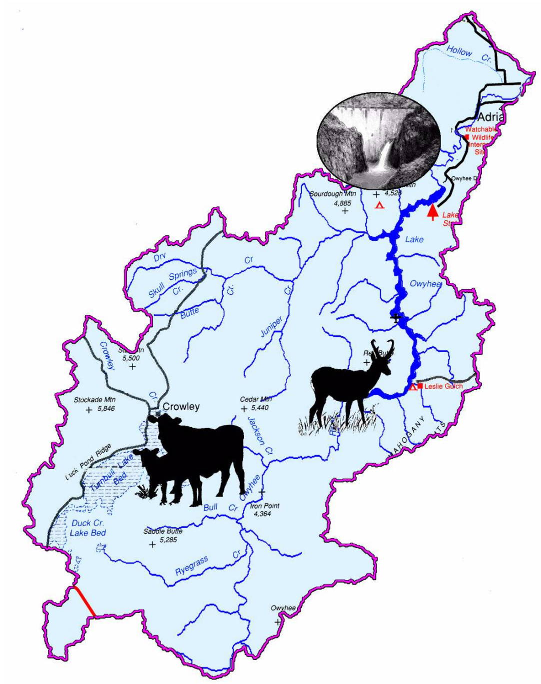

Lower Owyhee Watershed Assessment

XI. Riparian/wetlands and channel habitat type

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XI. Riparian/wetlands and channel habitat type

A. Riparian

1. What is a riparian zone?

A riparian zone is an area that supports vegetation requiring more moisture than the adjacent uplands. In arid and semiarid regions, riparian areas exist in the narrow strip of land along the borders of creeks, rivers, or other bodies of water where surface water influences the surrounding vegetation.[3,8,10,16]

Riparian ecosystems exist between the uplands where there is seldom standing water and the stream, river, or lake where free flowing or standing water is common. Riparian zones have nearly unlimited variations in hydrology, soil, and vegetation types. There are different interactions between the topography, soil, geology, elevation, hydrology, vegetative cover, evapotranspiration, animal use, and alterations by people. Consequently riparian zones vary considerably and may be difficult to delineate.[3,8,11,15,16]

Because of the proximity of riparian zones to water, the plant species are considerably different from those of the drier surrounding areas (Figure 11.1). Riparian zones are generally more productive in terms of plant biomass and are a critical source of diversity in rangelands. They create well-defined habitat zones but make up a minor proportion of the overall area in arid-land watersheds. Riparian plant communities are disproportionately important in southeastern Oregon and the lower Owyhee subbasin, but there is "probably less known about them"[3] than other plant communities. They represent an extremely significant component of the overall landscape although less than 0.5% of eastern Oregon rangelands are occupied by riparian areas (Figure 11.2).[3,8,10,11,12]

Figure 11.1. Photo along the Owyhee River in the lower Owyhee subbasin showing how riparian vegetation is very different from the surrounding upland vegetation.

2. Why are riparian areas important?

The vegetation in riparian areas affects the hydrology of the ecosystem. During high stream flows, water can be stored in the adjacent soil and in ponds, lessening the destructive effects of downstream flooding. The stored water can be a source of groundwater recharge, helping maintain stream flows later into the season.[8,15]

Stream banks with well developed riparian vegetation are less prone to erosion. The roots of riparian vegetation stabilize the soil. Water slowed by riparian vegetation has less power to erode the stream bank. Also, slower water will carry less sediment and sediments from floodwaters may be deposited in riparian vegetation.[8]

Riparian vegetation filters water both before and after it reaches a stream, removing sediments and nutrients, providing clean water and building up the soil.[8,11]

Abundant forage, water, and wildlife habitat attract a greater amount of use of riparian zones than proportional for their small land area. In addition to providing habitat for fish and wildlife, riparian areas in eastern Oregon provide scenic beauty. They are disproportionately important for many other uses (Figure 11.3). They provide opportunities for hunters, fishermen, and birdwatchers. Recreationists concentrate their use in and along such areas. Riparian zones tend to have relatively gentle topography which makes them attractive locations for roads. Frequently, stream margins are highly productive forage sites. Cattle concentrate in riparian areas not only to drink, but because of the shade, relatively gentle topography and vegetation that remains green after upland forage dries.[8,11,12,16,17]

Figure 11.2. Riparian vegetation at Hole in the Ground restricted by annual scouring and limited soil.

3. Importance to wildlife

The riparian zone is the most important wildlife habitat type in managed rangelands and is used more than any other type of habitat. Of course aquatic species such as fish and amphibians use the water in these zones, but many other semi-aquatic animals, such as waterfowl and muskrats, are found only in riparian zones. Riparian areas are critical to the life cycles of many other wildlife species.[8,12]

Stream side vegetation is also extremely important in the food chain. The organic detritus is a food source for aquatic organisms. The vegetation is an important habitat for terrestrial insects that form part of the diet of many bird and fish species.[8]

In southeastern Oregon 80% of non-bird wildlife species are directly dependent on riparian zones or use these areas more than other habitats.[11] Wildlife

Figure 11.3. There are many different uses for riparian zones. Owyhee Watershed Council 5th grade field day, 2005.

habitat consists of food, cover, and water. Riparian areas offer water. Many riparian zones also provide an unusually large part of forage for big game as well as livestock.[12]

Because riparian zones are a transitional zone, there are often several changes in vegetation between the wetland and the land with no subsurface water. This provides a number of different microhabitats so that there is a large diversity of breeding and forage sites. Some of these microhabitats tend to be more humid with more shade. Some wildlife species including deer and elk are attracted by the microclimate produced by the vegetation.[8,12,15]

Every riparian zone has different site attributes, but riparian zones are important to wildlife for many reasons.

4. Vegetation

Riparian plant communities are complex and highly variable in structure, number of species, species composition, productivity, and size. Plant species adapted to the upland may be unable to grow near river channels because they can't tolerate continuously wet soil and similarly species adapted to the river environment usually will not tolerate drier, less frequently flooded sites. Many riparian species must tolerate complete inundation some years or soil that may dry out completely other years, and sometimes both within the same year. [3,6,11,16]

Streams vary considerably over the course of a year and from year to year. Vegetation in riparian zones is even more variable than streams. There is not only a greater availability of water to plants, but frequently there are deeper soils. This leads to a great diversity of plant species. Riparian communities include many combinations of grasses, forbs, shrubs, and even trees. The density of the vegetation varies considerably. In similar environmental settings in southwestern Idaho at least 34 different riparian plant communities have been identified.[2,3,5,6,11,12]

Willows are the common woody riparian species in the lower Owyhee subbasin. The coyote willow (Figures 4.3 and 11.4) is an upright, deciduous shrub which is generally about 12 feet tall and about 15 feet wide. It grows along creek bottoms, both on the shoreline and sometimes in the water. Coyote willow forms dense thickets of pure, even-aged shrubs. Short-lived, they are threatened by both fire and drought. They can not survive long if the water table becomes too low.[21,22] Sedges and rushes are common herbaceous riparian species.

These species are well adapted to riparian areas. Numerous growing points and stems allow water to flow through a plant. A high density of roots or underground stems (rhizomes) which form a dense mat protect the stream bank from erosion and contribute to steam bank stability during high water.[2,11,15]

The dramatic contrasts between the plant communities of the riparian zone and the general surrounding upland range vegetation adds to the visual appeal.

Figure 11.4. Willows growing in Three Fingers Gulch in the lower Owyhee subbasin.

5. Proper functioning

A properly functioning riparian area will have adequate vegetation to filter sediment, to stabilize the stream bank, to protect the stream bank from erosion, to store and release water, and to recharge the aquifer. A properly functioning riparian area along a perennial stream would result in some of the following characteristics: late summer stream flows, high forage production, good water quality, and vegetation and roots that protect and stabilize the banks. It would provide shade, cooler water, good fish habitat, and a high diversity of wildlife habitats.[1,7,10]

6. Fragility

Since riparian zones occupy relatively small areas, they should be considered vulnerable to severe alteration. The distinctive vegetative community is important to the ecology of the whole region. There are many activities that can impact riparian areas.[1,12,16]

Indiscriminate recreational use can seriously disturb or destroy habitat in riparian zones. In riparian zones, recreational use per unit area is many times that for other vegetative communities.[1,12] The authors of this assessment has seen all terrain vehicle (ATV) damage in the riparian area along the Owyhee River in an area closed to ATVs. Campgrounds in riparian zones increase the opportunity for viewing wildlife but decrease the effectiveness of the riparian zone as wildlife habitat due to the "disturbance by humans, trampling, soil erosion, compaction, and loss of vegetation."[12]

Figure 11.5. Cattle in a riparian area in the lower Owyhee subbasin.

Figure 11.6. Bank erosion along a riparian area in the lower Owyhee subbasin.

The increased presence of vehicles and people on existing roads along riparian zones affects how wildlife use the area. New road construction in riparian zones will alter the size of the zone and of the vegetative community. It may impact water quality and alter the microclimate, destroying wildlife habitat. Road maintenance can disturb riparian areas.[1,12]

The U.S. Forest Service has identified the major factors affecting riparian areas in the Owyhee River basin as livestock grazing, floods, and dams.[16] There are some areas of the lower Owyhee subbasin where livestock grazing continues to affect riparian areas (Figure 11.5). Continuous or intensive grazing of riparian zones may alter vegetation with a reduction in plant productivity, a change in the plant community, or the encroachment of dry land vegetation. The change may result in a lack of adequate vegetation for bank protection and sediment filtering. The resulting erosion may lower the streambed and change the adjacent water table. Cattle in an eroded streambed may create further bank erosion with "hoof shear" (Figure 11.6).[1,3,12,15]

Management actions such as fire suppression may also alter riparian areas.[15]

7. Riparian areas in the lower Owyhee subbasin

Figure 11.7 shows riparian areas in the lower Owyhee subbasin identified by the Bureau of Land Management (BLM) in the Southeastern Oregon Regional Management Plan [1] and a few other known riparian areas. No study has identified the riparian areas on private lands.

There are probably other small riparian areas in the lower Owyhee subbasin which are not mapped. However, since riparian areas only exist where there is some connection to the water table, these will primarily be along perennial streams (see figure 5.7 in the hydrology component of this assessment). Some intermittent streams, such as Dry Creek, may also have riparian areas. However, the majority of the non-perennial stream reaches in the lower Owyhee subbasin have not been evaluated as to whether they are ephemeral or intermittent.

Sagebrush dies when flooded. Sagebrush does not tolerate saturated soil, and if the soil stays saturated for two weeks, sagebrush dies. Spreading water across sagebrush land for two weeks is a well known method of sagebrush control, since the root systems die from lack of aeration.[9] Stream channels that have sagebrush well

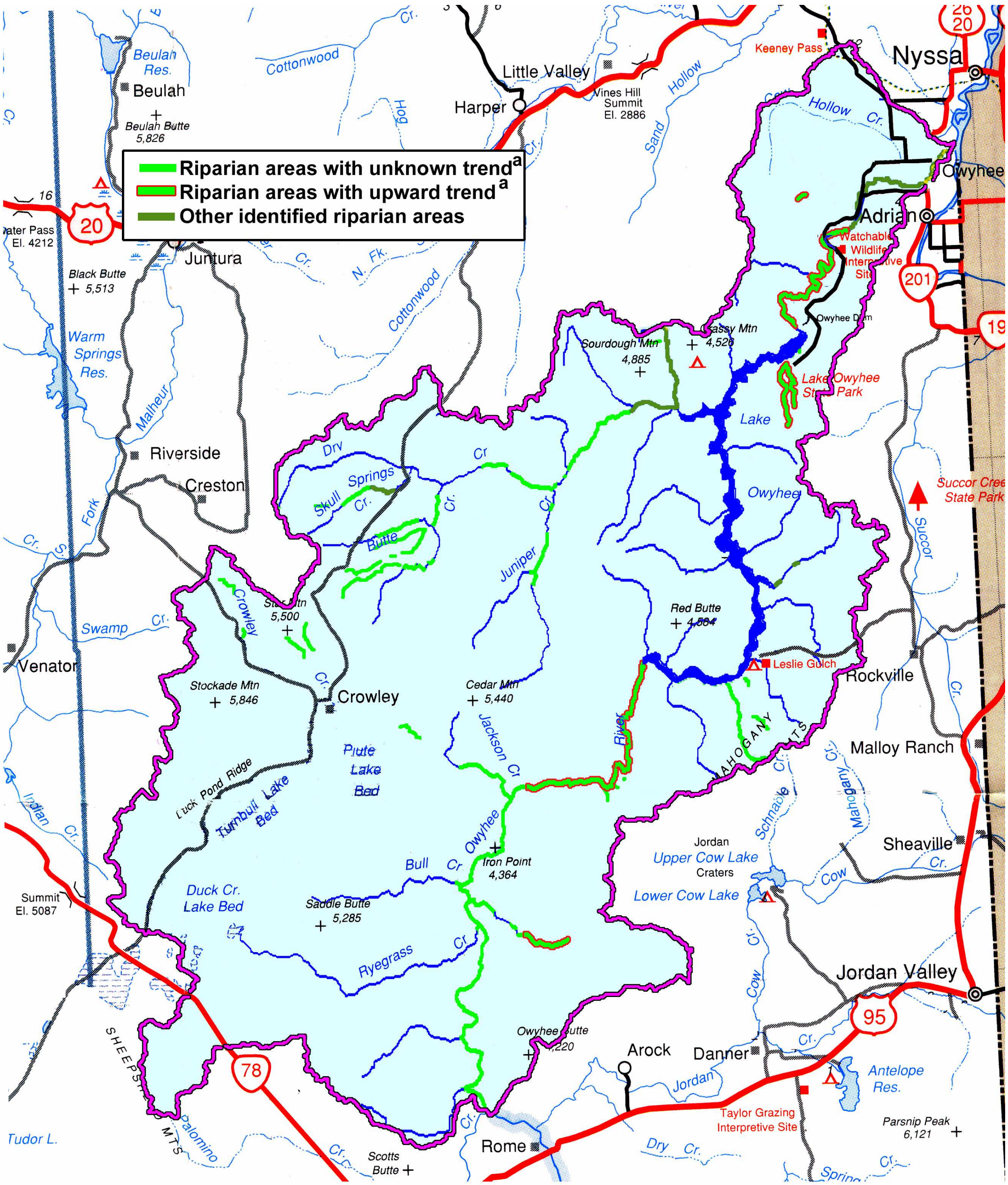

Figure 11.7. Known riparian areas in the lower Owyhee subbasin.
[a] noted in the Southeastern Oregon Resource Management Plan.[1]

developed growing directly in the bottom of the wash are not connected to the water table and are ephemeral and will not support riparian vegetation (Figure 11.8). However, sagebrush seedlings can germinate and begin growing where they can't survive subsequent flooding.

8. Wild and scenic rivers

Figure11.8. An ephemeral stream that will not support riparian vegetation. Note mature sagebrush growing in the water course.

The Owyhee River from the southern border of the lower Owyhee subbasin to the Owyhee Reservoir is designated as a wild and scenic river by the federal government. The Owyhee River from Crooked Creek to Birch Creek is designated as an Oregon State Scenic Waterway. The Vale BLM has recommended that portions of Dry Creek be designated as a wild and scenic river.[1] The section of the Owyhee River below the Owyhee Dam has also been recommended by the Vale BLM for wild and scenic river designation for its recreational value (Figure 11.9).[1]

Some sections of a wild and scenic river may contain riparian areas, other sections will not have riparian areas.

9. Invasive species.

Tamarisk (or salt cedar) is rapidly expanding in the lower Owyhee subbasin. The Bureau of Reclamation and the Owyhee Irrigation District cooperated to spray herbicide around Owyhee Reservoir for a number of years. They quit spraying about 20 years ago. Tamarisk is now advancing up a huge number of the draws from the reservoir.

A single tamarisk plant can use up to 200 gallons per day of water in the summer time. This prolific use of water can dry out riparian areas. It mines salts from the soil profile and redeposits them on the surrounding soil, rendering those areas unable to support plant species that cannot tolerate saline conditions. Tamarisk can out compete native riparian trees and shrubs. Tamarisk has very prolific seed production, grows very rapidly, and sends roots down deep. It provides very poor stream bank stabilization and erosion control.[18,19,20]

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. Large tamarisk plants in the drainages from Leslie Gulch and Three Fingers Gulch into the reservoir are surrounded with hundred of smaller plants and a green carpet of germinating seedlings. The Owyhee River below the dam is bordered by numerous spots with tamarisk plants (Figures 11.10, 11.11, and 11.12). It has begun to show up at some remote (from the river corridor) springs and intermittent streams.[18,19]

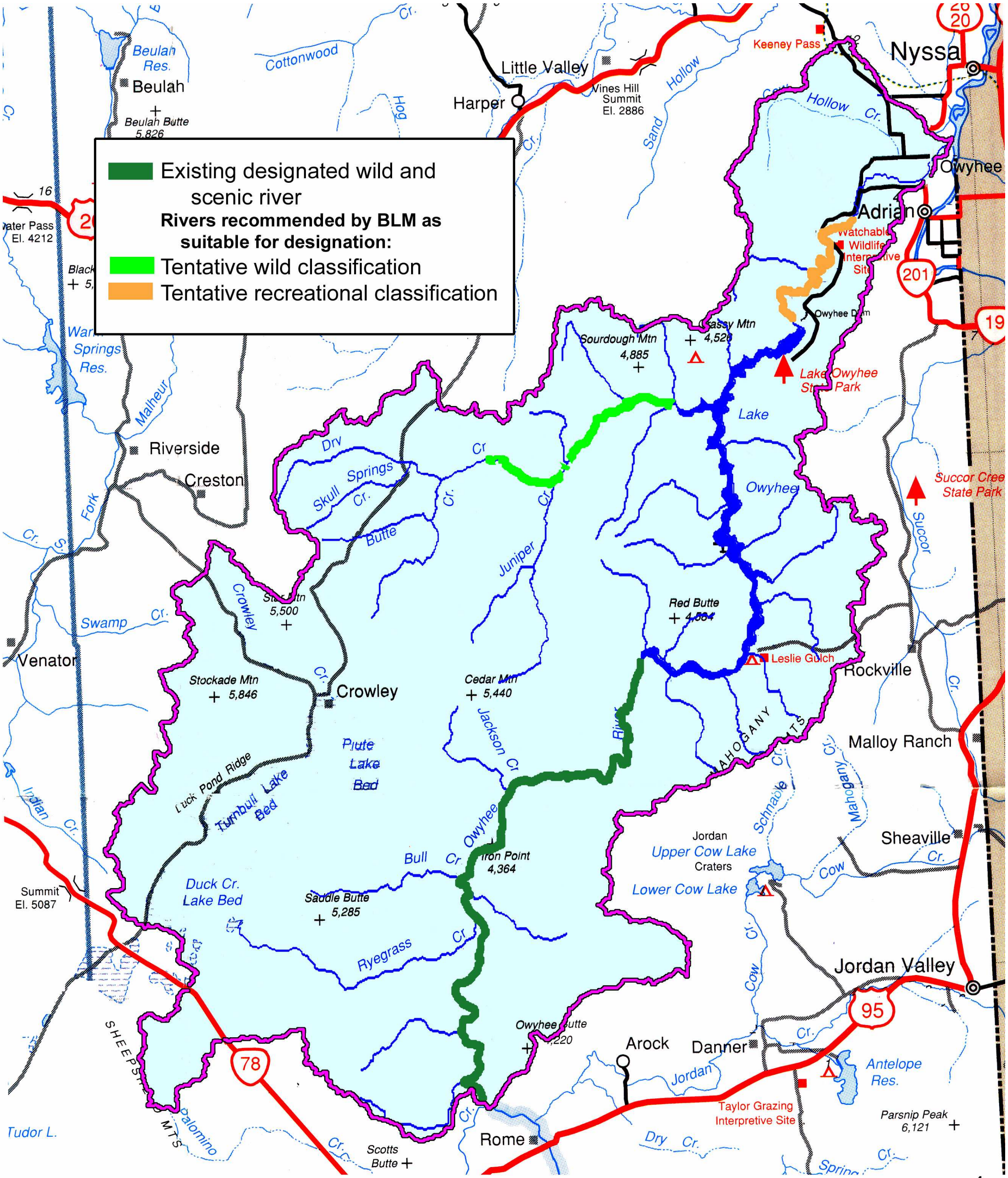

Figure 11.9. Existing and recommended wild and scenic rivers in the lower Owyhee subbasin.[1]

Tamarisk could be controlled today, but it is poised to replace native riparian vegetation. There is a the high probability that expanded salt cedar will limit the ground flow of water which will obviously affect water for wildlife and push some species toward extinctions.[18,20] Insects which rely on vegetation which has been replaced by tamarisk will disappear and species which feed off the insects will lose a food source. Larger

Figure 11.10. Tamarisk in Leslie Gulch, May 2006.

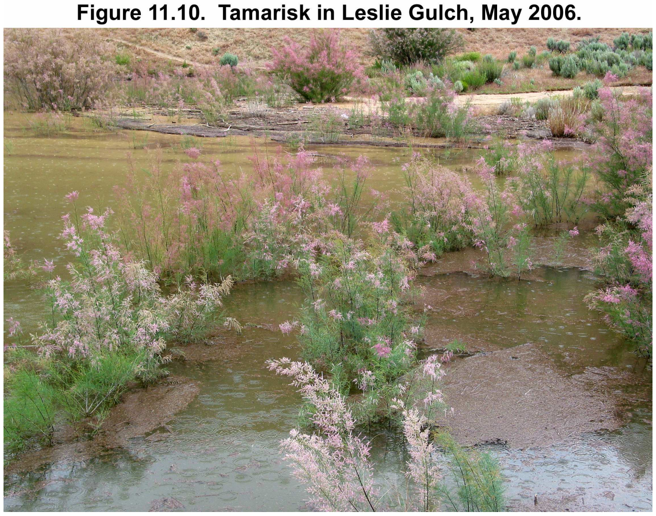

Figure 11.11. Tamarisk along the lower Owyhee River below the dam, May 2007.

Figure 11.12. Tamarisk invading Three Fingers Gulch, August 2007.

wildlife which frequent the wetter spots of intermittent streams to obtain water may be pushed out of the habitat due to lack of water availability.

Other invasive species in the lower Owyhee subbasin which adversely affect riparian areas include perennial pepperweed, white top, poison hemlock, houndstongue, and purple loosestrife (see invasive species discussion in the rangeland component of this assessment).

10. Discussion

The management of riparian areas is a vital environmental and economic issue. Although riparian zones in the lower Owyhee watershed are extremely limited, there are many different groups who are interested in their use and pose the potential for conflicts over how these areas should be managed. Riparian resources are utilized by livestock, wildlife, fish, vegetation, invertebrate animals, river rafters, hunters, fishermen, hikers, campers, boaters, birdwatchers, homesteaders and others. As a result, riparian zones are critical zones for multiple-use planning.

All ecosystems are dynamic and change over time. Riparian systems are probably more dynamic than the surrounding uplands.[11] Planning for riparian zones needs to consider their dynamic nature and attempt to maintain them as fully functioning ecosystems.[8] These ecosystems will vary from what they were during other climatic periods, from what they were before the Spanish introduced horses to the new world, and from what they were at the turn of the 19th century or the turn of the 20th century. There is no going back to some "pristine condition." Invasive species have affected riparian zones. Recreational use of riparian areas in the lower Owyhee subbasin is increasing as the population in the greater Boise area grows.

It is extremely important to consider all uses of riparian zones. No one use is inherently detrimental or beneficial.

Cattle grazing is sometimes cited as a primary negative factor in riparian areas. Although many riparian areas in the United States were mismanaged and degraded by improper livestock grazing, the negative effects of grazing can be minimized or eliminated with proper management.[8,12,17]

Management decisions about livestock grazing need to be made on a case by case basis since there are site factors that change from one riparian community to another. Techniques that attract livestock away from riparian areas, that promote avoidance of riparian areas, or that exclude livestock from riparian areas can all diminish the impact of grazing in one location. Grazing systems may also limit the duration or time of year when livestock graze in or near a riparian area.[3,7,12,17]

Water developments for livestock away from riparian areas may also benefit wildlife. Proper placement and design of water impoundments can create new wildlife habitat as well as providing water for cattle. "Small, wet meadows can also be created by piping overflow water from livestock troughs into fenced areas thereby creating and maintaining such meadows."[12] A pipeline to the west of the Owyhee River in the southern end of the lower Owyhee subbasin was built with the cooperation of the Owyhee Watershed Council, removing livestock grazing along the Owyhee River. It supplies water to numerous stock water troughs well away from riparian areas.

Because of the greater moisture in riparian areas and generally a deeper soil, riparian zones generally have a high rate of recovery of vegetation when they are appropriately managed and protected.

11. Unknowns

How will the expansion of tamarisk into many of the riparian areas of the lower Owyhee subbasin affect the hydrology and vegetation of the area. How would the hydrology and vegetative changes affect wildlife? Will public agencies respond before drastic losses occur?

All the riparian areas in the lower Owyhee subbasin have not been identified or characterized. In the lower Owyhee subbasin, the potential of riparian areas based on physical, biological, and chemical conditions is not known. The site specific physical, biological, and chemical conditions of riparian areas have not been surveyed.

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

What are the actual impacts of livestock on riparian areas? What reaches are not affected and what reaches are affected? Information on how grazing systems may be used to accomplish such goals as maintenance of woody stream bank vegetation and the prevention of bank crumbling and soil compaction is being developed by experience and research.[12] The management that will result in maintaining, restoring, improving, or expanding riparian areas in the lower Owyhee subbasin is poorly defined.

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

B. Wetlands

No wetlands have been identified in the lower Owyhee subbasin. Areas around the Turnbull, Piute, and Duck Creek dry lakebeds temporarily act as wetlands in very wet years as do several other smaller dry lakebeds. The extent and location of the temporary wetlands vary with flooding and desiccation cycles.

C. Channel habitat type

1. Definition

A stream channel runs across a valley floor. Valley characteristics and channel morphology (form) are interrelated. They help determine how the stream fits into, and interacts with, its valley.[4]

Basic channel habitat type is defined by three primary parameters: channel gradient, channel confinement, and bedrock. The channel gradient is the slope of the channel bed. The channel confinement is defined as a ratio of the "bankfull" channel width to the width of the modern floodplain. Typically channel confinement is a description of how much a channel can move within its valley before it is stopped by a hill slope or terrace. A broad valley floor may contain a stream channel that is either constrained or unconstrained. Constraints may be adjacent land forms or human constructions such as roadbeds or dikes. A "bedrock canyon channel" is where a stream has cut a gorge through bedrock.[4,14]

Identification of channel habitat type is designed to help identify those portions of the channel that are most responsive to factors which impact channel development. The principal factors which could affect channel characteristics are large woody debris, peak flows, and whether the sediment supply being washed down a stream is fine or coarse. The more responsive areas are most likely to show changes from both land management activities and restoration efforts.[14]

2. Channel habitat types in the lower Owyhee subbasin

Channel habitat types are applicable to perennial streams and some intermittent streams. In the lower Owyhee subbasin there has been no ground survey of valleys to identify which ones contain an intermittent stream as opposed to those which contain an ephemeral stream. Ephemeral streams only run for a short period of time after a significant rainfall or snowmelt event.

This preliminary analysis of the channel habitat types in the lower Owyhee subbasin concentrated on the Owyhee River, the principal perennial stream and on Dry Creek, an intermittent stream with perennial reaches. The analysis was conducted using the United States Geologic Survey topographic maps (Appendix A). Field verification was beyond the scope of this assessment. No channel habitat studies have been conducted in the lower Owyhee subbasin.

a. Owyhee River upstream from Owyhee Reservoir

All of the Owyhee River in the lower Owyhee subbasin above Owyhee Reservoir has a gradient of less than 1%. In approximately 48 river miles the elevation of the river drops from 3341 feet to 2670 feet, or a slope of 0.3%. The majority of the Owyhee River channel meets the criteria for confined, the width of the channel is less than two times the width of the floodplain. There are a few small stretches that may be moderately confined where the floodplain width is two to four times the width of the channel. There may even be three sections where the channel is considered unconfined with the floodplain greater than four times the width of the channel (Table 1).

Table 1. Stream reaches of the Owyhee River upstream from the Owyhee Reservoir where the channel is moderately confined (M) or unconfined (U).

Township	Range	Section	Confinement	Approximate length of stream reach
30 S	41 E	9	U	1 mi
29 S	40 E	32	Poss. M	¾ mi
29 S	41 E	29,30	Poss. M	1 mi
29 S	41 E	4	M	½ mi
28 S	41 E	29	Poss. M	½ mi
28 S	41 E	28	Poss. M	¼ mi
27 S	42 E	20, 21	U	½ mi
27 S	42 E	24	Poss. M	¼ mi
27 S	43 E	7, 18	M	1 mi
27 S	43 E	5, 6	M, some poss. U	3 mi
26 S	43 E	32	M	1 mi
26 S	43 E	21	M	½ mi

The majority of the Owyhee River upstream from Owyhee Reservoir is described as a low gradient confined channel. Typically rivers with this type of channel run across boulders, cobbles, or bedrock with pockets of sand, gravel, or cobbles. "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."[13] These channel types tend to pass most high flows without changing the channel and carry most of the introduced fine sediment downstream.[13] (See appendix H for a further description of channel types.)

b. Owyhee River below the Owyhee Dam

The Owyhee River below the outlet from the Owyhee dam is also a low gradient river. In 28 miles from the dam to the mouth with the Snake River, the elevation of the water goes from 2,345 feet to 2,180 feet, a 0.1% slope. However, the Owyhee River channel below the dam is much less confined (Table 2).

Table 2. Confinement of stream reaches of the Owyhee River downstream from the Owyhee Dam. C = confined, M = moderately confined, U = unconfined

Approximate River miles	Confinement	Approximate River miles	Confinement
28 to 25	M to U	16 to 15	M
25 to 24	C	15 to 13.8	C
24 to 22½	M to U	13.8 to 0	U, constricted at mile 10
22½ to 16	mostly U		

The majority of the Owyhee River below the Owyhee Dam is classified as either low gradient moderately confined channel or low gradient unconfined channel.

A low gradient moderately confined channel frequently has a narrow floodplain which runs alongside at least part of the channel. Low terraces which may be covered by flood flows may exist on one or both sides of the channel. The base material varies from fine gravel to bedrock. While a large portion of fine sediment is usually transported past these sections, coarser sediment is deposited. Channels of this type are particularly vulnerable to localized scour. The may also be responsive to bank stabilization efforts such as riparian planting and fencing.[13]

Low gradient unconfined channels are further classified by stream size determined by flow. Since the average annual stream flow of the Owyhee River is greater than 10 cubic feet per second, the channel is classified as low gradient large floodplain. Coarse sediment tend to be deposited by these channels. High water flows tend to spread out across the valley. There is little streambed scour, but the channel is subject to lateral movement and bank erosion occurs as new channels develop. "Due to the unstable nature of these channels, the success of many enhancement efforts is questionable."[13]

c. Dry Creek

Going upstream from Owyhee Reservoir on Dry Creek, the first 1500 feet have a gradient greater than 2%, considered a moderate gradient. From that point upstream past Freezeout Creek about ½ mile, the gradient is less than 2% or low. The next 3 miles have a moderate gradient of about 4%. Beyond this stretch the rest of the creek up to just south of Boundary Reservoir has a gradient less than 2%. The remainder of the creek up to Rock Spring Reservoir has a gradient greater than 2%.

Dry Creek is perennial in some reaches and intermittent in others. It is not possible without field verification to identify either the bankfull width of the stream or the width of the flood plain. One reach called Dry Creek Gorge has sections which probably would be classified as moderately steep narrow valley.

3. Unknowns

Thorough channel habitat studies have not been conducted in the lower Owyhee subbasin.

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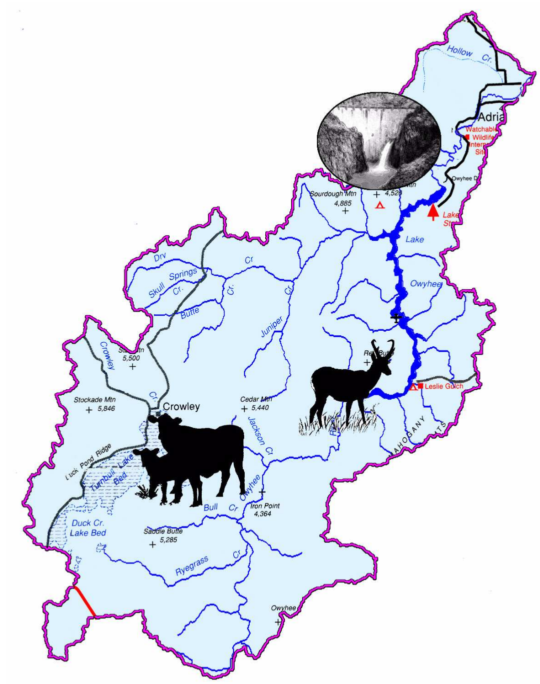

Lower Owyhee Watershed Assessment

XII. Channel Modification

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XII. Channel modification assessment

A. Channel modifications

There has been one primary channel modification in the lower Owyhee subbasin. The Owyhee Dam was built between 1928 and 1932. It dammed the Owyhee River and Owyhee Lake now covers 52 miles of the former Owyhee River channel. The other existing channel types in the lower Owyhee subbasin are unknown. Similarly, the channel types existing in the stretch of the Owyhee River covered by the dam are not and never were known.

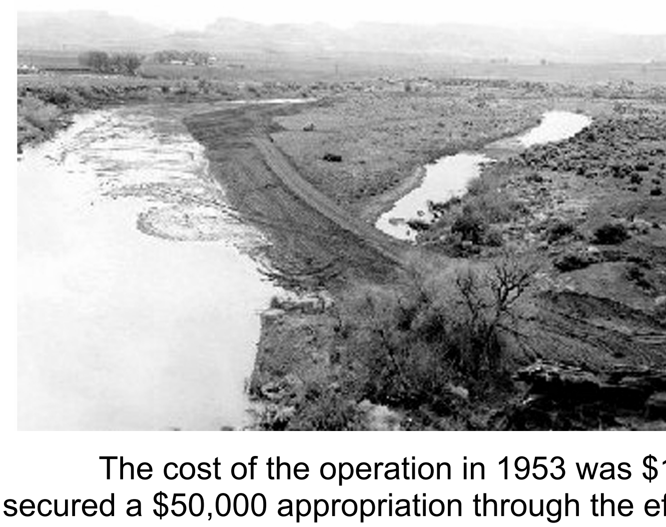
The Owyhee River upstream from Owyhee Reservoir runs in a channel which the river has slowly carved through the rock over millennia. For most of the distance, the walls of the ravine constrain the channel to its historic and pre-historic route. There are some vestiges of historic dams which diverted some of the river water across the broad terraces at The Hole in the Ground and Birch Creek Ranch. However, these are long defunct, and from their placement in the landscape, the main river channel was not altered by them.[Appendix A]

Following the construction of the Owyhee dam, the channel below the dam had less water flowing through it. However, Lewis Stamm remembers that the neighborhood kids in the 1940s would float the river from Mitchell Butte downstream. There weren't any trees anywhere below Snively Hot Springs and there wasn't a lot of undergrowth, just a few willows.[8]

Although the course of the channel did not change, the lack of annual spring scouring by flood events has resulted in slow silting in the Owyhee River channel below the dam. In the spring of 1952 about 4000 acres of land adjacent to the river were flooded. The newspaper report that there were 200 acres which could "never be reclaimed" may indicate that there were some changes in the channel.[5]

Following the flooding of 1952, work was done on the Owyhee River channel below the dam between October 1953 and May 1954. During 1953 the Army Corps of Engineers prepared plans and specifications for "clearing and snagging" of the Owyhee River and began clearing the river bed (Figure 12.1). The actual channel clearing and snagging was completed in 1954. Four heavy bulldozers worked in the lower 12 miles of the Owyhee River from the junction with the Snake River upstream. Silt and brush were cleared in about eight miles of the channel (Figure 12.1).[5,9,10] A resident remembers that the army corps cleaned out parts of the main channel (Figure 12.1) and built a couple of berms to protect the channel but they "really did very little."[8]

A berm and access road reconstructed across the entrance to the old Owyhee slough. It washed out repeatedly until the 1960s.



Bull dozers were used to scrape vegetation out of the river and off the banks.

Figure 12.1. Army Corps of Engineers clearing and snagging of the Owyhee River below Owyhee Dam, 1954.

The cost of the operation in 1953 was $1,188.80. In 1954 the army engineers secured a $50,000 appropriation through the efforts of the Owyhee Flood Control District which was organized by farmers whose lands were adjacent to the river channel.[5,9,10] The amount spent in the two years roughly equaled $384,000 in 2006 terms.[1,7]

Until the 1960s, there was an island where the Owyhee River joined the Snake River. The Owyhee River was on the north side and the old Owyhee slough (Keck slough) was on the south side of the island (Figures 12.1, 12.2, and 12.3). During high water, the river would split and run on both sides of the island.[8] There was a road across the slough. It washed out repeatedly, so about 1964 the Nyssa road department built a levee for the road to cross. The new road was six to eight feet higher than the old road. Subsequently the river has never breached the levee or run over it (Figures 12.2 and 12.3).[4]

Figure 12.2. Aerial view of the route of the old Owyhee slough.

In 1985, the army corps of engineers was authorized to remove gravel, brush and small trees from the first 12 miles of the Owyhee River from the mouth at the Snake River upstream. In both 1986 and 1987 gravel and organic debris were removed from the river. A total of $69,316 (equivalent to $81,000 in 2006) was spent by the federal government.[11,12,13,14] Residents remember that a lot of trees were cleared but very little dirt was moved and there was no rechanneling.[6,8]

Figure 12.3. Aerial view of the road construction which cut off water flow into the old Owyhee slough.

B. Discussion

In the lower Owyhee subbasin, the construction of Owyhee dam formed Owyhee Reservoir. It also modified the water flow below the dam so that the channel was only infrequently and partially scoured of vegetation by spring floods. The channel developed vegetation along the banks, including trees which apparently had not existed at the time of Euro-American entry into the area (see the conditions at contact section of the history component of this assessment). The lack of periodic scouring means that the channel width and depth have decreased and shading of the river has increased. When large amounts of water flow down the river, less of the water can be contained in the channel and more of the water flows beyond the confines of the channel, flooding the adjoining land.

The flatter the land, the more slowly water moves across it. Broad, flat valleys often have curving, sinuous river channels in them. Over time the channel reworks the entire valley floor. As the channel migrates, it leaves traces of former channel locations caused by the meandering. As the water course moves laterally, the sediment deposited from the river becomes smaller and smaller. Old stream beds are typified by gravel deep in the soil overlaid with fine silt and clays. These areas are usually excellent farm ground.[2]

From river mile eight to the mouth of the Owyhee River, farming has extended into the range where the channel of the Owyhee River wandered in recent geological times.[3] These lands are more likely to flood during high water events.

During flooding, trash coming down the Owyhee River is trapped against the railroad bridge that crosses the Owyhee River between Owyhee corner and the Snake River. This creates a dam and increases flooding upstream. Some residents think the removal of this bridge would decrease flooding.

C. Unknowns

When large amounts of water came down the Owyhee River, the old Owyhee slough and adjoining broad areas of land provided a second channel for moving water and possibly a safety valve to absorb large amounts of water quickly. Without access to the slough, it is possible that water cannot clear this spot on the river as rapidly. With high flows, the unintended consequence might be backing up water upstream from this point, spilling onto upstream land beyond the river banks.

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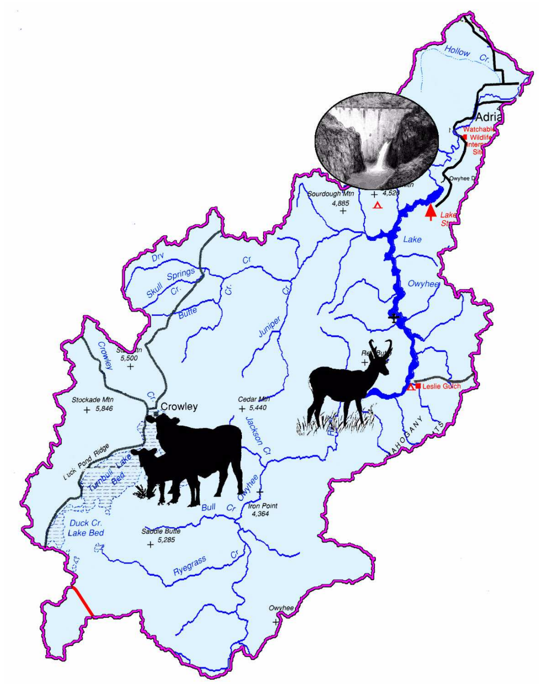

Lower Owyhee Watershed Assessment

XIII. Sediment Sources

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XIII. Sediment sources

Sediment enters rivers from runoff of water from the basin that is being drained. The greatest movement of sediment to the rivers is dependent upon extreme storm events that create substantial surface runoff. This section will consider runoff as well as the resulting sediment loss, or erosion, from rangelands and cropland.

A. Erosion

The sediment load transported by a river is obvious to most observers. Crystal clear stream water is not carrying substantial amounts of sediment, while murky brown waters are a result of a large sediment load within the river. The sediments in rivers come from erosion of soil and rock. The make up of the soils within the lower Owyhee subbasin is not well known, as discussed in the soils section of the background component of this assessment. Sediments within the Owyhee River also come from sediment contributed from further upstream. Wind erosion contributes a very minor amount of sediment directly to the rivers.

"Erosion is an intrinsic natural process but in many places it is increased by human land use."[20] All of the river canyons and gullies we see as scenic locations today were created by natural erosion (Figure 13.1). The goal of assessing sediment sources and erosion is not to halt the movement of sediments, but to mitigate the effects of modern human activities on soil loss.

Figure 13.1. Natural erosion processes shaped the deep Owyhee River canyon.

Management of sediment losses requires an understanding of how erosion functions naturally, what creates surface runoff within the lower Owyhee subbasin, and what cultural practices are management options.

1 What increases the amount of erosion during storms?

Erosion is the natural process by which sediment is moved down slope. Gravity is the major force in action, as in a rock fall. But, erosion is normally accomplished by water with the assistance of gravity. Two major factors contributing to how much erosion occurs are the slope of the land and type of precipitation. The greater the slope of the land, the more likely it is to undergo erosion. Steep slopes will lose more sediment than flat plains. High intensity and volumes of precipitation also increase the amount of erosion.[6] When heavy rains occur, the soil can not absorb all of the water and so some of the water starts running across the surface of the ground. If there is a large amount of surface runoff or the surface runoff is across a steep slope, this water will begin scouring the ground it is moving over and pick up sediment. Individual particles of sediment are small enough to be carried in the water and moved off of the land.[6]

The geological context of the lower Owyhee subbasin is that it is in the early stages of formation (see the geology section of the background component of this assessment). One implication is that erosion has not progressed very far in smoothing the landscape, so there are steep slopes that increase erosion risks. Another implication is that soils have only started to form, limiting the ability of the landscape to support vegetation and exposing the newly formed soils to erosion.

2 What will decrease the amount of erosion during storms?

The amount of erosion which occurs is largely controlled by the vegetative cover and type of soil. Vegetation and plant litter hold soils in place.[4] Soil that is being held in place is much harder to erode and will only be influenced by much more intense storm events.

Soils vary in the amount of clay, silt and sand they contain. Soils high in clay are harder to erode because the particles are held together more firmly and a greater force must be exerted by runoff to dislodge clay than silt or sand. Soils with a predominance of sand or coarser particles tend to absorb water very quickly, thereby reducing erosion.

Very large storm events have the power to dislodge both large particles and those which are held together firmly by forces in the soil. The influx of this sediment to the river system occurs over a short time period as the additional moving water has the force to carry these particles.[6]

3 Forms taken by erosion

When looking at the ground to see where erosion is happening, there are three types of soil movement to look for.[4,9] Sheet erosion moves sediment off the surface of a large area of ground and is generally more common in flat areas. Rill erosion consists of more or less parallel erosion paths across sloping ground. Gully erosion cuts through sediments in low areas where water accumulates during runoff events, creating features we call gullies.

Identification of what type of erosion has occurred will suggest the types of actions which can be taken to prevent erosion. In nature the quantity and speed of runoff water determine the form taken by erosion, and slopes will show a progression from sheet erosion at the top where they are nearly flat, to rill erosion on the slope, and finally gully erosion along the steepest incline.[4] On furrow irrigated fields the erosion occurring is analogous to rill erosion.

a. Management of sheet erosion

> "Sheet erosion can be prevented by maintaining plant cover and maximising infiltration of ponded water through the maintenance of soil structure and organic matter. Organic matter acts as a glue, stabilising pore spaces which transmit surface water deeper into the soil and thus reduce the volume of ponded water available for erosion."[3]

b. Management of rill erosion

> "Once runoff has been initiated, rill erosion can be prevented by either reducing flow velocity, or hardening the soil to erosion. . . . Flow velocity can be reduced by either reducing the flow volume or roughening the soil surface. Increasing surface roughness through the use of grassed waterways and grassed filter strips causes entrained soil particles to fall out of suspension. Flow volume can be reduced by not allowing sheet flow

to accumulate. Techniques such as ripped mulched lines and contour drains prevent runoff building up enough volume and speed to detach and entrain soil particles. . . . Where options to reduce runoff volume or velocity are limited, surface soils may be protected from scouring by hardening the surface."[2]

c. Management of gully erosion

"Once established, gully erosion can be difficult to control. In most cases a combination of approaches, including the use of vegetation, fencing, diversion banks and engineering structures are required. . . . Vegetation is the primary, long-term means by which gully erosion can be controlled. All gullies need to be fenced from stock and revegetated along the gully floor, sidewalls and surrounding areas. Establishing vegetation on gully sidewalls is often difficult due to moisture stress. Consideration should be given to supplying irrigation to get vegetation established."[1]

Suggestions from Tasmania, Australia include, revegetating the gully floor with rapidly growing grasses and the sidewalls with trees, revegetating the catchment above the gully, and using irrigation hydroseeding and mulching.[1] In areas where the gully erosion can not be controlled with vegetation, “gully erosion may be able to be controlled if runoff can be diverted and safely disposed of.”[1] However this requires engineering expertise and carries the, “risk of transferring instability from one area to another.”[1] While we may think of Tasmania as being a world away, similar erosion problems are found in many semi-arid regions of the world and their solutions are the same.

B. Sources of runoff water

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.

Sediments entering the river might be classified in three ways: that coming from springs and seeps, that originating in storm events, and that being transported in water from irrigation tail ditches. Water from underground aquifers, such as springs and seeps will carry little to no sediments. Thunderstorms and rapid snow melt can produce massive surface runoff. This runoff will likely carry sediment from the area it passes over. The floods that may result in narrow stream channels also have the potential to scour sediments from the banks of the channels.

Irrigation tail ditches will carry sediments from the fields that the irrigation water ran across. This is of concern to water quality since the soil may contain high quantities of phosphorus, nitrogen, bacteria, and pesticides.

C. Cultural practices related to soil losses

Erosion on rangeland has not been scientifically studied in the lower Owyhee subbasin. However, erosion can be observed by anyone, particularly those who use the same areas year after year. Current problems have been noticed by local residents.

Large sediment loads delivered to the rivers are the result of either extreme storms or other problems.

1 Current problems and concerns

Human land use, particularly related to vehicle travel is seen as a major source of sediment in the lower Owyhee subbasin.

a. Unimproved roads

Unimproved roads through rangelands create problems with erosion. Often the placement of dirt roads has developed as a matter of convenience, with no planning to minimize their effects on soil loss. Unimproved roads can erode more than improved roads. Improved roads will have runoff ditches along the sides which funnel water off the road and onto the range.

Unimproved roads erode in the tire tracks, collecting water running off the landscape and acting as sediment sources.[10] This happens because once water is in the wheel ruts, it can not escape. Water often flows within the wheel ruts for great distances, eroding deeper and deeper gullies into the land. Over time the erosion along one set of wheel tracks will lead drivers to move off of the existing road to drive on adjacent land. Those who use the range on a frequent basis notice that this problem becomes more pronounced with the steepness of the slope. Steep slopes have greater need of cuts designed to direct water off of the road at regular intervals.

Simple gutter improvements creating ways for water to escape from the wheel ruts of unimproved roads will decrease erosion.[10] Extensive descriptions for rural home owners, ranchers and rangeland managers on how to care for and improve rural roads are provided in the online publication “A Ditch in Time”.[10] Many of the unimproved dirt roads in the lower Owyhee subbasin are already acting as gullies and will likely continue to do so even without vehicle traffic because the gullies will not magically grow plants to hold the soil in place.

b. ATV tracks and off road recreation

Off road recreation by both small 4 wheelers and large 4x4 vehicles disturbs the surface of the soil. Repeated use of an area for off road recreation kills vegetation. Soil compaction, which results from vehicles driving over the soil, greatly increases the chance of precipitation flowing across the surface of the land.[4] These factors leave areas used for off road recreation extremely susceptible to erosion from rainstorms or snow melt. Areas which have been used repeatedly for off road recreation contribute increased amounts of sediment.

c. Stream bank erosion

Steambank scouring can be a natural process. This scouring can also be aggravated by excessive animal pressure on riparian vegetation, leaving stream banks excessively vulnerable to erosion.

d. Irrigation-induced erosion

Irrigation-induced erosion is a major source of sediment from irrigated farm ground in the lower Owyhee subbasin. Runoff water from fields irrigated below the Owyhee Dam is returned to the river through a system of tail ditches. There has been concern that field runoff contains high amounts of sediments. In addition agricultural runoff water can carry chemicals that have been applied on crop fields into the river.

e. Accumulation of sediment in the Owyhee Reservoir

When water enters the Owyhee Reservoir it slows and loses the power it had to carry sediments. This means that the sediments are deposited on the bottom of the reservoir. It is an increasing concern to residents that the Owyhee Reservoir is acting as a catch basin for sediments. Primarily the concern is that all of the mercury carried by runoff water from the Silver City area since the construction of the Owyhee Dam in 1932 has settled onto the bottom of the reservoir along with sediments carried by the river. This seventy nine year accumulation of mercury is showing it's presence in the water quality and fish quality (see the water quality component of this assessment).

f. Confined animal feeding operations

Concern has been expressed that sediments at confined animal feeding operations are extremely susceptible to erosion and that during storm events the sediment might be lost into the rivers, carrying with it a high concentration of animal wastes.

2 Possible solutions to current problems

a. Unimproved roads

Unimproved roads through rangelands eventually need to be repaired or replaced. Simply prohibiting vehicle traffic will not halt erosion which is already carrying sediment off the road. As replacement and repairs are necessary, minimal design considerations can be implemented to divert water strategically from the roadway at reasonable intervals. In some places, routes can be chosen with less erosive potential.

b. ATV tracks and off road recreation

Education of ATV and other off road vehicle users could be more energetic and effective.

c. Stream bank protection

The effects of cattle grazing along the main stem of the Owyhee River above the dam have been eliminated by their exclusion from access to the river. Major private investments have placed watering troughs across the landscape away from the river's edge and other riparian areas.

Below the dam, grazing pressure along the river is low.

Problems of livestock pressure on riparian vegetation exist in the Dry Creek drainage.

d. Irrigation-induced erosion

Irrigation induced erosion in Malheur County has been diminished and continues to diminish. Practices to reduce this erosion have been developed and are being implemented. Progress to reduce irrigation induced erosion is extensively documented in the Irrigated Agriculture component of this assessment. See the discussions of practices that have reduced irrigation-induced erosion including:

1. Laser leveling
2. Straw mulch
3. Gated pipe
4. Weed screens
5. Application of PAM to reduce irrigation-induced erosion
6. Surge irrigation
7. Sedimentation basins and pump back systems
8. Changes in irrigation systems to sprinkler and drip irrigation
9. Irrigation scheduling
10. Constructed wetlands

Major advances have been made in the reduction of sediment in runoff water by using straw mulching, the use of PAM, laser leveling, and upgrades in furrow irrigation systems.[13] Laser leveling makes fields flatter, and flatter fields are less subject to erosion because the water in furrows is moving slowly. Straw mulch and surge irrigation both slow the movement of water through irrigation furrows.[17] Slower water has less power to pick up and move sediment. Gated pipe allows for more uniform irrigation in furrowed fields so that the amount of water flowing down each row can be regulated and reduced. PAM, as an additive in irrigation water, binds sediment particles in furrows together, reducing the amount of sediment that can be picked up by irrigation water.[16] Weed screens are used to remove garbage from the water so that narrower openings on gated pipe or smaller siphon tubes can be used in irrigation.

Possibly the best way to deal with concerns with runoff water from agricultural fields is to eliminate the runoff all together. This can be done with controlled water application. If all of the irrigation water applied to a field stays on the field, there will be no run-off and no worry of accompanying chemicals.[19] Both sprinkler irrigation and drip irrigation systems can be designed to eliminate runoff from agricultural fields.[5,12,13] These cultural practices are used by many farmers.

Irrigation scheduling is combined with all types of irrigation systems so that water is applied in the proper quantity when needed by the crops.[14,15,21] Scheduling is accomplished by measurements of evapotranspiration at weather stations or by in-field measurements of soil water potential.[11] Evapotranspiration shows how much water plants consume and is based on local weather conditions including temperature and humidity. Growers can get this data for the Treasure Valley daily from the Malheur Experiment Station and AgriMet.[7] Soil water potential measures how much water is accessible to the plants from the soil in a given field.[18] Sensors that make these measurements have been growing in popularity with growers in Malheur County.

An additional method to eliminate most sediments from agricultural fields returning to the rivers is through the use of settling ponds in constructed wetlands or catchment ponds with pump-back systems. Settling ponds allow the sediment to fall out of suspension in the water and gather on the bottom of the pond.[13] After sediment has settled, water is returned clean to the tail ditch system.

e. Accumulation of sediment in the Owyhee Reservoir

Clean up of sediments already in the reservoir would be very costly. The most effective immediate measure would be to eliminate further introduction of mercury to the reservoir. This requires that clean up occur at the source of the mercury in the Silver City region. (See the water quality component of this assessment).

f. Confined animal feeding operations

The Oregon Department of Natural Resources confined animal feeding operations permit program is designed to address waste management at confined animal feeding operations (CAFO).[8] Waste removal programs are designed to protect water quality of ground water and surface runoff. All of the operations in the lower Owyhee subbasin which are large enough to require them have been issued CAFO permits.

D. 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 invasive weeds? 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 there soil loss problems following wildfires and controlled rangeland burnings?

There is no survey of locations within the lower Owyhee subbasin with erosion or any documentation of whether the current erosion rate is what would be expected to occur naturally or is aggravated by anthropomorphic activities. Only the latter would be amenable to remediation. Naturally occurring erosion has been substantial and is responsible for much of the beauty and incredible landscape of the lower Owyhee subbasin.

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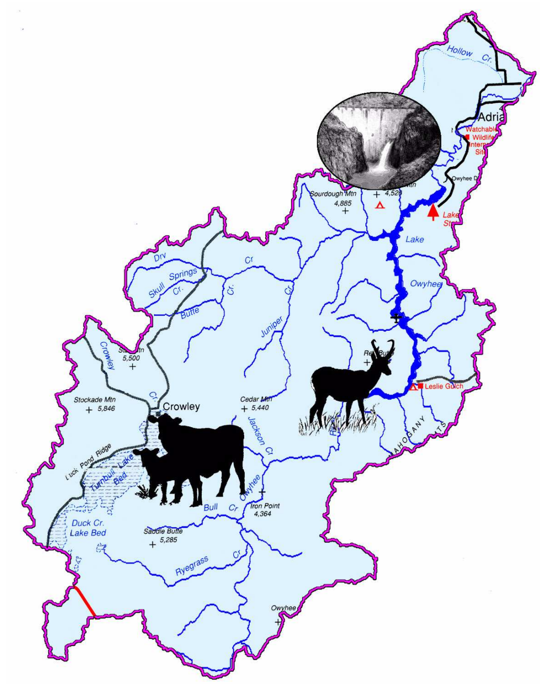

Lower Owyhee Watershed Assessment

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XIV. Fish and fish habitat

In the lower Owyhee subbasin there are both native fish and introduced species. Some of the fish are coldwater and some are warmwater. The species listed in Table 1 are those that are known to be present in the lower Owyhee subbasin.[42] Most of the fish considered to be nongame fish, fish that are not usually harvested by people, are native species.

A. Fish in the lower Owyhee subbasin

Fish in the lower Owyhee subbasin are found in the Owyhee River, in a few tributary streams, in the Owyhee Reservoir, and in stock ponds.

The two primary reaches of perennial streams in the lower Owyhee subbasin are the mainstem of the Owyhee River and a section of Dry Creek (Figure 14.1). In general, fish will be found in the perennial streams or their perennial reaches. The majority of the streams in the lower Owyhee subbasin are either intermittent or ephemeral. There is little data on which tributary stream reaches are intermittent and which are ephemeral. Intermittent streams have water in them for part of the year, but are dry for part of the year. Ephemeral streams carry water only immediately after rain or snow melt events. (See the hydrology component of this assessment for more discussion of perennial, intermittent, and ephemeral streams.)

Coldwater and warmwater game fish have been introduced into the reservoir, into the Owyhee River, and into stockponds. The 28-mile stretch of the Owyhee from the dam to the confluence with the Snake River contains a coldwater and warmwater fishery, the reach of coldwater fishery below the dam varies with the season.[3]

The data on the status of a species of fish is available primarily for the game fish. The information on the incidence of nongame fish is much less complete. However, a specie's preferred habitat may give an idea of where they might be found in the lower

Table 1. Fish species in the lower Owyhee subbasin

Common name	Scientific name	Temp.	Game fish
	Native fish		
	Trouts--Family Salmonidae		
Inland redband trout	*Oncorhynchus mykiss gairdneri.*	C	GF
Mountain whitefish	*Prosopium williamsoni*	C	GF
	Minnows--Family Cyprinidae		
Chiselmouth	*Acrocheilus alutaceus*		
Redside shiner	*Richardsonius balteatus balteatus*		
Longnosed dace	*Rhinichthys cataractae*		
Speckled dace	*Rhinichthys osculus*		
Northern pikeminnow	*Ptychocheilus oregonensis*		
	Suckers--Family Catostomidae		
Largescale sucker	*Catostomus macrocheilus*		
Bridgelip sucker	*Catostomus columbianus*		
	Sculpins—Family Cottidae		
Shorthead sculpin	*Cottus confusus*		
Mottled sculpin	*Cottus bairdi semicaber*		
	Non-native fish - Introduced species		
	Trouts--Family Salmonidae		
Rainbow trout	*Oncorhynchus mykiss irridus*	C	GF
Brown trout	*Salmo trutta*	C	GF
	Catfish--Family Ictaluridae		
Channel catfish	*Ictalurus punctatus*	W	GF
Brown bullheads	*Ameiurus nebulosus*	W	GF
Tadpole madtoms	*Noturus gyrinus*		GF
	Sunfish--Family Centrarchidae		
Largemouth bass	*Micropterus salmoides*	W	GF
Smallmouth bass	*Micropterus dolomieu*	W	GF
Black crappie	*Pomoxis nigromaculatus*	W	GF
Bluegill	*Lepomis macrochirus*	W	GF
Pumpkinseed	*Lepomis gibbosus*	W	GF
Warmouth	*Lepomis gulosus*		GF
	Perches--Family Percidae		
Yellow perch	*Perca flavescens*	W	GF
	Minnows--Family Cyprinidae		
Common carp	*Cyprinus carpio*		
Fathead minnow	*Pimephales promelas*		
Utah chub	*Gila atraria*		
Lahontan tui chub	*Siphateles bicolor*		
	Loach—Family Cobitidae		
Oriental Weatherfish	*Misgurnus anguillicaudatus*		

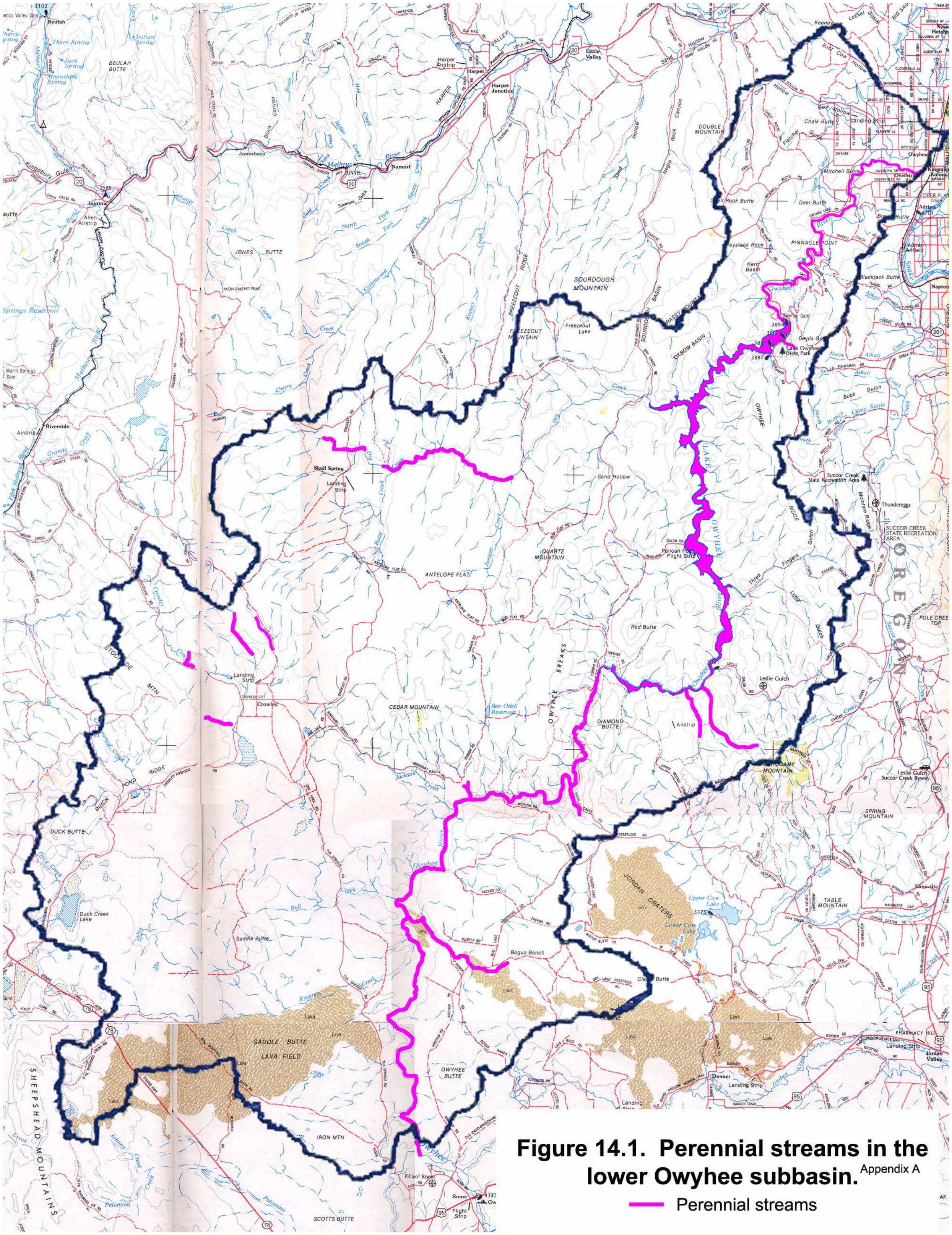

Figure 14.1. Perennial streams in the lower Owyhee subbasin. Appendix A

Owyhee subbasin. Native fish have adaptations to conditions present in at least part of the local habitat in the lower Owyhee subbasin river system. 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.

B. Historical presence

1. Coldwater game fish

The construction of the Owyhee Dam ended the runs up into the Owyhee River above the dam of anadromous fish, fish that migrated to the sea and back. The completion of Brownlee Dam ended salmon runs up the Snake River into the lower Owyhee River to the Owyhee Dam. Anadromous salmon are now extinct in the lower Owyhee subbasin.

In July 1859 upstream from Jordan Creek, Louis Scholl described the Owyhee River as "abounding with salmon."[44] Chinook are known to have migrated up the Owyhee River into Nevada.[14] Steelhead are thought to have migrated up the Owyhee River into the South and East forks possibly as far as Nevada. Coho salmon have been listed in some publications as being present in the Snake River in the Ontario area and possibly in the lower Owyhee River.[42]

The Owyhee River basin supported a run of spring chinook. C. G. "Chup" Fairchild in two letters written in 1870, recalls his childhood days around the turn of the century on the family ranch near Tuscarora, Nevada. His family, along with other families in the area, would go to the South Fork Owyhee River and Indian Creek and harvest salmon for winter food. He also remembered that in some years dead salmon could be found in the diversion ditches and fields. Salmon became less abundant around 1916, but continued to return at least until 1924. They were known to use Jordan Creek and the lower end of Cow Creek in Oregon. The run of spring chinook salmon up the Owyhee River ended in 1932 with the completion of Owyhee Dam.[42]

The Snake River in the Ontario area supported a run of fall chinook, though whether these fish utilized the Owyhee River is unknown. Juvenile chinook salmon were collected from below Owyhee Dam in the mid 1950s.

The Oregon Fish Commission operated a chinook salmon hatchery on the Snake River from 1902 through 1907. The hatchery was located on Morton Island about 20 miles downstream from the mouth of the Owyhee River.[53] Upstream migration was blocked with about 1000 feet of racks in the river, with approximately 600 feet of racks in the channel between Morton Island and the Idaho shore and 400 feet of racks between the island and the Oregon shore. A second row of racks was placed about 1500 feet downstream to form a pen on the Oregon side to hold the trapped fish.

Salmon were present in the Snake River at least from July into the fall. In each year that the hatchery operated, salmon were trapped the first day when rack placement was completed. They were spawned from mid October through November. Eggs collected in 1902 were released on gravel bars downstream of the racks. From 1903 to 1905 eggs were incubated in the hatch house with river water. Swim-up fry were released into the Snake River below the facility.[54] In 1906, fry were fed until April and early May then they were released.[55]

The operation of this hatchery was difficult at best. Hatchery workers had to sandbag 1400 feet of wooden racks. The flows down the Snake River during the summer and fall were quite variable. On many occasions the racks were destroyed or removed to allow excess flow to pass. High water usually released most if not all of the adults being held. Once the salmon were spawned problems continued. The hatchery used water directly from the river, which was heavily laden with sediment. Sediment settling out in the trays killed many eggs and fry. During extreme cold the water intake would freeze, shutting off water to the hatchery killing eggs and fry. Due to the difficulties associated with operation, the hatchery was closed and sold in 1907. Of the eggs taken in 1907, 126,000 were released back into the river and the majority (400,000) were shipped to Wallowa River hatchery to be reared and released.[55]

Prior to the 1900s, there may also have been steelhead trout and coho salmon in the lower Owyhee River.[48] Steelhead may have spawned in the upper Owyhee basin but the evidence is not conclusive. Local residents remember catching large “harvest” trout in the late fall, which might correspond to possible migration time of summer steelhead.[42] Some early scientific reports mention the existence of coho runs in the middle Snake River and possibly in the Owyhee River. No known records exist to confirm coho runs in the Owyhee River.[42]

No anadromous fish could return to the Owyhee River above the Owyhee Dam after its completion in 1932. Salmon runs up the lower Owyhee River to the dam ended with the completion of the first of the Hells Canyon complex of dams, Brownlee, on the Snake River in 1959.[11] Anadromous salmon are now extinct in the lower Owyhee subbasin. In 1969 the State Water Resources Board showed the mainstem of the Owyhee River as only having trout and warmwater game fish.[48]

In addition to the anadromous salmonids, resident game fish in the lower Owyhee subbasin consisted of inland redband trout and whitefish.[42]

2. Nongame fish

Lamprey was an anadromous fish which became extinct in the Owyhee River above the Owyhee Dam with the construction of the dam. Walter Perry recalls the water wheel at Island Ranch on the Owyhee picking up lampreys and putting them into the ditch. He says he's seen "them so thick in the field after they come up the flume that you couldn't hardly get out into the field because of them old dead eels."[43] Wally Jones of Ontario remembers the lampreys piling up at the base of the Owyhee dam right after it was built.[12]

Besides catching trout and salmon within their territory, the Tagötöka band of Northern Paiute who lived in the lower Owyhee subbasin report catching suckers.[49] Peter Skene Ogden found an Indian with a "good stock of small dried carp" on the Malheur River near Ontario.[17] Probably what he identified as carp, possibly northern pikeminnow, existed in the lower Owyhee subbasin also. On the Owyhee River in the area now covered by the reservoir, there were also bullhead catfish. James Page recalls that as soon as the line hit the water they would bite and says they "used to catch a hundred or two of them and clean and fry them."[40] By the early 1900s these could already have been an introduced specie.[20]

Of the other fish currently in the lower Owyhee subbasin, the chiselmouth, the redside shiner, the longnosed dace, the speckled dace, the northern pikeminnow, the largescale sucker, the bridgelip sucker, the shorthead sculpin, and the mottled sculpin are probably native to the subbasin.

3. Warmwater game fish

Oregon Department of Fish and Wildlife (ODFW) considers all of the warmwater game fish in the lower Owyhee subbasin to be introduced species, although historical records indicate that bullhead catfish may already have been present. Warmwater game fish were first introduced into Owyhee Reservoir in 1933, with subsequent releases in 1934 and 1935. The species that made up these first releases were not recorded but can be derived from an inventory gathered in the 1950s and early 1960s. Species observed in the 1950s and assumed to be in the first release groups included; largemouth bass, bluegill, black crappie, and bullheads (browns or blacks). Other species may have also been stocked but did not survive into the 1950s. Yellow perch could have been in the original release or escapees from illegal introductions in Antelope Reservoir and Cow Lakes. Channel catfish were first stocked into the reservoir in 1962 and later into the river upstream in 1970. Smallmouth bass were stocked into the upper river in 1970.[42]

4. Fish eradication

Rotenone is used to poison fish since it interferes with the use of oxygen in their bodies. In 1969, the ODFW poisoned the Owyhee River upstream from the dam. It not only killed fish but also killed crawdads.[58] Anecdotal information is that there were “lots of barrels” of rotenone used.

C. Native fish

1. Game fish

Inland redband trout and whitefish, the resident coldwater game fish in the lower Owyhee subbasin, will be discussed later in more detail in the section on coldwater game fish.

2. Non-game fish

Another native fish which prefers cooler water is the shorthead sculpin. It is most often found in the fast, rocky riffles of cold headwaters or creeks.[24] Like the shorthead sculpin, the mottled sculpin prefer rubble or gravel riffles which will have well-oxygenated, clear water.[23] Both sculpins are probably present in the lower Owyhee subbasin although they have never been collected here.[41]

The speckled dace and the longnose dace also will be found in rocky riffles or runs [37,38,15] although the longnose dace isn't as selective, being found in streams or lakes that may be muddy and warm or clear and cold.[15] Both of these species of dace are probably more abundant upstream in tributaries above the lower Owyhee subbasin.[42]

Bridgelip suckers can also be found in rocky riffles but they may also be in runs over sand or silt in creeks or along lake margins.[21] They are found in the Owyhee Reservoir.[42] The chiselmouth are also found in the Owyhee Reservoir [42] although they prefer flowing pools or runs over sand and gravel in creeks.[19] They may be found in the warmer parts of streams and rivers.[6] The largescale sucker which prefers pools and runs of rivers is also found in lakes.[22] It is not only present in the Owyhee reservoir, but also along the length of the Owyhee River.[42]

Northern pikeminnow prefer ponds, lakes, and occasionally runs.[36] They are very abundant in the Owyhee Reservoir and upstream in the Owyhee River.[42] The redside shiner prefers runs and flowing pools of water, usually over mud or sand and often near vegetation.[39] Although they are found in Owyhee Reservoir, they are probably most abundant upstream in tributaries in the lower Owyhee subbasin.[42]

3. Unknowns

There is little information on the non-game fish populations or fluctuations in populations.

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 non-native 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?

D. Coldwater game fish

1. Redband trout

a. Distribution

Inland redband trout are native to the lower Owyhee subbasin. Inland redband trout, rainbow trout, and steelhead are all members of the same species. The populations of inland redband trout within the Owyhee basin are grouped with the inland Columbia Basin redband/steelhead group (*Oncorhynchus mykiss gairdneri*) along with other populations upstream of Hells Canyon Dam.[42]

Upstream from the Hells Canyon dams many environments are semi-arid, cold-winter deserts. The characteristics of these environments have exerted selection pressures which probably account for some of the variations observed in *Oncorhynchus mykiss gairdneri*. Redband populations are divided in the tributaries and small population sizes are associated with genetic drift and a high level of variation among populations. There are dams, extreme water temperatures, and stream reaches that dry out in the summer. These barriers limit the ability of the trout to migrate between areas and isolate breeding populations. The redband trout in the Owyhee River basin "show the warmwater tolerance that is considered to be a classic characteristic of redband trout."[18]

Within the lower Owyhee subbasin, inland redband trout are found in Dry Creek and the mainstem of the Owyhee River.[42,18] There are an estimated five miles of redband habitat in Dry Creek in perennial reaches near springs.[42]

b. Habitat and life history

The life history of the inland redband trout within the lower Owyhee subbasin has not been studied. Chris Walser of Albertson College is conducting studies of the redband trout in Jordan Creek, a tributary of the Owyhee River upstream from the lower Owyhee subbasin. Walser has conducted electro fishing, tagged trout, fitted some with transmitters, and recorded fish recapture over three years. Early results have shown that the local population of redband trout can tolerate high water temperatures; one day the temperature taken at the bottom of a pool about two feet deep was 85°F. Contrary to expectations they have found the trout more abundant where less riparian vegetation was present. Although the bigger pools had more fish, some of the smaller pools had the largest individuals. For overwintering the trout moved to beaver ponds or in fairly large deep pools.[56]

Life history of redband populations in the Blitzen and Malheur River basins studied by Hosford and Pryble indicated that inland redband trout spawn from April through July depending upon water temperature. Spawning success was greatest in streams with clean gravel and cobble substrates. Most fish mature and spawn in their third year with a few in their fourth year. Most adults die after spawning.[42]

c. Production

The abundance of inland redband trout in the Owyhee River mainstem above the reservoir is unknown.[42]

Samples of redband trout from Dry Creek have been analyzed genetically. The results indicated that the population shows little evidence of hybridization with hatchery rainbow trout.[42]

Growth of redband in the lower Owyhee subbasin has not been studied, but individuals seldom get over 10 inches in the tributaries. Trout in the Owyhee River above the dam can reach 18 inches.[42] In Jordan Creek, Chris Walser has only recaptured five redband trout a year after first tagging them. These fish had gained 2¼ ounces, about a third of the rate that trout can grow elsewhere.[56]

d. Fishery

There is little fishing directed at catching inland redband trout compared to that for hatchery rainbow trout. Some native trout are caught incidental to the harvest of hatchery trout. Fish caught are usually from 6 to 9 inches long, with few individuals over 10 inches.[42]

e. ODFW management

i. Maintaining connectivity

The populations of inland redband trout upstream of Owyhee Dam are acting as a meta-population. A meta-population is a series of populations that exchange individuals over time. The confinement of small numbers of individuals in short perennial stream reaches increases the susceptibility of these populations to catastrophic events. If small populations are lost, the habitat can be re-seeded from other nearby populations. Maintaining the interconnectivity of redband trout populations within the Owyhee Basin is very important to their long-term genetic viability and survival.[42]

In desert watersheds the issue of water rights is a major concern. The issue of increasing water storage upstream of Owyhee Reservoir is a concern because construction of additional dams could further segment redband trout populations and destroy spawning habitat. The result could mean the isolation and eventual extinction of the small populations in the lower Owyhee subbasin.[42]

ii. Impact of stocked fish

Fishing directed toward catching redband trout is small and incidental to stocked hatchery rainbow trout and warmwater fish. Stocking hatchery rainbow trout attracts more anglers into remote areas where native fish occur. Stocking hatchery rainbow trout in areas with small native populations can be damaging.[42]

f. Unknowns

Introduced hatchery trout that can potentially interbreed with the native redband trout are still being planted in 24 stock ponds in the Owyhee subbasin in Oregon and upstream in Idaho and Nevada. Effects of stocked hatchery rainbow and redband trout upstream of waters with native redbands are unknown, but should be expected to change their genetic composition over time (see section 4 below).

What effects are the hatchery trout stocked into 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?

The effects introduced warmwater game fish have on native redband trout in the lower Owyhee subbasin are unknown.

Has there been removal of riparian vegetation which has allowed water temperatures to increase? Water impoundments can stabilize flow and decrease peak flows. Have there been increases in riparian vegetation due to flow stability from impoundments. 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 does more or less sediment in the streams affect the redband population?

What habitat limitations on the abundance of redband trout are due to natural causes? What is the natural thermal potential of streams? How does the natural thermal potential and naturally limited cold or cool water refugia affect the distribution of inland redband trout populations?

2. Mountain whitefish

a. Distribution

Historically whitefish were observed in the Owyhee River downstream of the reservoir, in the reservoir, and in the river upstream of the reservoir in the Three Forks area.[42] Ray Perkins of the Oregon Department of Fish and Wildlife (ODFW) has not seen any in the lower Owyhee subbasin in the last 16 years.[41]

b. Habitat and life history

Mountain whitefish are more common in larger stream environments. They become sexually mature at age 3 or 4 and at a length of 10 to 12 inches. Spawning occurs from October through December at water temperatures from 40°F to 45°F over gravel or gravel and rubble. They do not build nests similar to other salmonids, but rather they are broadcast spawners. Hatching occurs in March. Fry can be found near shore for several weeks but soon move offshore.[42]

c. Unknowns

There is a general lack of information on the populations of mountain whitefish in the lower Owyhee subbasin. Do they currently exist? There is no known fishing targeting this species in the lower Owyhee subbasin. Access to the river above the reservoir is limited and very difficult during the winter and spring. Some individuals are said to be caught in the lower river, but catches have not been documented. Just about everything is unknown about this species.[42]

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

3. Historical stocking

Over the years the lower Owyhee subbasin or the Owyhee basin upstream have been stocked with various species of salmon and trout. Owyhee Reservoir was stocked with westslope cutthroat from Montana, kokanee (sockeye salmon), coho (silver salmon), brook trout, and Kamloops rainbow trout. The river below the Owyhee Dam was stocked with kokanee, brook trout, and rainbow trout. Crooked Creek, a tributary to the lower Owyhee River, south of Burns Junction on Hwy. 95, received Lahontan cutthroat trout from Willow Creek in the Trout Creek Mountains and from Summit Lake in Nevada. Cow Lakes received cutthroat trout of unknown origin in 1964. Starting in 1990, brown trout were introduced into the Owyhee River downstream of Owyhee Dam. Parsnip Peak Reservoir was used as a brood site for redband trout from 1979 to 1982. The trout were spawned at the reservoir and fertilized eggs were taken to Klamath Hatchery. In 1982, only one ripe adult was collected. No eggs were collected. The program was discontinued.[42]

Salmonids other than rainbow trout are no longer being stocked in the Owyhee basin in Oregon.

4. Stocking within the basin outside Oregon

There are several different species and stocks of trout currently used for stocking programs upstream within the Owyhee basin. Lake Lenore Lahontan cutthroat and Succor Creek stock of redband trout have been used in Idaho hatchery and stocking programs. In Nevada, a triploid stock of rainbow, the Tahoe stock of redband, and a strain of Lahontan cutthroat have been used within the Owyhee basin. The Duck Valley Indian Reservation has used a stock of rainbow from Hagerman National Fish Hatchery in the past and currently is using a stock of rainbow from the hatchery program at the College of Southern Idaho.[42]

5. Artificial coldwater fishery

The construction of the Owyhee Dam changed the water flow patterns in the reservoir and in the lower Owyhee River below the dam. Under natural conditions, most of the water would flow past the area in the winter and spring, and the water in the river below the reservoir became warm or hot by summer. The water in Owyhee Reservoir is deep and the bottom layers are cold. This cold water is released throughout the late spring, summer, and early fall irrigation seasons. Water released from the bottom of the reservoir flows in the river until it is diverted into irrigation ditches.

This stretch of the river has been stocked with hatchery rainbow trout and brown trout that are not native to the Owyhee River. They provide game fish for recreational fishing.

6. Hatchery rainbow trout

a. Distribution

Hatchery rainbow trout are stocked annually into the Owyhee River below the dam and into two small BLM stock watering ponds within the lower Owyhee subbasin, Littlefield stock pond in the Dry Creek basin and Dunaway stock pond south of the Dunaway pump station. Hatchery rainbow trout are in the Owyhee Reservoir and the river upstream. They originate from stocking programs in Oregon, Idaho, Nevada and the Duck Valley Indian Reservation.[42,41]

b. Habitat and life history

Rainbow trout require fast flowing oxygenated waters for breeding, but they also live in cold lakes. Most rainbow trout subspecies prefer water that is about 54°F in summer.[9]

Fingerlings (Oak Springs Stock) make up a majority of the hatchery rainbow trout stocked into the lower Owyhee subbasin in any given year. Legal sized trout (Cape Cod Stock) are occasionally used to jump-start a fishery while the fingerling trout grow or the warmwater fish populations are rebuilding.[42]

Rainbow trout generally feed close to the bottom. They eat insects, mollusks, crustaceans, fish eggs, and minnows and other small fish.[9]

c. Production

i. Owyhee River downstream of reservoir

The relative abundance of rainbow trout in the Owyhee River downstream of the dam is quite variable. In a given year it is determined by the stocking rate, the harvest rate, the spring discharge down the river, and winter survival. There appears to be a trend of increasing abundance since about 1982. Reasons for the increase are attributed to a change in the hatchery program in 1977, a decrease in the bag limit for trout streams in 1981, and possibly an increase in the number of anglers practicing catch and release. The hatchery program changed from an annual "put-and-take" program using about 10,000 legal sized rainbow from Hagerman National Fish Hatchery to an annual "put-and-grow" program using about 40,000 fingerling Oak Springs stock from Oregon Fish and Wildlife Department hatcheries. The daily bag limit prior to 1980 was 10 per day; in 1981 it changed to 5 per day. Through the 1980s and into the 1990s the number of trout caught and released has increased substantially.[42]

ii. BLM stock ponds

The relative abundance of each population at a BLM stock watering pond varies with the stocking and water conditions in a given year. The number of fish stocked into a pond varies with the size of the pond, the water year, and sometimes the road conditions. The number of fish stocked varies from about 100 to 1,000 fingerlings per pond per year. None of these rainbow trout populations reproduce consistently in the wild. Occasionally wild produced fingerlings are observed during fish inventories, but the number is very low and limited to a few ponds. Most ponds dry up or do not have enough water for fish to survive during cycles of repeated years of low precipitation.[42]

No fish are stocked in the mainstem of the Owyhee River above the dam or its tributaries in Oregon. Most hatchery fish drift into the river from the stocking programs upstream from the state line. A few might occasionally flush into the river from Oregon's stock pond reservoir stocking program.[42]

d. Survival from one year to the next.

The following size groups are used to describe the population: nine inches, twelve inches, fifteen inches and eighteen inches. The nine inch size group corresponds to the proportion of the population that was stocked the previous spring. The other size groups roughly correspond to fish that have survived one or more years in the river. These indices are used to advise anglers on the expected quality of the fishery in the future.[42]

Harvestable trout size has traditionally been six inches in length. Although it has recently changed to 8 inches, 6 inches will be used in this discussion because it was the harvestable length for most of 50 years management has occurred in this basin.[42]

i. Owyhee River downstream of reservoir

The size structure of the population of trout has changed over the years. Prior to 1983 the proportion of the sample greater than 9 inches was less than 40 percent of the fish over the legal catch length of 6 inches. During this time period there was very little survival of fish through their first winter. After 1983 the proportion of the population greater than 9 inches increased to over 50 percent in most years. Prior to 1987, the proportion of the sample greater than 12 inches averaged 6 percent. Since 1987, the proportion of the sample greater than 12 inches averaged 39 percent. The proportion of the sample greater than 15 inches has been variable with the high percentage observed in 1991 attributed to the high stocking rates in 1989 and 1990. The proportion of the sample greater than 18 inches has averaged 2 percent.[42]

ii. BLM stock ponds

The growth rate of rainbow trout in the BLM stock ponds has not been studied.[42]

e. Fishery

i. Time of operation

- *Owyhee River downstream of reservoir*

The major hatchery rainbow trout fishery in the lower Owyhee subbasin takes place in an eight-mile reach downstream of the dam affected by the release of cold water. The angling effort peaks in the early spring just before irrigation flows are turned on and again in the fall just after irrigation flows are turned off. Fishing on the river through the summer is fairly consistent but lower than in the spring or the fall. During the winter, fishing is light, with some angling through the ice. Since the late 1970s this fishery has gained in popularity. It has a reputation of producing fair numbers of large trout. It gets a lot of publicity in the Boise fly shops and the Boise media.[42]

- *BLM stock ponds*

Angling effort at BLM ponds usually begins increasing in the late winter when roads are still frozen, but the ponds are ice-free. In the early spring when roads are soft and wet angling effort declines. As the roads dry in late spring and early summer angling effort again increases. During the heat of the summer angling effort is light. Again, in fall as temperatures decline, angling effort increases. Some say this is the best time to fish these ponds. Hometowns of anglers vary with pond location. Hunters, rockhounds, and others from a wide geographic area also fish the ponds incidental to other recreational activities.[42]

ii. ODFW Management

The ODFW manages the fisheries to provide continued opportunities for fishing to the public and to maintain certain populations of fish.

- *Owyhee River downstream of reservoir*

The rainbow trout fishery below the dam is managed under the ODFW "Basic Yield" option of the Trout Management Plan. The current regulation (2006) is 5 fish daily bag limit and the possession limit is two daily bag limits with no more than one fish over 20 inches long.[42]

Maintaining the quality of the fishery is dependent upon maintaining the relative abundance and structure of this population. Many factors affect these two attributes.

The stock type and stocking rate can be major factors determining the abundance. Fish survival through spring flood flows, the angling pressure, and the survival over the winter affect the structure of the population. Recruitment of fingerlings into the fishery is a primary goal. This appears to be occurring when the proportion of the sampled fish greater than 9 inches is 50 percent or more. If the proportion greater than 9 inches is significantly higher or lower than 50 percent for more than one year an investigation should be undertaken to determine the causes.[42]

Operation of the reservoir and natural flooding can affect this population. The abrupt changes in flow downstream of the dam can be very disruptive to the population. Flows can vary greatly during the spring. Historically flows varied from less than 10 cubic feet per second (cfs) to over 2,000 cfs, back down to 300 cfs then up to 4,000 cfs in one month. In late October the flows were shut off. Winter flows down the river are a combination of leakage and some releases from the dam by the irrigation district. These winter flows had an average 15 cfs at the USGS gage downstream of the dam (USGS River Data.)[42] Currently the irrigation district tries to maintain a 30 cfs minimum flow.

Requests for additional flows from Owyhee Reservoir could affect the hatchery rainbow trout. There could be flooding releases requested from Owyhee Dam at times when the extra flow would flush out trout from this area into areas less hospitable for trout. The impact of any additional flow request on the trout populations in the lower Owyhee River will depend upon the amount of water requested and when the water will be released.[42]

- *BLM stock ponds*

Each pond is stocked annually or when conditions permit. The pond rainbow trout fisheries are managed under the ODFW “Basic Yield” option of the Trout Management Plan with the same daily and possession limits stated above.[42]

Trout abundance, population size structure, and growth varies from year to year and from pond to pond. The fisheries on individual ponds are small, but in the aggregate they provide opportunities over a wide geographic area where there are few angling opportunities of any kind.[42]

f. Unknown factors

The social impact of the growth in the human population in the Boise metropolitan area is affecting the fishery. At present Idaho anglers are estimated to comprise most of the fishing on the river. A great many of these anglers are asking the ODFW department for more restrictive regulations, specifically to outlaw the use of bait.[42] The impacts of the recreational fishery are discussed further in recreation component of this assessment.

7. Hatchery brown trout

Brown trout are a native of Northern Europe and the British Isles. They were introduced into North America in the early 1800s.

a. Distribution

Browns were first introduced into the lower Owyhee subbasin in 1990. They were introduced to provide a quality or trophy trout fishery and to see if they might work as a large predator on nongame fish populations. The nongame fish periodically spill through the dam and move in from downstream areas and the Snake River.[42]

Brown trout are found in the Owyhee River downstream of Owyhee Dam. There are no perennial tributaries of the Owyhee River downstream of the dam.[42] Brown trout are favored by the artificial collection of cold water in the Owyhee Dam and its subsequent release during the warmer part of the year.

b. Habitat and life history

Brown trout prefer cold, well-oxygenated waters, especially large streams. The availability of cover is important to brown trout. They are more likely to be found where there are submerged rocks, undercut banks, and overhanging vegetation.[2]

Brown trout can mature at age two (8 inches in length). They spawn in the fall. They prefer to spawn in small gravel substrate streams as do most other trout, but can use other habitats such as rocky shelves along lake shores. They have been observed spawning in the Owyhee River on several gravel bars near the Tunnel in 1994 and 1995.[42]

Brown trout are thought to do better than other trout species in slower, warmer waters. They have also been observed actively feeding in slush ice. They probably have a wider thermal range of activity than do most other trout species.[42,59]

Brown trout are active feeders. They are most active near dawn and dusk and after dark in streams. They are carnivorous and eat a wide range of organisms. The diet of brown trout includes aquatic and terrestrial insects and their larvae, crustaceans (especially crayfish), mollusks, salamanders, frogs, rodents, and fish. Other fish generally do not play a prominent part in the diet of brown trout under 12 inches in length.[42]

c. Production

The abundance of brown trout has gradually increased since its introduction in 1990. During the first years after introduction the principal objective was to establish a population in the river. From 1990 to 1992 both fingerling and legal sized brown trout were stocked into the river. In 1992 the fingerling program was discontinued. In 1993 the legal stocking program was cut back to 3000 legals every other year. After 1997 the population have been self sustaining with some stocking continuing until at least 2000.[42]

d. Fishery

Fishing for brown trout occurs concurrently with fishing for rainbow trout. The angling effort peaks twice, once in the early spring just before the reservoir starts spilling flood flows or irrigation flows are turned on and again in the fall just after irrigation flows are turned off. Fishing effort through the summer is fairly consistent but much lower than in the spring or fall. There is very little angling in the winter after the river freezes over.[42]

Since 1990 the number of anglers targeting brown trout has increased. This fishery attracts a lot of anglers from the Boise-Nampa-Caldwell area in Idaho. Status of fishing conditions is posted on all of the information boards in the fly shops.[42]

Brown trout of all sizes are being caught. There appears to be no dominate size group in the catch. Most anglers can not target the larger individuals.[42]

The brown trout fishery and management program is well developed. Currently the brown trout are being managed under the “Trophy or Quality “ option in Oregon's Trout Management Plan. Regulations are release unharmed.[42]

The average fish size has increased. Since this fishery is under a catch and release regulation it was expected to produce large fish since all fish are returned unharmed to the river and continue to grow. Brown trout growth appears to be equal to or slightly better than that of hatchery rainbows.[42] The abundance of the brown trout population has increased and appears to be only slightly less abundant than the hatchery rainbow trout population.[42]

The fishery is very popular and fishing has increased over time.[42]

The ODFW has the same concerns in trying to maintain this fishery as for the hatchery rainbow trout fishery. Operation of the reservoir or natural flooding can affect this population in the same fashion as mentioned above for rainbow trout.[42]

e. Unknown factors

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

The social impact of the growth in the human population is affecting the fishery. At present (2006) Idaho residents are estimated to comprise the majority of the effort on the river. The anglers are beginning to request special angling regulations for this river reach. The fishery is gaining a reputation outside the local area. Anglers are being attracted from other areas of the country. The potential impacts of increased use of this artificial recreational fishery are unknown.

What impacts are brown trout having on the native amphibians?

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

E. Warmwater gamefish

1. Background

Like the artificial coldwater fishery below Owyhee Dam facilitated by the construction of the dam, the warmwater fishery in Owyhee Reservoir was created by the construction of the dam. A layer of warmwater develops on top of the cold water in the reservoir each year. The warmwater gamefish are all introduced species, although there is a possibility that there were carp and bullhead catfish in the region before their introduction into the reservoir.

The warmwater fishery on Owyhee Reservoir is by far the largest fishery in the lower Owyhee subbasin in terms of the number of anglers and angler hours per year. The fishery on the reservoir prior to 1957 was very different from the fishery today. Boat access was limited to small boats that could be launched from shore near road access points or larger boats that could be launched near the power house by a boat crane. This limited the number of boats that could reach distant areas of the reservoir. In 1958 the first ramp was built near the powerhouse. Subsequent ramps were built at the Cherry Creek Resort, at Owyhee State Park, Owyhee Day-Use-Area, and at Leslie Gulch. Bank angling access has always and continues to be restricted to areas around limited road access points. These access points include the road around the east side of the reservoir and the roads into Cherry Creek, Dry Creek Arm, Pelican Point, Leslie Gulch, and towards Watson. There is also a road to the river at Birch Creek Ranch, just upstream of the reservoir. The road into Pelican Point has not been improved in years.[42] The dirt roads into the Dry Creek Arm and into Watson are precarious.

After the construction of boat ramps, Owyhee Reservoir became a very popular recreational site. From 1935 to the late 1950s the reservoir was about the only major large reservoir warmwater fishery for southeastern Oregon and southwestern Idaho. Beginning with the completion of Brownlee Dam in 1957 other large reservoirs began to attract anglers. Reservoirs like Brownlee Reservoir have easier access for both Oregon and Idaho residents. Idaho residents do not have to purchase a nonresident license at Brownlee Reservoir, and there are better catfish and trout populations.[42]

2. Status

There are four major warmwater gamefish populations in the lower Owyhee subbasin: black crappie, largemouth bass, smallmouth bass, and channel catfish. Several other species are present but support only minor fisheries: yellow perch, brown bullhead, warmouth, and bluegill. Very little fish life history information specific to this subbasin has been collected.

3. Black crappie

a. Distribution

Black crappie were probably introduced into Owyhee Reservoir after the completion of Owyhee Dam in 1933. They are the most common gamefish species in the reservoir. During the spring, summer and early fall they appear to be well distributed throughout the reservoir at a depth of 15 feet or less. During the winter they tend to school in deeper (30 to 50 feet) parts of the reservoir.[42] Population of crappie depend on natural reproduction. They are not stocked.

Black crappie are found in Owyhee Reservoir and in the river both upstream and downstream of the reservoir. In the past, crappies were found as far upstream of the reservoir as Birch Creek. During the drought years from 1987 to 1994 they extended their distribution upstream several miles.[42]

b. Habitat and life history

Black crappie are found in lakes, ponds and pools of streams. They usually prefer to reside among vegetation over either a mud or sand bottom. They also prefer clear water.[35]

Crappie spawn in the spring when the water temperature reaches 66°F to 68°F which occurs during late June and early July in the lower Owyhee subbasin. Males construct their nests on hard substrate among cobble and boulders in protected shallows along the shore and in coves. In Lake Owyhee crappies are known to spawn in the areas around the Elbow, Three Finger Gulch, and Doe Island. They also spawn in conjunction with largemouth bass in the Pelican Point area. When spawning is complete the females move back to deeper water to recover. The males continue to guard the nest and the fry after they hatch. The amount time from nest construction to fry dispersion varies with water temperature from 4 days to 3 weeks.[42]

c. Productivity

Relative abundance of black crappie is variable and follows a boom and bust cycle. Years with high crappie abundance are usually followed by years with very low abundances. Good examples of this phenomenon occurred in 1966 and 1967, 1979 and 1980, and 1982 and 1983.[42] The reasons for high or low crappie abundance in the reservoir are complicated and have not been studied in the Owyhee Reservoir. Large variations in the water elevations between years due to differences in precipitation affects both human uses of the reservoir and fish reproduction, survival, and growth.[42]

d. Size structure

The crappie size structure is almost as variable as its abundance. The population has been consistently dominated by individuals less than 8 inches in length, although there are years when about half of the individuals are above 8 inches.[42]

e. Growth

Growth of crappie in Owyhee Reservoir is about average for the area and latitude. On average, "stock size", 5 inches, is reached in the second year. "Quality" size, 8 inches, is reached in the third year. "Preferred size", 10 inches, is reached in the sixth year. "Memorable", 12 inch, and "trophy", 15 inch, sizes might be reached after the eighth year. Crappie over 12 inches are very rare.[42]

f. Fishery

The fishery on Owyhee Reservoir begins as the water warms up in the early spring and peaks in late April through early July. Fishing declines during the hot part of the summer. In the fall, especially during hunting seasons, fishing increases but not to spring peak levels. Fishing over the winter is very light.[42]

Anglers primarily use boats in pursuit of crappies in Owyhee Reservoir. Boat angling is concentrated in the lower half of the reservoir, from Pelican Point to the dam. Bank fishing is concentrated around road access points, with most occurring from the dam to the resort.[42]

Crappie fishing has attracted most of the angling effort on the reservoir. Over the years the proportion of the anglers pursuing other species has increased. The most recent information indicates crappie still attract the largest proportion of the anglers.[42]

In most years large proportions of the crappies caught are kept. The size of harvested crappie varies from year to year based on the size available and the abundance. The majority of the harvest is composed of 8 to 10 inch crappie. There appears to be no trends toward smaller or larger fish sizes in the catch.[42]

g. ODFW management

The projected increase in population growth in the Treasure Valley is expected to increase the demand for recreation including crappie angling.[42]

Crappie abundance has varied over the years from relatively scarce to abundant. Individuals less than 8 inches in length have consistently dominated the population size structure. Larger individuals are rare. Crappie attracts more anglers, but the amount of effort directed toward bass and occasionally catfish can approach the crappie fishery. The crappie catch has apparently declined, but the variation is large enough that it is difficult to determine if the change is significant.[42]

Current management of this population is for “Basic Yield” under the Warmwater Fish Management Plan. The characteristics of this option are a wide range of available sizes, angler determined catch and release, and variable catch rates.[42]

Other states have tried more restrictive bag limits and size limits to increase the biomass in the harvest. These regulations have shown promise in some water bodies. If these regulations are to be considered on Owyhee Reservoir, a better understanding of the cyclic nature of this population would be necessary.[42]

4. Largemouth bass

a. Distribution

Largemouth bass are found in Owyhee Reservoir and in Dunaway Pond in the Lower Owyhee subbasin. They occasionally are found in the Owyhee River downstream of the dam. They are assumed to be part of the initial group of warmwater fish introduced into Owyhee Reservoir after the completion of the dam. Dunaway Pond south of Nyssa has had largemouth bass since the early 1960s. It is not known whether the ODFW or some other entity introduced largemouth bass into the pond.[42]

b. Habitat and life history

Largemouth bass inhabit clear, vegetated lakes and ponds. They prefer quiet water and over-grown banks.[30]

Largemouth bass spawn in the spring when the water temperature is between 60°F and 75°F. In the lower Owyhee subbasin spawning usually occurs from late April through early July, with the peak occurring in late May and early June. Nests can be found near shore or in coves which tend to warm up first in the spring. Nests tend to be in 1 to 4 feet of water. Bass tend to nest in groups with spacing between nests averaging about 6 feet.[10] In the reservoir they spawn from Dry Creek upstream to the hot springs south of Leslie Gulch.[42]

Males build the nest. A male courts one or more females to spawn with him. Most successful nests contain between 5,000 and 43,000 eggs. Once the eggs are laid the female leaves. She may spawn with another male or retreat to deeper water to recover. The male guards the nest. He continuously fans the nest keeping the eggs silt free and guaranteeing that the eggs are in constant contact with freshwater.[10]

Time to hatching varies with water temperature. Fry are usually free swimming 10 days after hatching. They must start eating within about 6 days after becoming free swimming or they die.[10]

The diet of largemouth bass is variable with age, season and water body. They changeover to a fish diet when they reach about 2 to 4 inches in length.[42] In addition to feeding on fish, adult bass are known to eat crayfish and frogs.[30]

c. Relative abundance

Since 1986, relative abundance of largemouth bass in the Owyhee Reservoir has been variable. Local anglers characterize the population in the late 1970s as being more abundant, specifically with many larger individuals than now exist. A combination of effects from the high water years in the early 1980s and the drought in the late 1980s and early 1990s combined with increased mortality associated with increased angling probably left the reservoir with many weak year classes and a largemouth bass population with a much lower abundance.[42] Low water years result in rapid water draw down making spawning success more difficult.

The population in Dunaway Pond has been sampled for largemouth bass only twice and fell within the range of values observed at Owyhee Reservoir.[42]

d. Size structure

Individual largemouth bass less than 12 inches in length have dominated the population in Owyhee Reservoir with a couple years when individuals over 12 inches made up at least half of the population.[42] Individuals less than 12 inches in length also dominated the population in Dunaway Pond.[42]

e. Growth

The growth expressed by the population of largemouth bass in Owyhee Reservoir appears to be about average for water bodies of this region. Largemouth start to be harvested at 8 inches in their third summer. "Quality size", 12 inches, is reached on average in their fourth summer. Largemouth bass reach 15 inches on average in the sixth summer. "Memorable size", 20 inches, is reached in their ninth summer. "Trophy size", 25 inches, is seldom reached.

Growth of bass from Dunaway Pond has not been studied.

f. Fishery

Fishing for largemouth bass in Owyhee Reservoir is very popular with anglers from Oregon and Idaho. The bass fishery on this reservoir is dominated by boat angling. Very little of the bank effort on this reservoir is directed toward either bass species. Angler effort targeting largemouth bass usually increases in the early spring. It peaks in May and June. It declines through the summer. It increases slightly in the fall and is very low through the winter.

The bass fishery on Dunaway Pond is popular with local residents from the Nyssa area. The amount of fishing is quite small. Fishing directed toward bass begins to increase in the spring with a peak in the late spring. It then drops off in summer. This pond is favored by local families and kids.[42]

The number of largemouth bass kept is a very small part of the total catch on Owyhee reservoir. This is in part because there were so few large bass available and because anglers are voluntarily releasing most bass they catch. On Owyhee Reservoir, most of the bass kept were between 10 and 14 inches long. At Dunaway Pond very few of the bass are kept because they are not large enough to satisfy anglers.[42]

g. ODFW management

Since 1986 the abundance of largemouth bass in Owyhee Reservoir has been variable. Local anglers have reported that the abundance and size of largemouth bass has declined since the 1970s. It has started to rebound some in the last few years. Individuals less than 12 inches have dominated the size structure of the population. The annual mortality rate appears to be very high in some years. The fishery has grown in popularity since the mid 1970s. The catch rate remains high but the harvest rate is very low due to angler choice.[42]

Current management of the largemouth bass population in Owyhee Reservoir and Dunaway Pond is for “Basic Yield” under the ODFW Warmwater Fish Management Plan. The characteristics of this option are a wide range of available sizes, optional catch and release, and variable catch rates.[42]

Future management of this species may include changing regulations that may take advantage of largemouth’s piscivorous (fish eating) nature and a growing population of Lahontan tui chubs. These chubs have the reproductive potential to over populate the reservoir and affect other fisheries.[42]

Regulation changes may include increasing the length limit. This would hopefully increase the survival of bass into large sizes where they are better predators. The success of any such change in regulations would depend upon the natural mortality rates of bass. If natural mortality is high, then most of the bass saved by the regulation would probably die. If the mortality rates stayed low then there is a chance that an increase in the size structure of the population could occur.[42]

Very little information is known about the population of largemouth bass in Dunaway Pond. More basic information about the dynamics of this population should be gathered before changes in the current management scheme are undertaken.[42]

h. Unknowns

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

The effect of rapid human population growth in southwest Idaho is unknown.

The effect of future demands for salmon flush flows is unknown. How much water and when it is released could depress the largemouth bass spawning and population.

5. Smallmouth bass

a. Distribution

Smallmouth bass are found in Owyhee Reservoir, Owyhee River above and below the reservoir, and sometimes in Dry Creek. Smallmouth bass were first introduced into the river upstream of the reservoir in 1970. Bass in the lower 10 miles of the river most likely moved up from the Snake River or spilled through the Owyhee Dam.[42]

b. Habitat and life history

Smallmouth bass prefer the shallow rocky area of lakes or the gravel-bottomed runs of clear, cool flowing streams or flowing pools of rivers.[31] They are relatively intolerant of pollution but are more adaptable to changes in water conditions than most trout species.[47]

The diet of smallmouth bass varies with their size, prey size, and prey availability. Juveniles tend to prey on insects but fish and crawfish start entering their diet. As adults their diet is primarily crawfish and fish, with some insects.[47,4,7]

Smallmouth bass spawn in the spring. In the reservoir they spawn primarily in May and June. In 1992 during the drought they were being caught off their nest in late March. Spawning takes place throughout the reservoir, but is concentrated from the Dry Creek Arm upstream to Leslie Gulch. Spawning in the river is thought to take place slightly later than in the reservoir.[42]

Males start moving into shallower water when water temperatures start exceeding 50°F.[4] Males construct their nest in protected shallows away from current and wave action.[7] Nests are usually located on sand, gravel or rubble near structures in 10 to 15 feet of water.[4] Nests constructed in rivers tend to be in shallower water.[7] They tend to avoid substrates with silts and clays.[7] Each male may build several nests before spawning in one.[4,7]

Males may spawn with one or more females in one nest. Females will spawn with more than one male, once done they move to deeper water to recover. Males guard the nest and the fry until they disperse. The amount of time from egg deposit to fry dispersal varies with water temperature from one to four weeks.[4,7]

c. Relative abundance

The number of smallmouth bass in the Owyhee Reservoir has been gradually increasing since their introduction and appears to have stabilized. Since 1989 they have composed 12 to 26 percent of the bass numbers in the reservoir.[42]

As in the reservoir, smallmouth abundance in the Owyhee River upstream of reservoir has increased since their introduction in 1970. In 1988 when a comparative study was conducted, the average relative abundance in the river was twice that in the reservoir.[42]

Natural mortality can be very high some years.[42]

d. Size structure

Individuals between 7 and 11 inches have consistently dominated the size structure of smallmouth bass in Owyhee Reservoir. Few individuals greater than 14 inches and no individuals greater than 17 inches have been observed during the spring inventory. Anglers occasionally catch larger individuals, but none have been verified.[42]

Smallmouth in the Owyhee River upstream of the reservoir have been sampled only once with electrofishing gear, in 1988. Very few of the fish in the sample were over 11 inches. Anglers describe the river population as numerous, but dominated by smaller individuals. One angler snorkeled several pools and noted that larger individuals are present, but clouds of smaller individuals never let the lure get down to the larger ones.[42]

e. Growth

The growth rates for smallmouth bass in Owyhee Reservoir are slightly above average for populations at this latitude. They tend to grow faster than other populations in the Snake River. Growth rates of bass in the Owyhee River have not been studied.[42]

f. Fishery

Smallmouths began making up part of the fish that were caught and kept from the reservoir in the early 1980s. In 1988 they composed about 20 percent of the harvested bass. The smallmouth fishery in the reservoir is a part of the “bass” fishery. Anglers do not distinguish between the two species of bass. Angler possession (creel) data from the reservoir indicate that the catch rate has probably increased.[42]

Anglers began learning about bass in the Owyhee River in the late 1970s. The fishery has a reputation of producing many small fish. The fishery in the river is gaining in popularity as much as the remoteness and lack of access will allow. Access to the river above the reservoir is very limited by geographical features.[42]

g. Size at harvest

The majority of the smallmouths harvested in Owyhee Reservoir are less than 12 inches in length. This coincides with inventory information which indicated there were few fish over 11 inches. Anecdotal information indicates that few fish over 12 inches are caught from the river as well.[42]

h. ODFW management

The fishery in the reservoir is part of the “bass” fishery. The reservoir bass fishery is depressed compared to anecdotal evidence from local anglers.[42]

Current management of this population is for “Basic Yield” under the Warmwater Fish Management Plan. The characteristics of this option are: a wide range of available sizes, optional catch and release, and variable catch rates.[42]

High natural mortality in some years appears to be the primary limiting factor for the reservoir population of smallmouth bass. Very little mortality is thought to be associated with angler harvest. The high natural mortality may be associated with low abundance and a high hooking rate that stresses a large portion of the population.[42]

Looking into the future, changes in reservoir operation could become another major limiting factor. Large water level fluctuations in the May and June to flush salmon smolts in the Columbia River could decrease smallmouth reproduction.[42]

6. Channel Catfish

a. Distribution

Channel catfish were first introduced into the Owyhee Reservoir in 1962. They were introduced into the upper Owyhee River near Rome in 1970. Catfish are found in Owyhee Reservoir and in the Owyhee River upstream to Rome. They are also in the lowest 10 miles of the Owyhee River. Individuals in the lower 10 miles of the river are migrants from the Snake River and from spill out of the reservoir.[42]

b. Habitat and life history

Channel catfish thrive in a diversity of environments: small rivers, large rivers, reservoirs, natural lakes, and ponds. They prefer clean, well oxygenated water.[5,27]

This species is omnivorous. Young individuals tend to eat aquatic insects. Although older individuals feed primarily on small fish, crayfish, clams and snails, they will eat most anything that is available. This includes insects, crabs, algae, tree seeds, frogs, bullheads, and suckers. They predominately use their barbels (whiskers) and taste to find food at night or in cloudy, muddy or stained water. In clear water habitats they tend to use sight to find food more than do other catfishes. This species primarily feeds on the bottom of lakes and reservoir, but some individuals, especially younger ones, will feed at the surface.[42,5,27]

Spawning occurs from late spring into summer when the water temperature is between 75°F and 85°F. In Owyhee Reservoir this occurs from late May to early July. Spawning takes place in secluded semidark sites. Males build the nests in holes, under undercut banks, log jams, and rocks. After spawning is complete females leave the nest to recover while the male guards the nest. Hatching takes place in 5 to 10 days at water temperatures from 60°F to 82°F. The male probably broods the young.[42]

c. Relative abundance

The catfish can and probably do move freely between the upper river and the reservoir. The majority of the information on channel catfish was collected in the reservoir.

The relative abundance of the channel catfish population in Owyhee Reservoir has increased since their introduction in 1962. The river portion of the population is thought to have increased in relative abundance over the same time period.

In 1988 there were twenty sites along the Owyhee River and in Owyhee Reservoir that were sampled for channel catfish. Their relative abundance was greatest just upstream of the reservoir near Birch Creek. They were also found at both sites sampled near Rome. In Owyhee Reservoir channel catfish less than 16 inches in length have dominated the population.[42]

d. Growth

The growth rates of the channel catfish in Owyhee Reservoir and in the Owyhee River have not been studied.[42]

e. Fishery

The major channel catfish fishery in the lower Owyhee subbasin is located in Owyhee Reservoir. Most catfish fishing is concentrated at the head of the reservoir. Angling effort begins to increase when the weather warms in spring. It usually peaks in late spring through early summer. During the heat of the summer it declines. Again in the fall as temperatures cool and hunting seasons take place it increases.

The fishery in the reservoir has been growing in popularity since it began in the early 1970s. The amount of fishing for channel catfish has increased with the increase in its abundance. In years when the reservoir is full and access to the head of the reservoir is good, effort can be quite large.[42]

There is a very limited fishery in the river upstream of the reservoir. This fishery is limited by access to the river. Access to the river is available at few points. Very little harvest information is available on the river fishery in the river.[42]

Channel catfish taken from Owyhee Reservoir from 10 to 16 inches in length dominate the size at harvest. Very little of the harvest is of fish over 16 inches or under 10 inches in length.[42]

f. ODFW management

This species is currently managed under the “basic yield” option in the Warmwater Fish Management Plan. Placing a bag and/or size limit on catfish might not produce predictable or measurable changes in the future.[42]

g. Unknowns

The interactions of the different warmwater fish are unknown. What effect does an increase in the catfish population have on the native warmwater fishes? What effect does it have on the other warmwater game fish? What fish does it compete with for food and habitat?

7. Warmwater gamefish not discussed above

The other species of introduced gamefish in the Owyhee Reservoir are perch, bluegill, brown bullhead, warmouth, pumpkinseed, and tadpole madtoms. They have much smaller fisheries.

The yellow perch can inhabit either fresh or brackish water and is found in salt lakes. They are most commonly found in clear water near vegetation either in beds of weeds or under overhanging trees or bushes.[33,57]

The brown bullhead is native to eastern North America and the Mississippi River basin. It inhabits pools and sluggish runs over soft substrates in creeks and rivers. It may also be found in impoundments, ponds, and lakes. Although it rarely enters brackish water, it can tolerate high carbon dioxide, low oxygen concentrations, and high temperatures. It has been observed to bury itself in mud to escape adverse environmental conditions.[20]

The bluegill are native of the great lakes and Mississippi River basin. They are found frequently in lakes, ponds, reservoirs, and sluggish streams. They are noted for seeking out underwater vegetation for cover.[29,1]

The pumpkinseed is native to the eastern United States. They prefer vegetated warmwater ponds, lakes, and quiet pools of streams. They use weed patches or logs for cover and stay close to shore.[28,45]

The warmouth is native to the central and eastern United States drainages. They live over mud in ponds, lakes, and quiet water areas of streams with vegetation.[46]

The tadpole madtom is native to eastern North America and the Mississippi River basin. They inhabit lakes and rock, mud, or detritus bottomed pools of creeks and rivers.[32]

F. Non-native, nongame fish

Non-native, nongame fish were introduced into the lower Owyhee subbasin intentionally to provide a source of protein for human consumption or accidentally as bait in the pursuit of game fish. They were also introduced as forage for game fish.[42]

1. Common carp

The common carp is native of Europe and Asia. It tolerates a wide variety of conditions and has been introduced around the word. It prefers large bodies of water with slow flowing or standing water over soft, vegetative sediments. Common carp thrive in large turbid rivers.[13,8]

Carp were introduced into the Snake River and/or adjacent ponds as a food fish around the turn of the century. They have spread up and down the Snake River and into the Owyhee River. They are very abundant in Owyhee Reservoir.[42]

Common carp are omnivorous and will eat almost anything including water plants, insects, crustaceans, seeds, or even dead fish. Since they feed by grubbing in sediments, the adults uproot and destroy submerged aquatic vegetation. They can cause serious damage to duck and native fish populations. They have attributes that allow them to invade and dominate new ecosystems with serious effects on the ecosystem and native fauna.[13,8]

Have carp altered or are they altering the ecology of the Owyhee River in the lower Owyhee subbasin? What effects are they having on the remaining populations of native fish?

2. Lahontan tui chub

The Lahontan tui chub is another invasive fish in the Owyhee Reservoir with the potential to over populate the reservoir. Since tui chub inhabit lakes and quiet, vegetated, mud or sand-bottomed pools and are native to other areas of the Columbia River drainage and of the Great Basin,[26] they are well adapted to the conditions of the Owyhee Reservoir.

They were originally introduced into Wildhorse Reservoir upstream in Nevada. They escaped downstream. Attempts to poison them failed. At least in high water years chub continue to escape and are now present in the Owyhee Reservoir.[42]

The ODFW is considering ways to manage the largemouth bass, a piscivorous (fish eating) fish, to try to control the Lahontan tui chub population.[42]

3. Introduced fish in the lower Owyhee subbasin below the dam.

Several Utah chub have been found in the lower drain ditches in the Owyhee basin.[42] The Utah chub is adapted to a myriad of environmental conditions. Its habitat ranges from irrigation ditches to lakes to alkaline springs. It is often found in vegetation over mud or sand. It is found in the upper Snake River Basin in Idaho.[25,52,51]

Utah chub are omnivorous and can become so common that they create pressure on other fish populations through intense competition for food and space.[52] Eradication programs to reduce numbers have had no effect, the chub population easily bounces back.[51]

The fathead minnow inhabits muddy pools in streams and is also found in ponds and small lakes. It tolerates high turbidity, high temperatures, and poorly oxygenated water. It can also live in intermittent streams.[16,34]

Fathead minnow populations exist throughout the Treasure Valley. They can be found in many of the irrigation and drain ditches in the lower Owyhee River basin. They are popular as live bait and could be escapees from the aquarium trade. They have also been introduced into several ponds in the Treasure Valley as forage for bass and catfish.[42]

The oriental weatherfish is a native of Asia. They live in rivers, lakes, or ponds but prefer muddy bottoms of streams and ponds.[50] Several individuals have been found in the lower drain ditches in the Owyhee basin. They are most likely escapees from the aquarium trade.[42]

G. Other considerations

There have been no studies of the interactions between the species of fish in the lower Owyhee subbasin. Little is known about the distribution of many species within the lower Owyhee subbasin.

Mercury contamination of fish in the lower Owyhee subbasin is discussed in the water quality component of this assessment as are the associated health limits recommended for fish consumption from the subbasin.

There are discussions about whether or not flows in the lower Snake River should be augmented to improve conditions for the seaward migration of juvenile salmon and steelhead which enter the Snake River below the Hells Canyon complex of dams.[3] This is a political and social policy decision outside the scope of this assessment.

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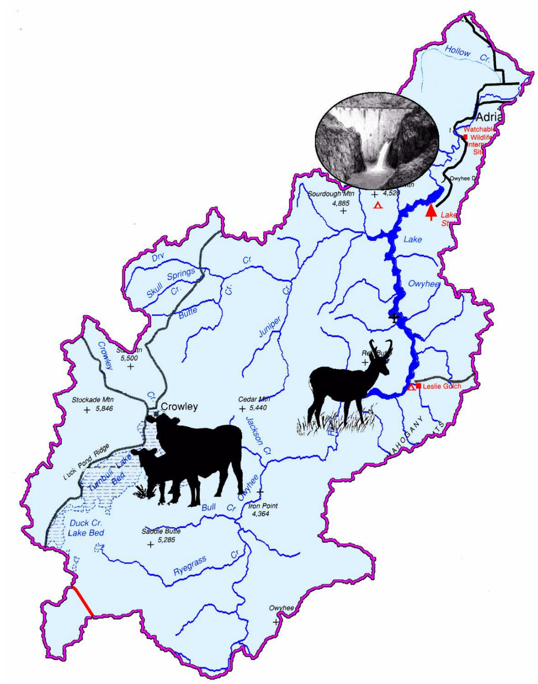

Lower Owyhee Watershed Assessment

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XV. Water Quality Assessment

A. Introduction

The water in the lower Owyhee subbasin is a valuable resource. Not only does it provide natural beauty, but it also supplies the water necessary for farming, ranching, recreation, drinking water, wildlife, and aquatic life. We all want to maintain the quality of our water so that it can continue to meet human and habitat needs.

In examining the water quality of the rivers in the lower Owyhee subbasin, it is necessary to distinguish between naturally existing conditions and conditions caused by human activities (anthropogenic causes). A distinction also needs to be made between legacy use of the landscape and current use. Naturally existing conditions are not open to remediation.

B. Naturally occurring conditions

1. Vegetation along water courses

a. Historical

Revisiting the descriptions in the historical section, the earliest Euro-Americans in the area commented on the lack of any trees (see the at contact section of the history component of this assessment), even along the waterways.

If the banks of the rivers and streams did not have trees growing on them, what did they have? Ogden's statement "excepting a few willow on the banks of the river"[34] gives us some idea. Willows are mentioned when vegetation along the banks is discussed. Most of Ogden's references to willows indicated that in general they were sparse. "When we reach[ed] . . . a fork of [upper] Owyhee River but from all appearances destitute of beaver. . . also wood there being but a few willows and thinly scattered."[34] Traveling one day east of the Owyhee on the Snake River, Ogden records that "wormwood [sagebrush] is more abundant but wood of any other kind equally scarce with the exception of a few scattered willow on the banks of the river, and even these not in abundance."[34]

Narcissa Whitman confirms the observations about lack of trees and sparse willows after traversing the region of the mid-Snake and arriving in LaGrande. "Perhaps you think we always encamp in the shade of some thick wood. Such a sight I have not seen, lo, these many weeks. If we can find a few small willows or a single lone tree, we think ourselves amply provided for."[44]

Lewis Scholl's detachment of an exploratory group of the US army ascended the Owyhee River from the mouth in 1859. He describes the river flowing "in a close and narrow defile, through a solid field of curious shaped lava mountains."[37] As he leaves the Owyhee River to turn east, he contrasts the green landscape which he encounters with the landscape that has been "barren the entire distance I traversed to date."[37]

b. Vegetation

Figure 15.1. The Owyhee River in 1948. No trees grow along its banks.[50]

The willow which the trappers mention is not a tree but coyote willow (Figures 4.3 and 11.4). It is an upright, deciduous shrub which may grow to 23 feet but is generally about 12 feet tall and about 15 feet wide. It grows in sagebrush country along creek bottoms, both on the shoreline and sometimes in the water. Willows form dense thickets of pure, even-aged shrubs. Short-lived, they are one of the most shade intolerant native species and are threatened by both fire and drought. They can not survive long if the water table becomes too low.[7,8]

Coyote willows along a waterway would provide limited shade, however the historical observations indicate that they were only found in some areas. They also would disappear in times of drought and would probably not be found along most sections of intermittent streams and never in draws identified as ephemeral streams.

c. Flooding

Figure 15.2. Trees along the banks of the Owyhee River broken over by the flood waters of 2006.

The largest stream flow measured at the Rome gauge since 1950 was March 18, 1993 with 55,700 cfs.[40] The Bureau of Reclamation (BOR) estimates that the most severe "reasonably possible" flow above Owyhee Dam is 356,000 cfs.[5] An idea of the how the larger water flows scour the banks of the river can be obtained by observing what happened in 2006 when 11,600 cfs were released from Owyhee Reservoir. Although this flow was only a fraction of the water which would have flowed in the Owyhee River if the dam had not been built, the flow below the dam ripped out many of the large cottonwoods that had not existed prior to the dam construction (Figure 15.1) and had established themselves following previous flooding (Figure 15.2). There are still many piles of debris left by this relatively minor flood event. The BOR maximum probable flood is thirty times as great as the flow in 2006 and six times greater than the flow in 1993.

The damages caused by spring-runoff are a common source of stories for early settlers who lived along the river. High flows in the spring would send the river out of its banks. It could be a mile wide in some places when the water was high.[2] The high flows could carry ice and rocks. Walter Perry explains that "the ice would get the rocks rolling."[33] A sudden flood in January 1920 also damaged the railroad bridge over the Owyhee on the Homedale spur.[38]

However, at "Hole in the Ground" upstream from Birch Creek Ranch there is evidence that much more catastrophic events have happened at some time in the past. Well above the presumed level of the 1952 and 1993 floodwaters, there are single water polished boulders taller than a man that were deposited there some time in the past. The event that left them high and dry may have been a combination water-ice flow to have been able to lift them that far or flooding down Crooked Creek from Lake Lahontan.[51]

Gene Stuntz characterizes the spring floods most years before the construction of Antelope Reservoir and Owyhee Dam as turning the Owyhee River into a torrent which uprooted everything within reach of the raging water.[38] The evidence that flooding scours the river course and removes vegetation comes from early descriptions, recent events, historical events, and the river bank landscape.

2. Stream temperature

a. Stream flow

There are tremendous natural variations in water flow in the Owyhee River. These variations cause both flooding, scouring the banks, and diminution of the water flow to almost a trickle.

The minimum flow at Rome since 1950 is 42 cfs on four different dates.[40] Where the Owyhee River stream bed is wide the water would be very shallow and more prone to heating from solar radiation.

i. Historical

Gene Stuntz says the Owyhee varied, dwindling to a small trickle in the hot summer time.[38] Chesley Blake remembers that when the river level went down the water would get warm, and the children would swim in the river.[2]

b. Climate

The discussion in the background section characterizes the air temperatures in the lower Owyhee subbasin (see the climate section of the background component of this assessment). Additional information from the Malheur Experiment Station weather records is available for the soil temperature (Figure 15.3).[13] The average maximum soil temperatures rise above 50°F from March through October, while the average minimum soil temperatures are above 50°F from April through October. Compared to air temperatures, the maximum soil temperature

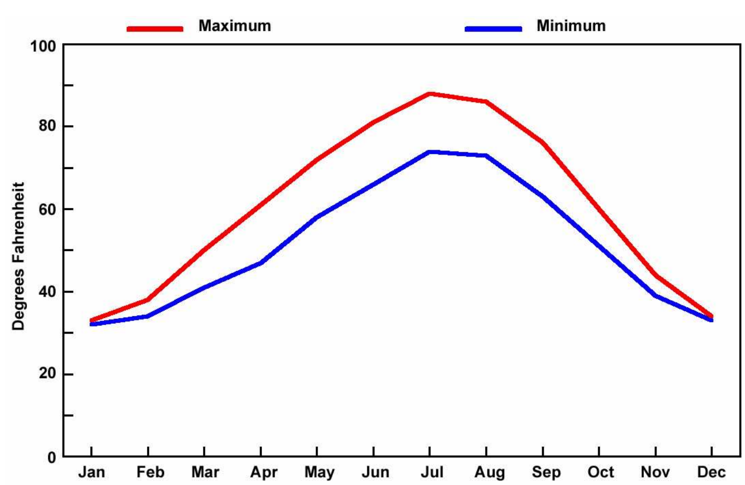

Figure 15.3. 38 year average monthly soil temperature at 4-inch depth, Malheur Experiment Station, Oregon State University, Ontario, OR

rises and falls in a similar pattern, but doesn't quite reach as high temperatures. However, although the minimum soil temperatures follow a similar curve, they remain considerably higher than the minimum air temperatures (Figure 15.4).[41,42]

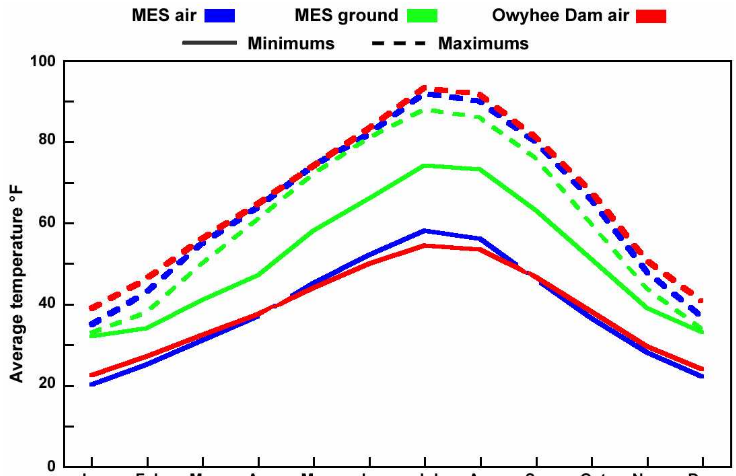

Figure 15.4. Average maximum and minimum air temperatures at Owyhee Dam and Malheur Experiment Station compared to average maximum and minimum soil temperatures at 4-inch depth at Malheur Experiment Station.

The expectation from the temperatures of the air above and the soil below both increasing during the summer months is that the stream temperature would be somewhere between the maximum and minimum temperatures.

Except for the maximum temperatures each day, the soil temperature is above the air temperature for much of the time. The histogram in Figure 15.5 indicates how often a combination of a specific air temperature and soil temperature occurred between 1992 and 2007. Shading varies from dark red for the fewest readings through yellow to green for the most readings. The points to the left of the blue line are the readings when the soil temperature was higher than the air temperature. There are many more particles in the soil than in the air, so the soil absorbs more of the sun's energy than the air does.

c. *Topography*

The Owyhee River runs through deep canyons. The canyon is generally 50 feet to 1300 feet below the level of the plateau.[36,35] Where there are sheer rock walls, they are frequently 600 to 1200 feet tall. Thus, in many places, the canyon itself provides shading for the river during part of the day.

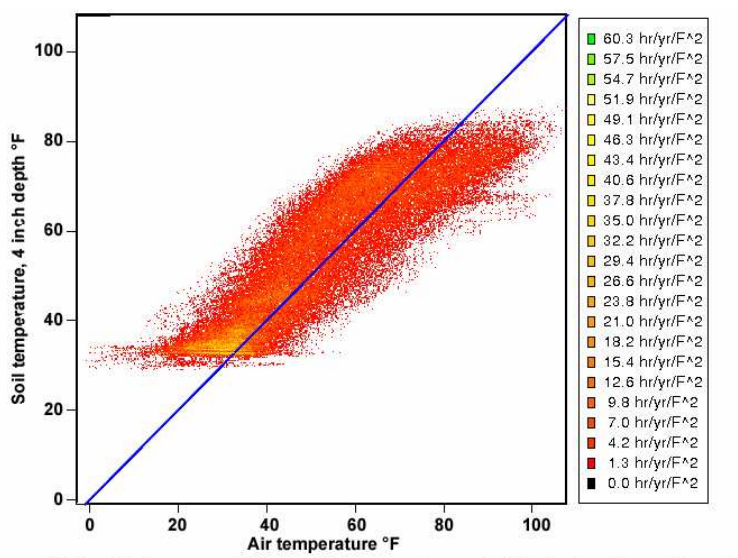

Figure 15.5. Histogram of the soil temperature at 4 inch depth vs. the air temperature at the agrimet weather station, ONTO, from 1992 to 2007.

3. Geological

Minerals which occur naturally in rocks can slowly leach and end up in river waters or be moved with rocks and sediment in the water. These minerals may exist upstream from the lower Owyhee subbasin and still be found in the lower Owyhee subbasin.

a. Mercury

"While mercury most frequently occurs as deposits in rock fractures and veins, it may also be found in low concentrations in other geological formations. Considering the entire Owyhee River watershed, mercury is commonly found as an anomaly, present in 12 of 23 random outcrop rock-chip samples."[2] The occurrence of anomalous high mercury concentrations (>0.2ppm) is also recorded in rock samples taken by the BLM within the lower Owyhee subbasin wilderness study areas. "The study found 10 sample locations with high mercury concentrations in rock chip samples along the west side of Owyhee Reservoir and two locations with high values on the east side of the reservoir."[33]

b. Arsenic

Arsenic is a natural part of volcanic activity and the hydrothermal activity following volcanism. In Oregon, the principle source of arsenic in surface water and groundwater is volcanic and subsequent hydrothermal activity that has deposited arsenic in the rocks and soil.

Arsenic in the lower Owyhee subbasin is from natural geological processes.

C. Legacy anthropogenic conditions

1. Mercury

Except for iron and platinum, all metals dissolve in mercury and chemists refer to the resulting mercury mixtures as amalgams. In the late 1800s into the early 1900s, gold miners in Malheur County and on Jordan Creek in Idaho used mercury for processing much of the gold ore. The gold-bearing rock was crushed and treated with mercury to dissolve the gold out of the ore and form a gold amalgam. The amalgam of gold and mercury was then heated to separate the gold from the mercury by a process of distillation.[21] Silver ore can be recovered in a similar fashion. Precious metal separation by boiling off mercury works because the boiling point of mercury is 357°C but the boiling point of gold is 2808°C and silver is 2210°C. The volatilized (gaseous) mercury would be condensed and reused. "Due to inefficiencies and poor handling practices, large amounts of mercury vapor and liquid often escaped into the environment."[21]

From 1864 to 1920, there was extensive gold and silver mining around the Silver City, Idaho region of the Owyhee basin.[9,15] Most of the mining during this period used mercury amalgamation to recover the gold and silver.[9,15] Estimates of the losses of mercury to the environment vary, but according to Hill et al. 76 pounds (one flask) of mercury may have been lost daily.[15] The Idaho Bureau of Land Management puts the possible loss of mercury during the late 1860s even higher with each of the 14 mills near Silver City losing one flask (76 lbs) of mercury per day for several years.[3]

The result of using a mercury amalgam process to recover gold and silver was elevated mercury levels "in steams located near the processing sites."[21] The Idaho BLM states that "mercury appears to have moved down through the watershed, probably originating from mercury inputs from amalgamation processes from . . . mills operating near Silver City."[3]

2. DDT, Dieldrin

Prior to being banned, growers used DDT, Aldrin, Dieldrin, Endrin, and other similar products. DDT was banned in 1972,[45] Aldrin and Dieldrin were banned in 1974,[47] and Endrin was banned in 1986.[48] These products have very long half lives. Hence they decay slowly. Traces of the legacy pesticides can be found in runoff water and sediment in the lower reach of the Owyhee River near the Snake River.

D. Data

1. Stream temperature

The Oregon Department of Environmental Quality (ODEQ) collected water temperature data between July 31 and September 13 in 1997 and 1998 on the Owyhee River at Rome, upstream and just south of the lower Owyhee subbasin, and the Owyhee River at Sand Springs in the lower Owyhee subbasin (Figure 15.6). The information in the ODEQ report was summarized in chart form and the numbers used here are derived from their graphs.[20]

They calculated a "maximum seven-day moving average", in other words, the highest average maximum temperature for seven consecutive days. At Rome the temperatures were 77°F and 79°F respectively for the two years. At Sand Springs the temperatures were 80°F and 81.5°F respectively.[20]

To obtain an approximate measure of how long the temperature remained hot, ODEQ calculated the number of hours that the temperature exceeded 64°F. Of the 1080 hours during which measurements were made, the temperature exceeded 64°F for all 1080 hours at both locations in both years.[20]

Using the limited dates of observation, ODEQ also calculated the seasonal **maximum** daily change in the temperature of the stream. The 24 hour fluctuation at Rome was 12°F in 1997 and 10°F in 1998. At Sand Springs the fluctuation was less, 3.4°F in 1997 and in 3.1°F 1998.[20]

2. Mercury

a. Stream sediment

The United States Geological Survey (USGS) sampled the Owyhee River at several points between the Oregon state line and the Owyhee Reservoir in 2001 and 2002 in cooperation with the Vale office of the Bureau of Land Management (BLM). The water at each site was sampled three times, once each in April 2001, June 2001, and April 2002. The bed sediment was sampled once in June 2001.[14] In the lower Owyhee subbasin the sites sampled were the Owyhee River below Crooked Creek, the Owyhee River above Bull Creek, and the Owyhee River near Birch Creek (Figure 15.6). The bed sediment at these sites showed 0.13 μg/g (micrograms per gram) mercury, 0.13 μg/g mercury, and 0.28 μg/g mercury respectively.[14] Upstream from these sites, before the confluence with Jordan Creek, the mercury bed sediment of the Owyhee River was 0.04 μg/g. In Jordan Creek just before the confluence with the Owyhee River the sediment showed 0.86 μg/g mercury.[14]

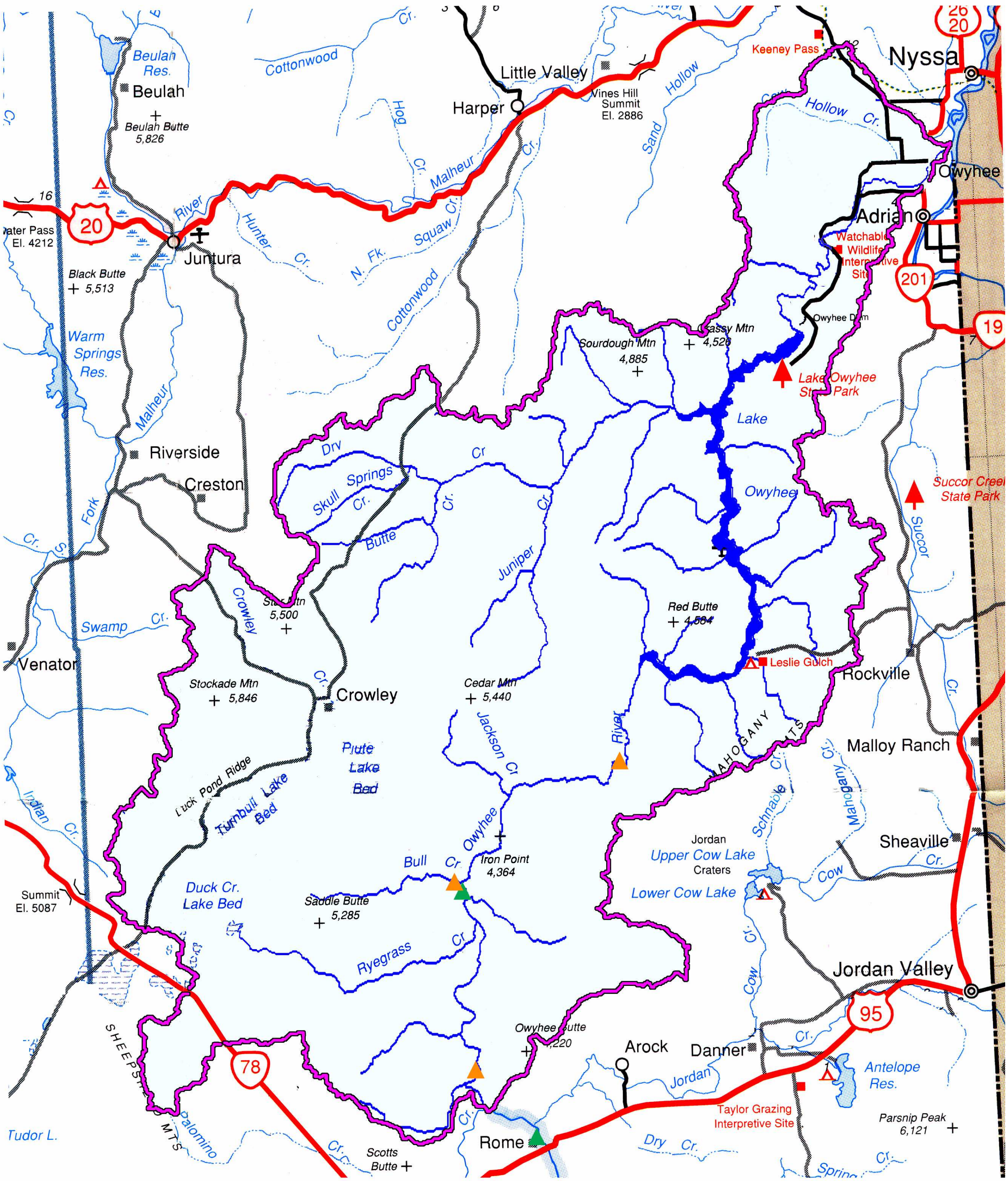

Figure 15.6. Water quality sampling locations in the lower Owyhee subbasin.
▲ USGS ▲ ODEQ

Hill et al. collected 126 sediment samples during their study of pollutants in the Jordan Creek drainage, upstream from the lower Owyhee subbasin. Apparently only the 51 samples from Jordan Creek are in the database. The highest stream sediment mercury reported was 17.1 ppm (parts per million) at Antelope Reservoir with the highest concentrations consistently found in samples from Jordan Creek.[16,15]

ODEQ sampling in 1994 showed that the mercury concentrations in Owyhee River sediments were lower in the Owyhee River above the confluence with Jordan Creek (0.08 µg/g) than downstream from the confluence (0.16 µg/g). The study measured 0.6 µg/g mercury in bed sediments of Jordan Creek just above the confluence with the Owyhee.[16]

b. Fish

Fish tissue sampled in 1989 in the Owyhee drainage by the ODEQ showed up to 0.68 ppm mercury in catfish. Eight percent of the catfish tested exceeded the EPA screening value of 0.6 ppm mercury (Hg). Twenty five percent of the smallmouth bass sampled had fish tissue levels above 0.6 ppm. Some of the bass had fish tissue mercury levels up to 0.93 ppm.[16]

Data collected from Owyhee Reservoir between 1987–1994 showed 65 percent of the samples analyzed had total Hg levels exceeding the EPA health screening value of 0.6 mg/kg. [23] (0.6 mg/Kg is similar to 0.6 ppm).

The state has issued fish consumption advisories for the Owyhee Reservoir due to high concentrations of mercury.

c. Water

Water in the Owyhee River sampled in mid April near Rome, above the confluence of the river with Jordan Creek averaged 9.75 ng/L (nanograms per liter) of total mercury. Samples taken below the confluence with Jordan Creek averaged 13.0 ng/L total mercury. Samples taken at the same locations in September averaged 2.56 ng/L total mercury near Rome and 5.41 ng/L total mercury below the confluence with Jordan Creek.[9]

Water entering Owyhee Reservoir in the spring and summer carried an average total mercury of 6.92 ng/L. Water leaving the reservoir had an average total mercury content of 24.4 ng/L.[9] Owyhee Reservoir concentrations were elevated relative to inflow waters sampled at Rome, Oregon, for most nutrients, Hg, and trace elements.[9]

3. Dissolved oxygen

The oxygen which is dissolved in water is needed to different extents by organisms living in the water. The oxygen in water is enhanced when stream water is stirred up and mixes with the air above the stream as in the turbulent waters of rapids. Oxygen is also released into the water by photosynthesis of water plants such as algae. Oxygen is depleted from the water by respiration of stream organisms and the decomposition of organic materials.[14] The ODEQ recommended standard for dissolved oxygen is 11 mg/L for salmonid spawning and 8.0 mg/L for cold-water aquatic life.[25]

The ODEQ measured dissolved oxygen in the Owyhee River. The levels of dissolved oxygen ranged from 7.6 mg/L at Sand Springs in September to 10.0 mg/L at Rome in May (Figure 15.6).[20] Measurements of dissolved oxygen made in April and

June by the USGS ranged from 8.0 mg/L in June at Birch Creek to 10.6 mg/L in June at Bull Creek (Figure 15.6).[14]

Samples taken from the surface of the Owyhee Reservoir showed an average dissolved oxygen content of 7.36 mg/L with a range from 0.05 to 12.0 mg/L. However, during the summer months the water in the lake does not appear to mix very much although the surface waters are frequently stirred by wind.[9]

E. Regulatory background

The national Clean Water Act (CWA) defined two principal goals: 1) to restore and maintain the chemical, physical, and biological integrity of the nation's waters and 2) where ***attainable***, to achieve water quality that promotes protection and propagation of fish, shellfish, and wildlife, and provides for recreation in and on the water. This goal is commonly known as "fishable/swimmable." "Federal regulations are not intended to result in standards that are so stringent that compliance would cause severe economic impacts."[11]

Under the legislation, the states are responsible for developing water quality standards to implement the goals of the CWA. The policies are supposed to protect, maintain, and conserve existing uses of the water. The water quality necessary to protect these existing uses needs to be maintained. This policy is known as the "antidegradation" policy. It was developed "so that it minimizes adverse effects on economic growth and development and at the same time protects CWA goals."[11]

The second type of use is a designated use. States are responsible for establishing designated uses of a waterbody. In a way these uses are provisional, they are a first guess as to how the waterbody can be used in addition to existing uses. This is obvious from the fact that the CWA clearly states that "Designated uses, on the other hand, may be changed upon finding that the use cannot be attained."[11]

The designated use can be modified if attainment is not possible because of one or more of the following factors: 1) naturally occurring pollutant concentrations; 2) natural, intermittent or low-flow water levels; 3) anthropogenic conditions or sources of pollution that cannot be corrected; 4) dams, diversions, or other hydrologic modifications; 5) physical conditions associated with the natural features of the waterbody, unrelated to quality; 6) more stringent controls would result in substantial and widespread economic and social impact.[11]

F. 303d listings

1. Designated beneficial uses

In Oregon, water quality standards are established to protect designated beneficial uses of the state's waters. Designated beneficial uses are assigned by basin in the Oregon Administrative Rules for water quality.[31]

The designated beneficial uses of water in the lower Owyhee subbasin are public domestic water supply, private domestic water supply, livestock watering, fish and aquatic life, wildlife and hunting, fishing, boating, water contact recreation, and aesthetic quality. In addition industrial water supply and irrigation are listed as designated beneficial uses in all water bodies in the lower Owyhee subbasin except those designated as wild and scenic river.[28] The beneficial use designations for fish are "cool water species (no salmonid use)" from the mouth of the Owyhee River to the confluence with Snively Gulch and "Oregon redband or lahontan cutthroat trout (20°C)" in all other Owyhee basin waters.[29]

2. Water quality assessment

Based on the designated uses and ODEQ evaluations of water quality data, different reaches of the Owyhee River in the lower Owyhee subbasin are included on the ODEQ 2002 list of water quality limited streams. The last 18 miles of the Owyhee River before the mouth are listed for fecal coliform, chlorophyll a, DDT, and Dieldrin (Table 1, Figure 15.7). The reach from river mile 18 to the dam is listed for dissolved oxygen as is the reach from river mile 104 to 120 (Table 1, Figure 15.8). The reach above the reservoir to the southern edge of the lower Owyhee subbasin is listed for temperature and mercury (Table 1, Figure 15.9).[27]

From Oregon's 2004/2006 integrated report, arsenic has been added as a parameter for listing the reach above the reservoir as water quality limited (Table 2, Figure 15.9).[30] The integrated report also listed Endrin in the last 18 miles of the Owyhee River and total phosphates in the Owyhee River from the mouth of the river to the southern border of the lower Owyhee subbasin as being of "potential concern".[30] The listing of any Dieldrin in the reservoir is a clerical error noted to ODEQ over a decade ago but it is still retained in the listings.

Appendix D contains a summary of the assessment criteria for the parameters listed for the lower Owyhee subbasin in Oregon's 2004/2006 integrated report.[25]

Table 1. Reaches of the Owyhee River listed as water quality limited streams on the 2002 Oregon 303(d) list.

River Mile	Parameter	Criteria		Data used for listing	
0-18	Chlorophyll a	0.01 mg/l	Summer	USBR Data (Site OWY012, Hwy 201; RM 2.9): 29% (17 of 59) Annual values exceeded standard (15 ug/l) with 3 month averages exceeding standard in 88, 91, 92, 94, and 95 based on data collected between WY 1988 - 1995.	
0 to 18	DDT	Table 20	Year Around	USGS Data (Owyhee R @ Owyhee): 3 water samples with a range of 0.001 - 0.007 ug/l and an average of 0.005 ug/l exceeded DDT standard (fresh chronic criteria - 0.001 ug/l, water and fish ingestion - 0.024 ng/l) in 1990.	
0 to 18	Dieldrin	Table 20	Year Around	USGS Data (Owyhee R @ Owyhee): 3 water samples with a range of 0.002 - 0.013 ug/l and an average of 0.008 ug/l exceeded Dieldrin standard (fresh chronic criteria - 0.0019 ug/l, water and fish ingestion - 0.071 ng/l) in 1990.	
0 to 18	Fecal Coliform	Mean of 200, No more than 10%>400	Summer	USBR Data (Site OWY012, Hwy 201; RM 2.9): 38% (15 of 39) Summer values exceeded fecal coliform standard (400) with a maximum of 1400 between WY 1986 - 1995.	
18 to 28.5	Dissolved Oxygen	Spawning: 11 mg/L or 95% saturation	Spring/Summer	USBR Data (Site OWY101, 200 meters below dam, RM 29): 51% (27 of 53) of April - September values exceeded spawning dissolved oxygen standard (11 mg/l or 95% saturation) with a minimum of 6.7 between WY 1986 - 95 (Cold water spawning, approx. April - Sept).	
18 to 28.5	Dissolved Oxygen	Cold water: 8 mg/l or 90% saturation	Winter/Spring/Fall	USBR Data (Site OWY101, 200 m below Owyhee Dam; RM 29): 12% (5 of 42) October - March values exceeded rearing dissolved oxygen standard (8 mg/l or 90% saturation) with a minimum of 3.3 between WY 1986 - 1995 (Cold water rearing, approximately Oct - Mar).	
28.7 to 71	Mercury	Public health advisories	Year Around	OSHD fish consumption advisory (1993): Mercury values in fish from Owyhee Reservoir ranged between 0.65 - 1.77 ppm which exceed EPA advisory levels of 0.6 ppm and FDA advisory levels	Y
71.2 to 124.2	Mercury	Public health advisories	Year Around	Health Division Consumption Health Advisory issues for Mercury in fish tissue (.56 ppm) based on data collected since 1969. Reference level (.35 ppm)	
71.2 to 124.2	Temperature	Spawning: 12.8 C	March 1 - June 30	LASAR 12258 RM 110: 3/00-6/00, 1 day with 7 DMA > 12.8 C. 3/01-6/01, 8 days with 7 DMA > 12.8 C.	
71.2 to 124.2	Temperature	Rearing: 17.8 C	Summer	BLM sites at Birch Creek in 1995/96, 7 day ave. max. temperature was 78.6/91.5°F, and at Rome was 79.8/81.0°F both exceeded temperature standard of 64°F.	
104 to 120	Dissolved Oxygen	Spawning: 11 mg/L or 95% saturation	March 1 - June 30	DEQ data. LASAR site 12258 RM 109. 2/8 samples < 11 mg/L and 90% saturation	

Table 2. Oregon's 2004/2006 integrated report, water quality assessment database for the Owyhee Reservoir and Owyhee River in the lower Owyhee subbasin. River reaches already on the 303(d) list are marked. The other reaches are of potential concern (P), have insufficient data (I), or are marked as attaining (A), i.e on the way to reaching the criteria for some uses. Table 20 is included in Appendix D.[133]

303(d)	River Mile	Parameter	Season	Criteria		Data used for listing
	0 to 200.4	Alkalinity	Year Around	Table 20 Toxic Substances	A	[DEQ/ODA] River Mile 2.8: 10/15/1996 to 12/10/2003, 0 out of 50 samples < 20 mg/L. River Mile 127.7: 5/21/1996 to 7/13/1999, 0 out of 3 samples < 20 mg/L. River Mile 109.8: From 5/24/1994 to 9/9/2003, 0 out of 11 samples < 20 mg/L.
	0 to 200.4	Ammonia	Year Around	Table 20 Toxic Substances	A	[DEQ/ODA]. River Mile 2.8: 10/15/1996 to 12/10/2003, 0 out of 54 samples > applicable Table 20 criterion. River Mile 127.7: 5/21/1996 to 7/13/1999, 0 out of 8 samples > applicable Table 20 criterion. River Mile 109.8: From 5/24/1994 to 9/9/2003, 0 out of 21 samples > applicable Table 20 criterion.
X	71 to 200.4	Arsenic	Year Around	Table 20 Toxic Substances		[USGS] River Mile 165: From 4/17/2001 to 6/25/2001, 2 out of 2 samples > applicable Table 20 criterion.
	0 to 200.4	Chloride	Year Around	Table 20 Toxic Substances	I	[DEQ] River Mile 127.7: From 9/30/1998 to 7/13/1999, 0 out of 2 samples > applicable Table 20 criterion. River Mile 109.8: From 9/29/1998 to 9/10/2002, 0 out of 3 samples > applicable Table 20 criterion. River Mile 130.7: From 9/10/2002 to 9/10/2002, 0 out of 1 samples > applicable Table 20 criterion.
	0 to 18	Chlorophyll a	Fall/Winter/ Spring		I	[DEQ] River Mile 2.8: From 10/15/1996 to 1/12/1997, average Chlorophyll a of 0.006 for 1 samples in 1 months.
	18 to 28.5	Chlorophyll a	Summer	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	A	USBR Data (Site OWY101, 200 meters below Owyhee Dam; RM 29.0): 4% (3 of 77) Annual values exceeded standard (15 ug/l) between WY 1988 - 1995.
X	0 to 18	Chlorophyll a	Summer			[DEQ] River Mile 2.8: From 6/5/2001 to 9/2/2001, average Chlorophyll a of 0.007 for 2 samples in 2 months. USBR Data RM 2.9): 29% (17 of 59) Annual values exceeded standard (15 ug/l) with 3 month averages exceeding standard in 88, 91, 92, 94, and 95 based on data collected between WY 1988 - 1995.
X	0 to 18	DDT	Year Around	Table 20 Toxic Substances		USGS Data (Owyhee R @ Owyhee): 3 water samples with a range of 0.001 - 0.007 ug/l and an average of 0.005 ug/l exceeded DDT standard (fresh chronic criteria - 0.001 ug/l, water and fish ingestion - 0.024 ng/l) in 1990.
X	0 to 18	Dieldrin	Year Around	Table 20 Toxic Substances		USGS Data: 3 water samples with a range of 0.002 - 0.013 ug/l and an average of 0.008 ug/l exceeded Dieldrin standard (fresh chronic criteria - 0.0019 ug/l, water and fish ingestion - 0.071 ng/l) in 1990.

	28.7 to 71	Dieldrin	Year Around	Table 20 Toxic Substances	P	DEQ Data (Catfish): 1 composite sample exceeded EPA screening values but no fish consumption advisory given (EPA, 9/1992).
	0 to 200.4	Dissolved Oxygen	Year Around (Non-spawning)	Cool water: Not less than 6.5 mg/l	A	[DEQ/ODA] River Mile 130.7: 5/25/1994 to 9/9/2003, 0 out of 11 samples (0%) < 6.5 mg/l and applicable % saturation. River Mile 127.7: 5/21/1996 to 7/13/1999, 0 out of 5 samples (0%) < 6.5 mg/l and applicable % saturation. River Mile 2.8: 6/11/1997 to 8/20/2003, 1 out of 14 samples (7%) < 6.5 mg/l and applicable % saturation. River Mile 2.8: 10/15/1996 to 12/10/2003, 0 out of 30 samples (0%) < 6.5 mg/l and applicable % saturation. River Mile 109.8: 5/24/1994 to 9/9/2003, 0 out of 16 samples (0%) < 6.5 mg/l and applicable % saturation.
	0 to 18	E Coli	Fall/Winter/ Spring	30-day log mean of 126 E. coli organisms per 100 ml; no single sample > 406 organisms per 100 ml	A	[DEQ/ODA] River Mile 2.8: From 12/18/1996 to 12/10/2003, 0 out of 30 samples (0%) > 406 organisms; maximum 30-day log mean of 0
X	0 to 18	E Coli	Summer			[DEQ/ODA] River Mile 2.8: From 12/18/1996 to 12/10/2003, 2 out of 14 samples (14%) > 406 organisms; maximum 30-day log mean of 0
	0 to 18	Endrin	Undefined	Table 20 Toxic Substances	P	USGS Data (Owyhee R @ Owyhee): 3 water samples with a range of <0.001 - 0.004 ug/l and an average of 0.002 ug/l, one value exceeded Endrin standard (fresh chronic criteria - 0.0023 ug/l, drinking water MCL - 0.002 ug/l) in 1990.
	0 to 18	Fecal Coliform	Fall/Winter/ Spring	Fecal coliform log mean of 200 organisms per 100 ml; no more than 10% > 400 per 100 ml	A	USBR Data (Site OWY012, Hwy 201; RM 2.9): 10% (6 of 61) FWS values exceeded fecal coliform standard (400) with a maximum of 2000 between WY 1986 - 1995.
	18 to 28.5	Fecal Coliform	Fall/Winter/ Spring		A	USBR Data (Site OWY101, 200 meters below Owyhee Dam; RM 29.0): 0% (0 of 58) FWS values exceeded fecal coliform standard (400) between WY 1986 - 1995.
X	0 to 18	Fecal Coliform	Summer			USBR Data (Site OWY012, Hwy 201; RM 2.9): 38% (15 of 39) Summer values exceeded fecal coliform standard (400) with a maximum of 1400 between WY 1986 - 1995.
	18 to 28.5	Fecal Coliform	Summer		A	USBR Data (Site OWY101, 200 meters below Owyhee Dam; RM 29.0): 3% (1 of 40) Summer values exceeded fecal coliform standard (400) with a maximum of 500 between WY 1986 - 1995.
X	28.7 to 71	Mercury	Year Around			OSHD fish consumption advisory (1993): Mercury values in fish from Owyhee Reservoir ranged between 0.65 - 1.77 ppm which exceed EPA advisory levels of 0.6 ppm and FDA advisory levels of 1.0 ppm.
X	71.2 to 124.2	Mercury	Year Around			Health Division Consumption Health Advisory issues for Mercury in fish tissue (.56 ppm) based on data collected since 1969; Reference level (.35 ppm)
	0 to 71	Nutrients	Undefined		I	
	0 to 18	Pesticides	Undefined	Table 20 Toxic Substances	I	

	0 to 18	pH	Fall/Winter/ Spring		A	[DEQ/ODA] River Mile 2.8: From 10/15/1996 to 12/10/2003, 0 out of 34 samples (0%) outside pH criteria range 7 to 9.
	18 to 200.4	pH	Fall/Winter/ Spring	pH 7.0 to 9.0	A	[DEQ/ODA] River Mile 127.7, 109.8, 130.7 (0%) outside pH criteria range 7 to 9.
	0 to 18	pH	Summer		A	[DEQ/ODA] River Mile 2.8: From 6/11/1997 to 8/20/2003, 0 out of 14 samples (0%) outside pH criteria range 7 to 9.
	18 to 200.4	pH	Summer		A	[DEQ/ODA] River Mile 130.7: From 9/15/1997 to 9/9/2003, 1 out of 6 samples (17%) outside pH criteria range 7 to 9. River Mile 109.8, River Mile 127.7 (0%) outside pH criteria range 7 to 9.
	0 to 130.7	Phosphate Phosphorus	Summer	Total phosphates as phosphorus (P): Benchmark 50 ug/L in streams to control excessive aquatic growths	P	[DEQ] River Mile 109.8: From 9/10/1996 to 9/9/2003, 4 out of 10 samples > 50 ug/L benchmark criterion. River Mile 2.8: From 6/11/1997 to 8/20/2003, 14 out of 14 samples > 50 ug/L benchmark criterion. River Mile 127.7: From 9/10/1996 to 7/13/1999, 1 out of 4 samples > 50 ug/L benchmark criterion.
	0 to 18	Sedimentation	Undefined	The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life	I	
X	16.8 to 200.4	Temperature	Year Around (Non-spawning)	Redband or Lahontan cutthroat trout: 20.0 degrees Celsius 7-day-average maximum		[DEQ] River Mile 109.8: From 6/30/2000 to 10/5/2001, 156 days with 7-day-average maximum > 20 degrees Celsius. River Mile 130.7: From 7/17/1999 to 9/29/2000, 134 days with 7-day-average maximum > 20 degrees Celsius. River Mile 167.7: From 7/17/1999 to 10/5/2001, 217 days with 7-day-average maximum > 20 degrees Celsius.
	0 to 18	Turbidity	Undefined	10% increase Nephelometric Turbidity Units	I	
	28.7 to 71	Aquatic Weeds Or Algae	Undefined	The development of fungi or other growths having a deleterious effect on stream bottoms, fish or other aquatic life, or which are injurious to health, recreation or industry may not be allowed.	I	

G. Discussion

Any discussion of water quality in the Owyhee River and the Owyhee Reservoir must take into account the transport into the lower Owyhee subbasin from upstream sources. Almost all of the water originates outside the lower Owyhee subbasin.

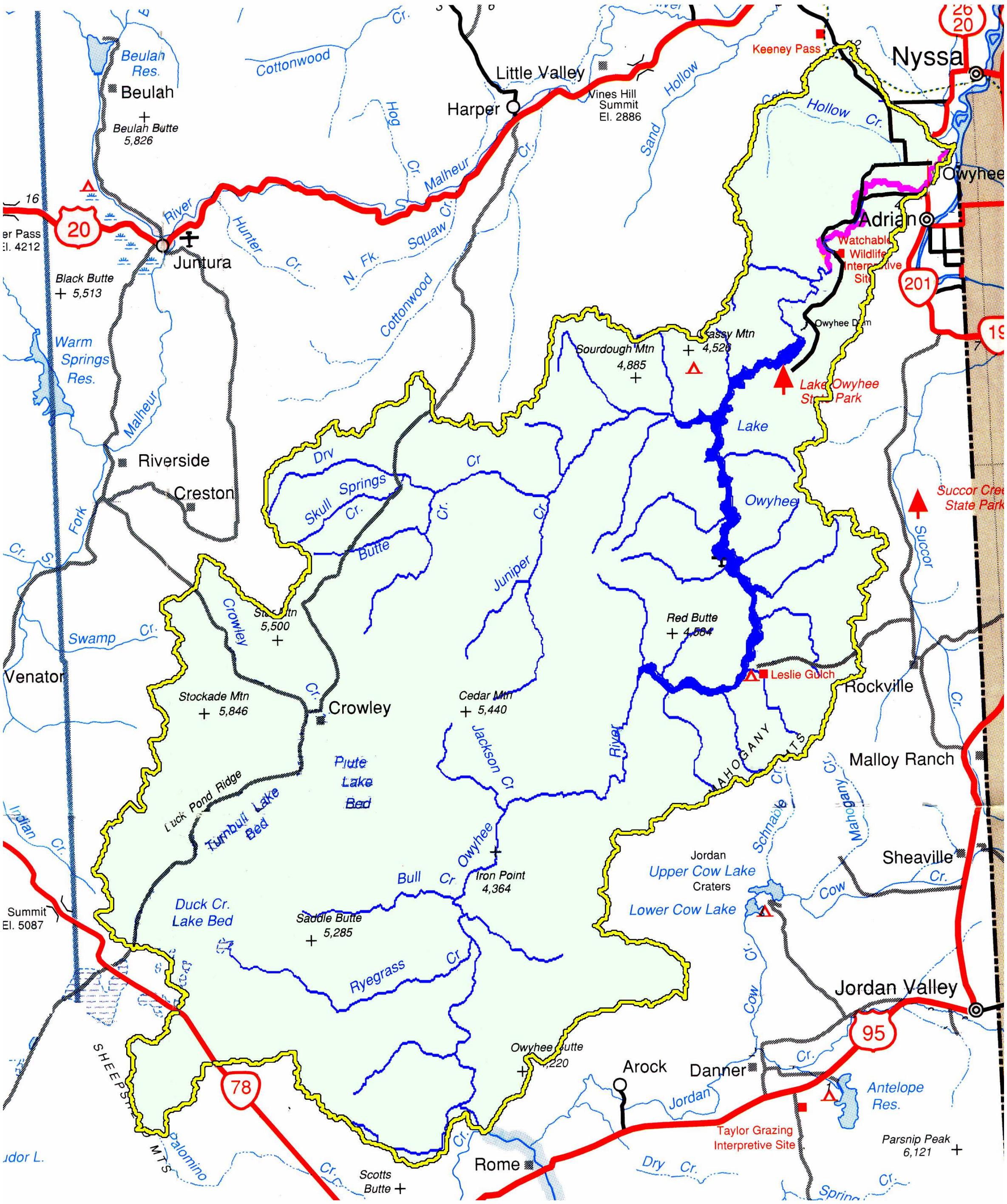

Figure 15.7. Stream segments in magenta in the lower Owyhee subbasin are listed as 303d streams due to fecal coliform, chlorophyll a, DDT, and Dieldrin.

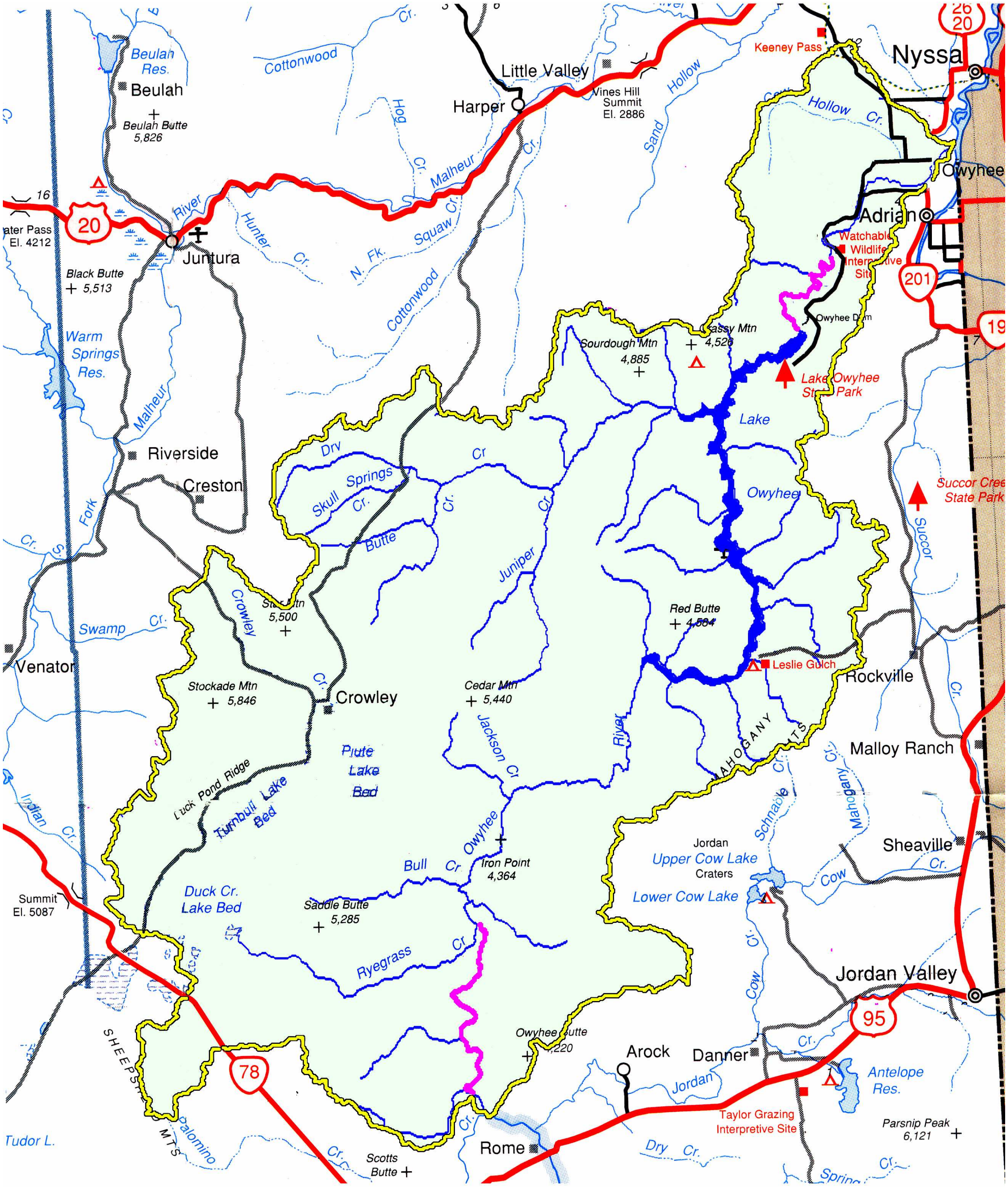

Figure 15.8. Stream segments in magenta in the lower Owyhee subbasin are listed as 303d streams due to low dissolved oxygen.

1. Designated beneficial uses

In defining the purpose of the clean water act, the EPA in their "Introduction to Water Quality Standards" stated that the goals of the act were applicable "where

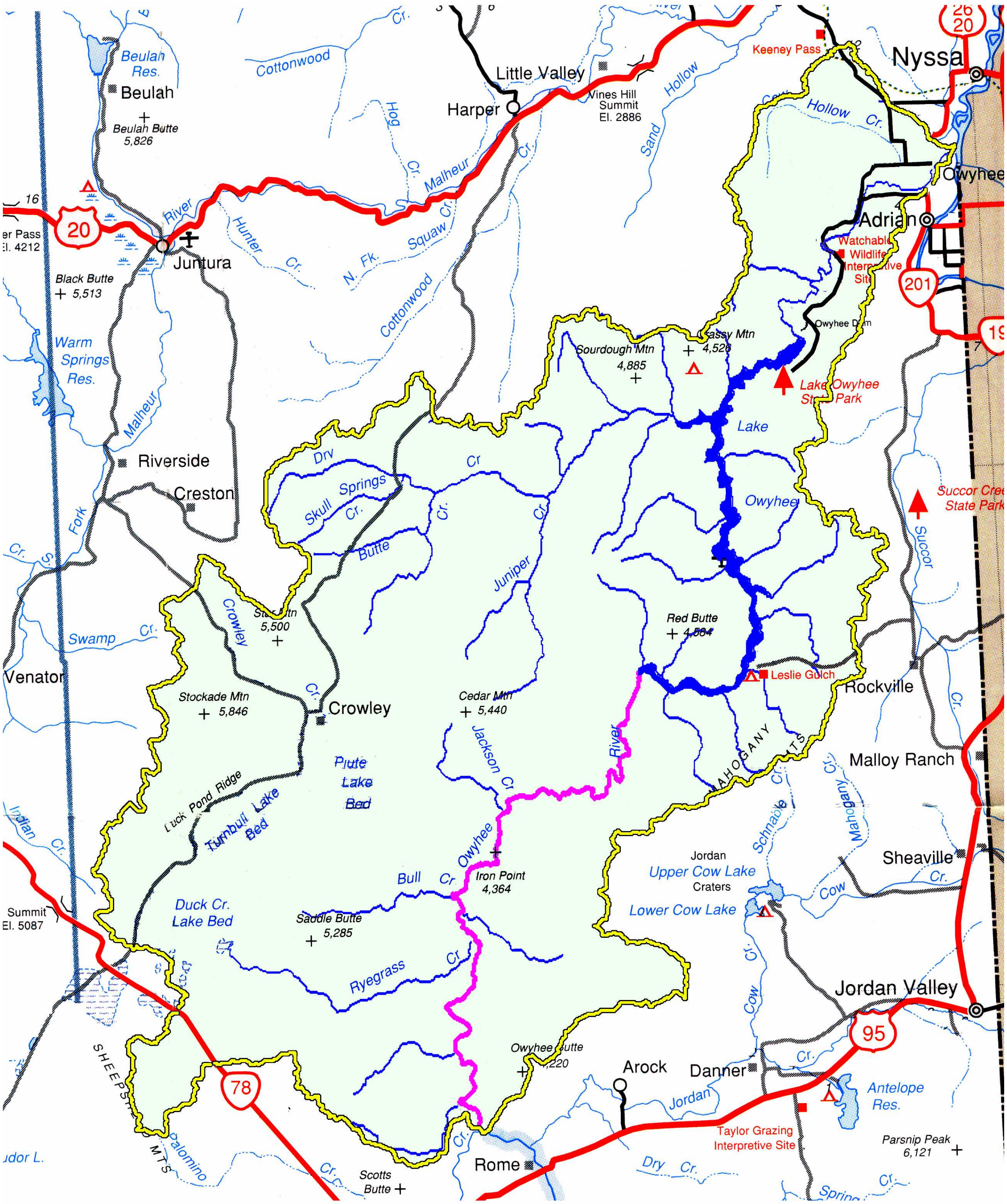

Figure 15.9. Stream segments in magenta in the lower Owyhee subbasin are listed 303d streams due to mercury, temperature, and arsenic.

attainable, to achieve water quality . . ." The italics and bold attributes are from the EPA document. Whether the water quality is attainable depends in part on the designated use. Boaters don't necessarily want to drink the water where they launch a boat.

It is valuable in examining the water quality in the Owyhee River within the lower Owyhee subbasin to first consider what is attainable. If the realities of the situation are not taken into consideration, meeting the goals is doomed to failure. The CWA provides a method of changing a designated use. This assessment presents data which should be taken into account in evaluating the attainability of water quality criteria mandated by a specific designated use.

Oregon statute requires the DEQ to determine whether specific reaches of rivers are capable of attaining designated uses. To conduct its analysis of attainability, DEQ should include appropriate documentation and defensible data.[32] The statute states that in determining guidelines for non-point sources, physical characteristics such as stream flow, geological sources, seasons and other factors which represent the variability and complexity of hydrologic systems are to be considered.[32]

2. Temperature

The available data substantiate the fact that the temperature in those reaches of the Owyhee River above the reservoir exceed the year round temperature standard of 20°C (68°F) for redband or Lahontan cutthroat trout. Not only did the Owyhee River exceed this temperature in the summer, but in 1997 and 1998 it exceeded 64°F every single hour from July 31 and September 13. Also, the temperature varied very little over a 24 hour period, including the period of no solar radiation at night.

a. Effect of climate

The small variation from daytime to nighttime temperatures agrees with the conclusions of several studies in northeast Oregon. Meays et al. discovered that the atmosphere provided a strong buffer on stream temperatures. The effect of the atmosphere on stream temperature was to effectively set limits within which stream temperatures would occur.[19] Carr et al. also found that climatic factors, including maximum and minimum air temperatures, were the dominant factors in stream temperature patterns.[6] Borman and Larson found that weather conditions were the dominant influence on river temperature with mean air and water temperatures being nearly equivalent.[4]

In the Truckee River at Reno, the stream temperature could be predicted using maximum air temperature and average daily flow as variables.[22] Taylor et al. state that it is generally accepted that there is an inverse relationship between stream flow and the size of daily variation in stream temperature, the more water there is in a stream the less it will cool during the night or heat during the day.[39] Meays et al. related the stream temperature to both the velocity and the distance. The slower the water traveled and the greater the distance that it traveled, the closer the stream came to achieving an equilibrium with mean air temperatures.[19]

The histogram comparing soil temperature to air temperature at the Malheur Experiment Station Agrimet weather station, shows that the soil temperature is higher than the air temperature more of the time (Figure 15.5). If the air temperature is predictive of the water temperature, it doesn't matter whether the water is being heated by the air, by the soil, or by direct solar radiation. Probably the soil is absorbing solar radiation and reradiating it to both the air and elsewhere. No well developed understanding of the physics involved in stream heating has been used to determine stream temperature standards.

b. Effect of shading

Improved river flow stability below dams has increased riparian vegetation beyond what was present at the time of Euro-American contact.

The amount of vegetation along the Owyhee River banks above the reservoir remains much as it has been since the first contact of Euro-American trappers in the early 19th century. There is no evidence that at the time of Euro-American contact there was substantial riparian vegetation anywhere along the Owyhee River (see the at contact section of the history component of this assessment). There is evidence that any woody vegetation which starts to develop along the river banks has been periodically scoured away by flooding. A large portion of the stream banks also have little capability to support vegetation due to their deeply incised position in bedrock and lack of sediment. There is little possibility of vegetation shading the river at these incised locations.

When the relationship of shade to maximum stream temperatures was studied by Kruegar et al., they concluded that the "study does not provide evidence that shade is a driving force in temperature change on these streams."[17] Similarly Meays et al. found that canopy cover alone was not sufficient to prevent water temperature from trending toward equilibrium with air temperature.[19] And, Carr et al. concluded that shade functioned in a subordinate role to climate in affecting stream temperature.[6]

c. Need for water standard based on natural conditions

The Idaho Division of Environmental Quality (IDEQ) studied the inconsistencies between water temperatures and fish data that indicated viable, self-sustaining assemblages of fish existed. They concluded that "current water temperature criteria for Idaho appear to be not working well since they do not comport with biological reality"[12] and suggested that a scientific basis be developed for water quality to assure the relevance of temperature data. Climatic and geographic differences were postulated as primary factors affecting natural stream temperatures. A factor presented to account for the discrepancy between stream water temperatures and the presence of salmonids was the presence of thermal refugia.[12]

There are inland redband trout in the lower Owyhee subbasin. The stream temperature in the subbasin frequently exceeds the ODEQ criteria for redband trout. It follows that some similar factor accounts for this discrepancy in Oregon to what IDEQ postulates occurs in adjoining stream segments in Idaho .

The temperature criteria guidelines were developed by the EPA. They recognize that there may be inconsistencies and provide some alternatives to using the recommended "biological numeric" criteria. States may adopt a "narrative natural background provision that takes precedence over numeric criteria when natural background temperatures are higher than the numeric criteria. This narrative can be utilized in TMDLs [Total Maximum Daily Load] to set water quality targets and allocate loads."[26]

New temperature standards for the lower Owyhee River need to be developed that take into account the natural condition of the water and the climate of the lower Owyhee subbasin.

3. Mercury

Mercury is a problem when it ends up in fish tissue. "Most fish advisories in Oregon are based on levels of mercury and PCBs in fish. Small amounts of mercury can damage a human brain that is just starting to form and grow . . . Too much mercury may affect a child's behavior and lead to learning problems later in life. Mercury can also harm older children and adults, but it takes larger amounts. It may cause tremors, changes in vision or behavior, as well as damage to kidneys."[24]

There is mercury in the tissue of a large number of the fish caught in the Owyhee River and in the Owyhee Reservoir. Where does this mercury originate? Is there anything other than limiting the amount of fish that we consume that can be done about it?

Most of the mercury entering the lower Owyhee subbasin waters can be traced to the Jordan Creek. ODEQ[121] and USGS[120] measurements both show the levels of mercury in the bed sediments as rising significantly in the Owyhee River after the confluence of the river with Jordan Creek. The BOR comparison of Owyhee River station data above and below the confluence with Jordan Creek suggests that the inflow from Jordan Creek is a significant source of mercury not only into the Owyhee River, but as an important mercury source for Lake Owyhee.[9]

Where does the mercury in Jordan Creek come from?

a. Historic anthropogenic activities

Past studies have positively identified the Silver City area as a source of mercury.[16] From 1860 to 1920 there were probably 76 pounds per day of mercury that vaporized in the vicinity of Silver City.[3,15] Most of those **three million pounds** of mercury would have condensed and returned to the ground close to where they were lost. Studies in the Silver City area have detected 1,685 ppm mercury in an inactive mill pool and, in 1973, free mercury could be panned from some pools.[15]

The mercury concentration in sediments consistently increases in the vicinity of historic processing sites near Silver City.[15] Streams near these historic milling sites show elevated mercury levels.[21] The Idaho BLM identifies the mercury moving down through the watershed as probably originating from mills operating near Silver City.[3] The legacy sources of this mercury are well known to IDEQ and ODEQ, but there has been no cleanup effort.

b. Geologic sources

There are many natural mercury deposits in the lower Owyhee subbasin and upstream in the Owyhee basin. Mercury occurs naturally in the environment and the occurrence of mercury is not an issue of concern. Only the concentrated levels of mercury are of concern because there is an increased likelihood of mercury release by natural or human processes.[16]

Although there are no identified geologic locations in the lower Owyhee subbasin that have mercury concentrations of concern, there are localized geologic sources of mercury and elevated mercury concentrations have been observed in volcanic rock located near Lake Owyhee.[9] The distribution of mercury in Owyhee Reservoir is consistent with a distant mercury source.[1]

c. Mitigation and remediation

In 1995 concern over high concentrations of mercury in fish prompted the ODEQ and the interagency Mercury Working Group to initiate a study on mercury in the Owyhee River basin. The study was conducted in cooperation with other agencies including what is now the IDEQ. The report concluded that Silver City milling sites could be considered as point sources and they could be contained or removed to prevent mercury transport to downstream areas. The first step would be delineating the distribution of mercury at the sites. If specific areas of mercury occurrence could be identified, remedial efforts suggested included possible removal, capping, sediment containment, and revegetation.[16]

Although both the mercury sources and the risks that this mercury contamination pose for human health, for land and water contamination, and eventually for livestock health are known, agencies responsible for the mercury cleanup in Idaho and Oregon have taken no action. Mercury continues to be distributed across the landscape in the vicinity of Silver City and continues to be transported by water to areas of human contact and use.

d. Sites of recent mining

The EPA has listed the Delamar Silver City mine as a site where no further remedial action is planned by the EPA. It is not on the national priorities list for long-term clean up action under the Superfund Program.[10] It is unclear if the original 1988 listing referred to the then operating Delamar mine or to the legacy milling sites in the vicinity of Silver City. The operating mine is not the source of mercury continually entering and polluting Jordan Creek and eventually reaching the lower Owyhee subbasin.

4. Dissolved oxygen

Oxygen solubility in water is inversely related to temperature. In other words, as water temperature rises, the solubility of oxygen is reduced.[14] It is not surprising that the reaches of the Owyhee River where the temperature is high also have lower levels of dissolved oxygen than are recommended for fish. The concentrations of oxygen also rise during the day when algae are creating oxygen as a by-product of photosynthesis. However, algae uses oxygen at night so the concentrations go down.[14] Since the temperature of the river is a product of the natural conditions in the lower Owyhee subbasin, the amount of dissolved oxygen is controlled, at least in part, by natural water temperature fluctuations.

5. pH

The pH of stream water tends to be increased by the photosynthesis of aquatic plants during the day and decreased by the respiration of plants and animals at night.[14]

6. Phosphorus and nitrogen

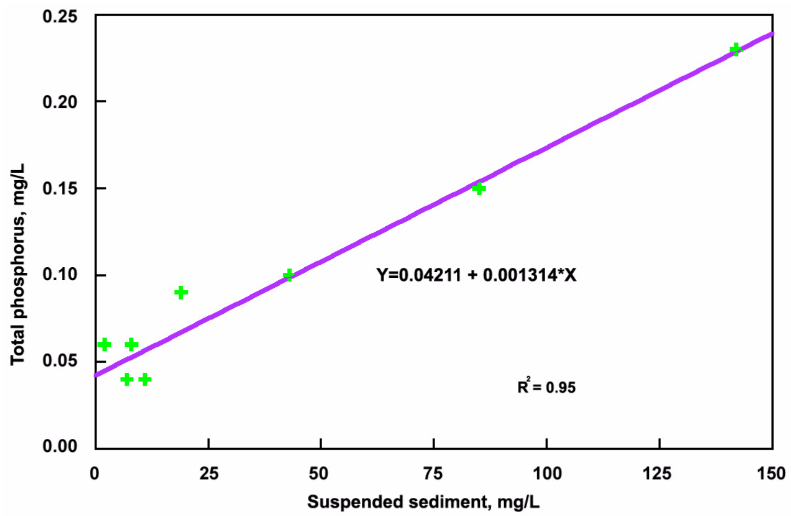

Figure 15.10. Relationship of total phosphorus to suspended sediment in the Owyhee River between Crooked Creek and Birch Creek, 2001 and 2002.

Both phosphorus and nitrogen are essential to aquatic plant growth. However, high levels of phosphorus may lead to too vigorous growth and algal blooms. The over-abundance of phosphorus in warm surface water promotes the growth of algae. When unusually large amounts of phosphorus overpower a body of water, they cause a sharp increase in algae production known as an algal bloom. As the large mass of algae begin to die, vast amounts of oxygen are used in the decomposition. Little oxygen remains for the fish.[49]

Igneous rocks, like lava flows or basalt, commonly contain relatively high concentrations of phosphorus as compared to many other rocks.[14] Some western SRP lavas contain anomalously high concentrations of phosphate.[43]

Analyzing the USGS data on sediment and phosphorus in the water of Owyhee River in the lower Owyhee subbasin, their is a linear relationship between the amount of sediment and the amount of phosphorus (Figure 15.10).[14] As the amount of sediment increases, the amount of phosphorus increases. This indicates that much of the phosphorus load is being transported with the sediment. The highest concentrations of sediment increase exponentially with increased runoff (Figure 15.11). We infer that the largest phosphorous loads entering the reservoir and the Snake River occur at times of peak flow in the Owyhee River.

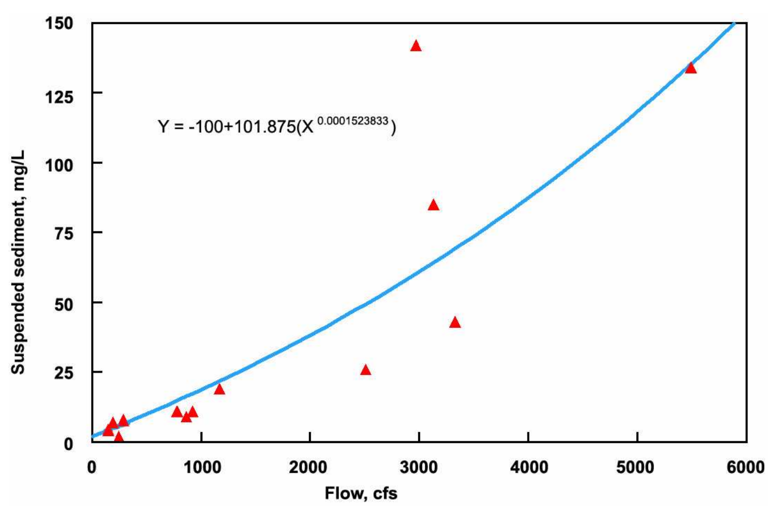

Figure 15.11. Relationship of suspended sediment to flow in the Owyhee River between Rome and Birch Creek, 2001 and 2002

7. Legacy pesticides

Pesticides used before 1975 and their breakdown products have been detected in sediment along the lowest reaches of the Owyhee River below irrigated farmland and in drain water return canals. Pesticides currently in use in the Owyhee watershed have short half lives and are not detected in the water, fish, or sediments. There is no evidence of negative effects of legacy pesticides on fish or wildlife in the Owyhee Basin.

8. Arsenic

Traces of arsenic in the watershed are from natural volcanic and subsequent hydrothermal activity with no other significant source.

9. Fecal coliform

Litter and improperly managed human defecation by recreationalists are major sources of pollution and are extremely disagreeable to local residents. These are also discussed in the recreation component of this assessment.

H. Unknowns

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 that have not been sampled. 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.[9] Remobilization of mercury and phosphorus 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 Irrigated Agriculture Component of this assessment, 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.[18] However, changes in agricultural techniques began before 1978 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.

I. Conclusion

We are fortunate in America to enjoy an abundance of water resources. As a nation, we value these resources for their natural beauty; for the many ways they help meet human needs; and for the fact that they provide habitat for thousands of species of plants, fish and wildlife. Our activities, the land, the species in each watershed, and the waterways interact in complex ways. The waters of the lower Owyhee subbasin above the Owyhee reservoir have limiting characteristics which are due to the natural conditions of the area and historic human activities which have since ended.

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