits to rafters?

Are there adequate resources and administrative concern to ensure that weeds that are introduced and expanding in the area do not end up compromising the values of the area?

Are private float parties bringing all their refuse out of the canyon?

How will the continued encroachment of tamarisk along the lower Owyhee River interfere with the vegetation needed for the insect life which provides food for the fish in the cold water fishery below the dam. The disturbance in the food chain could affect the availability of fish for fly fishing.

How would the potential wild and scenic river designation of the lower Owyhee River for recreational purposes affect the ability to maintain access through the river corridor to the recreational activities at Owyhee Reservoir?

How would the potential wild and scenic river designation of the lower Owyhee River affect the ability to quickly gain access for maintenance or repairs on Owyhee Dam by enlarging the roadway to support heavy construction equipment and supplies?

Is better collection of trash and garbage needed along the lower Owyhee River below the dam.

Will the designated camping facilities at Leslie Gulch be adequate to accommodate increased recreational use?

How can operators of OHVs be made aware of which routes are acceptable for use of OHVs?

Do recreational uses of the lower Owyhee subbasin contribute to the spread of noxious weeds?

D. Wildlife

What are the forage preferences of different wildlife species? How do forage preferences for each specie differ by time of year. What forage is used by bighorn sheep, by deer, by pronghorn?

Do wild horses compete with bighorn sheep forage preferences?

Are wild horses competing with cattle for forage? What are the effects of wild horse populations being maintained within the BLM targets? What are the effects of wild horse populations exceeding BLM targets?

What specific ranching practices will improve rangeland forage production? How can cattle grazing improve forage for wildlife? When will grazing of grasses encourage the growth of forbs? How can cattle grazing be used to stimulate the growth of winter forage? Can cattle grazing be used to control invasive species that out-compete the forbs necessary in wildlife diets?

What types of shelter do different types of wildlife need? Bands of shrub vegetation, rocky areas?

Is competition for natural resources limiting the reproductive capabilities of rangeland species?

We know little about the ecology of free ranging horses. Is the BLM managing to keep horse stocking rates within the parameters they have set? How often should wild horses be gathered?

How many cougar are actually in the lower Owyhee subbasin?

At what level does the cougar population significantly affect wildlife populations? Ranching?

What levels of coyotes pose a problem? What types of control programs might be necessary?

Are enough of the range fences adapted for the passage of pronghorn?

Do fences interfere with the movement of bighorn sheep?

Ground studies are needed to verify the GAP program database.

What, if any, is the magnitude and nature of grazing's influence on Columbia spotted frogs?

What is the occurrence of nonnative animal species within the lower Owyhee subbasin?

How are wildlife populations being influenced by the expansion of weeds? Are restrictions on weed control placed on BLM past lawsuits having unintended negative effects on the native food supplies required by native wildlife?

E. Riparian / Wetlands and Channel Habitat Type

How will the expansion of tamarisk into many of the riparian areas of the lower Owyhee subbasin affect the hydrology of the area. How does the hydrology impact native riparian vegetation?

Where are the true riparian areas in the lower Owyhee subbasin? What are their characteristics?

What is the potential of riparian areas in the lower Owyhee subbasin based on physical, biological, and chemical conditions? The site specific physical, biological, and chemical condition of riparian areas has not been surveyed.

No study has identified the riparian areas on private lands.

The relative impact of different uses of riparian areas in the lower Owyhee subbasin is not known. What impact do river rafters have on riparian areas? There are limited camping areas along the Owyhee River corridor and these tend to be in riparian areas.

What are the actual impacts of livestock on riparian areas?

What are the affects on the riparian vegetation and functioning of increased traffic and fishing on the Owyhee River below the dam?

How can grazing systems be used to accomplish such goals as maintenance of woody streambank vegetation and the prevention of bank crumbling and soil compaction? What management will result in maintaining, restoring, improving, or expanding riparian areas in the lower Owyhee subbasin?

No channel habitat studies have been conducted in the lower Owyhee subbasin.

1. Channel Modification Assessment

Would the removal of the old railroad bridge between Owyhee corner and the Snake River decrease flooding upstream?

Did removing water access to the old Owyhee slough increase flooding upstream?

2. Sediment Sources Assessment

The sources of water entering the rivers in the lower Owyhee subbasin have not been delineated. In addition, the amount of sediment carried by runoff and streams varies based upon the source. This is a data gap.

Erosion on rangeland has not been scientifically studied in the lower Owyhee subbasin.

a. Questions that need to be answered about soil losses

How much vegetation is needed on the rangeland to avoid erosion related to thunderstorm events? Do different types of vegetation have different amounts of sediment losses?

What is the difference in sediment loss between rangeland on a flat plain and that on the slope of a hill? How does grazing affect sediment losses?

How is the amount of soil erosion changing with the invasive species? With juniper cover?

How much vegetation is needed along a stream bank for stabilization? What species of vegetation that are adapted to local environmental conditions would grow in these places?

What types soils in the Lower Owyhee subbasin are most susceptible to erosion?

To what extent are soil losses following wildfires and controlled rangeland burning problems?

There is no survey of locations within the lower Owyhee subbasin with erosion or any idea whether the erosion occurs naturally or is caused by anthropomorphic activities. Only the latter would be amenable to remediation. Naturally occurring erosion has been responsible for much of the beauty and incredible landscape of the lower Owyhee subbasin.

F. Fish and Fish Habitat Assessment

Most of the habitat data for fish species is from generalized data for the United States since specific information on adaptations within the lower Owyhee subbasin is not available.

What types of interactions are there between species of fish in the lower Owyhee subbasin? What is the distribution of each specie within the lower Owyhee subbasin?

What are the populations and fluctuations of populations of non-game fish in the subbasin?

How do the native non-game fish fit ecologically into the food webs in the lower Owyhee subbasin?

How do introduced fish compete for food and habitat with the native fish?

The nonnative European brown trout was originally introduced partially as a predator on nongame fish populations below the Owyhee Dam. What would be the effect of eliminating non-game fish in this area?

What effects are the hatchery trout stocked into ponds in the lower Owyhee subbasin having on the native redband trout populations? What effects are the nonnative trout stocked into the upper basin in Idaho and Nevada having on the population of native redband trout in the Owyhee basin including the lower Owyhee subbasin area? Is the genetic composition of native redband trout changing?

What are the effects of introduced warmwater game fish on native redband trout in the lower Owyhee subbasin?

What habitat restrictions on the abundance of redband trout are due to natural causes? What is the native thermal potential of streams? How does this affect the distribution of inland redband trout populations?

Have there been increases in riparian vegetation due to impoundment decreases of flows? Has there been removal of riparian vegetation which has allowed water temperatures to increase? Does the addition or elimination of riparian vegetation affect redband trout?

Are stream banks where riparian vegetation has been removed less stable and apt to flush more sediment into streams during high water events? Are stream banks where riparian vegetation has been added more stable and less apt to flush sediment into streams during high water events? How would more or less sediment in the streams affect the redband population?

Do mountain whitefish exist in the lower Owyhee subbasin? Just about everything is unknown about this species.

Are smallmouth bass and channel catfish in the Owyhee River upstream of the reservoir having an adverse impact on this population of native fish by predation or competition for food?

What effect does the reputation that the fishery below the dam is gaining outside the local area have on the local area? What are the potential impacts of increased use of this artificial recreational fishery? What are the peripheral social impacts of the fishery as the population in the Boise metropolitan area grows? What percentage of the anglers are from Idaho?

How do recreational fishermen affect the presence of different species of fish?

What impacts will very large (24 inches or 5 pound) brown trout have on the recruitment of rainbow trout?

What impacts are brown trout having on the native populations of amphibians?

What would the impacts be on other salmonid species if brown trout were flushed downstream by a major flood event? Could they pass downstream over the Hells Canyon complex of dams? Would the brown trout go upstream on the Boise and Payette Rivers?

What is the effect of Lahontan tui chubs in the Owyhee Reservoir? They may favor bass populations.

What would be the effect on fish species both in the Owyhee Reservoir and in the Owyhee River below the dam of future potential demands for salmon flush flows. How would it affect spawning and populations?

Why is there a high mortality of smallmouth bass in some years?

What are the interactions between different warm water fish? How does an increase in the catfish population affect the native warmwater fishes? What effect does it have on the other warmwater game fish? What fish do catfish compete with for food and habitat?

G. Water Quality Assessment

1. Mercury

No comprehensive survey has been done to locate possible sources of mercury in the lower Owyhee subbasin. There are large areas of the basin have not been sampled. There is virtually no information on mercury in the groundwater. Although geothermal wells and springs have been documented, there is a scarcity of data to indicate the possible influence of mercury in the hydrologic system of the basin. Similarly, the data is inadequate to characterize the effect of the hydrologic system on mercury.

Likewise, a comprehensive survey would be needed to identify geologic locations in the lower Owyhee subbasin that have mercury concentrations which might contribute to mercury in the river system if they were disturbed naturally or by human activities. There are localized geologic sources of mercury and elevated mercury concentrations have been observed in volcanic rock located near Lake Owyhee. Some of the richest mercury deposits in the US are located just south of the Owyhee watershed at McDermitt, NV.

Past studies have positively identified the Silver City area as a source of mercury. Follow up studies are needed to characterize mercury sources, concentrations and distribution in the Silver City area. Delineating the distribution and concentration of mercury is essential if action to remediate at these sites is to be taken. Site characterization would establish a baseline for comparison with future monitoring efforts, both in the Silver City area and in downstream areas.

We do not know how long it would take for the mercury from Silver City that is already in the river system of the basin to dissipate if the Silver City site were cleaned.

To better understand mercury in the Owyhee River ecosystem, there need to be studies of the mixing and transport hydrodynamics of Lake Owyhee, and stratification of the reservoir during autumn, winter, and mid-summer. Remobilization of mercury to water from lake bottom sediment has not been studied

2. Temperature

The physics involved in stream heating are not utilized in ODEQ's water temperature standards.

In the lower Owyhee subbasin, the relative contribution to stream heating from solar radiation, from the air and from the ground have not been described . The cooling effects of the existing shading of the streams from the canyon walls has not been estimated. The effect of evaporative cooling from the surface of the river on the water temperature has not been estimated. None of these parameters have been measured in the lower Owyhee subbasin. There is a lack of good stream temperature science to realistically consider the thermal potential of the Owyhee River and tributaries.

Thermal refugia (places to hide and hang out) have not been mapped in the lower Owyhee subbasin. Refugia might allow fish species to survive where the general temperature of the stream waters is above the specie's preferred habitat.

3. Baseline data

In the lower Owyhee subbasin below the dam there have been significant changes in agricultural practices, covered in the section on agriculture, which have led to less sediment and nutrients returning to the stream system from agricultural land. There is a need to analyze stream data and return flow data collected in the past to establish baseline conditions. Data was collected from 1978 to 1980 when the Malheur County Court recognized a possible problem with non-point source pollution and evaluated water quality. However, changes in agricultural techniques began before this with laser leveling and concrete ditches decades ago. Innovations continue being made today with the adoption of many advanced practices. Accurate current data needs to be generated to provide a snapshot of the results of changes which have already taken place. Current data needs to provide an accurate mid-point baseline for evaluating changes in the future.

4. Generalizing from other situations

It is inappropriate to generalize water quality criteria with sweeping prescriptions for all sites. The complexity of the natural world requires site-specific criteria based on the nature of each site and the uses appropriate and economically feasible at that site. The continual variation of geology, soil, slope, plant and animal communities, and other environmental features impose fiscal, biological, and practical constraints on potential beneficial uses.

H. Rangeland

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.

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.

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.