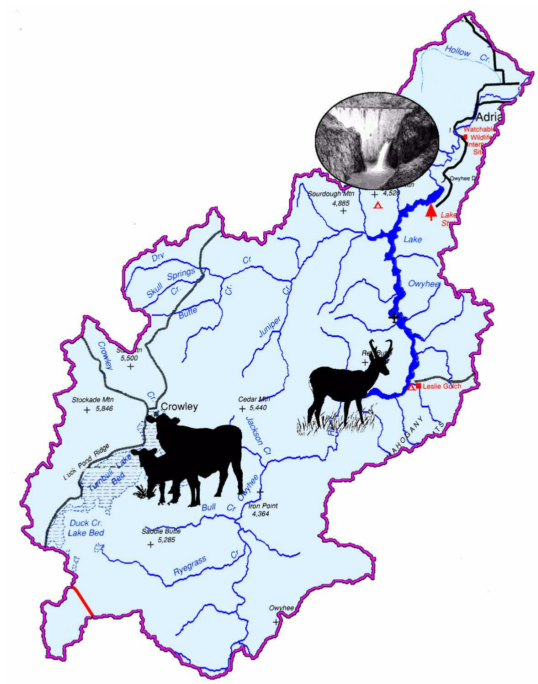

Lower Owyhee Watershed Assessment

XV. Water Quality

Contents

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.

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

c. Flooding

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

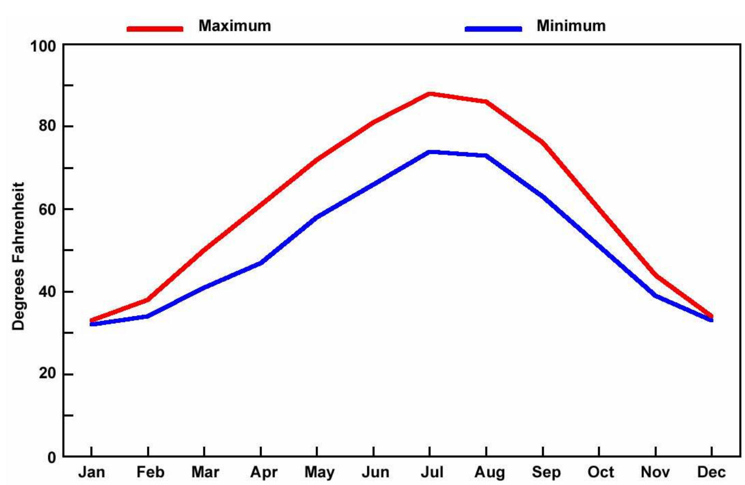

Figure 15.3. 38 year average monthly soil temperature at 4-inch depth, Malheur Experiment Station, Oregon State University, Ontario, OR

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]

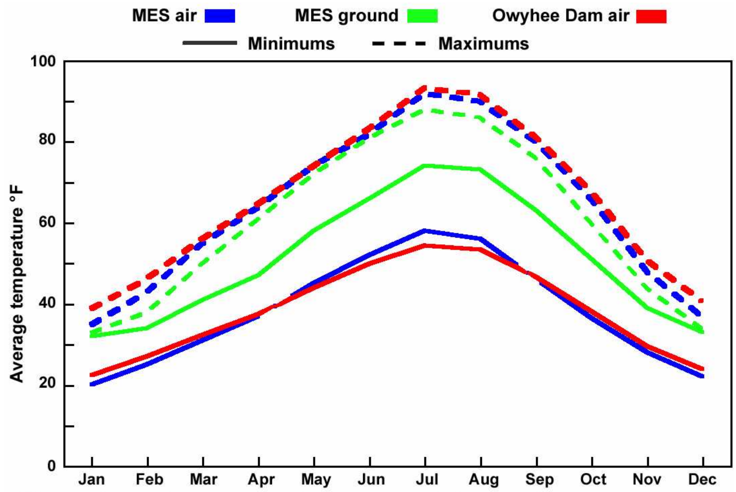

Figure 15.4. Average maximum and minimum air temperatures at Owyhee Dam and Malheur Experiment Station compared to average maximum and minimum soil temperatures at 4-inch depth at Malheur Experiment Station.

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.

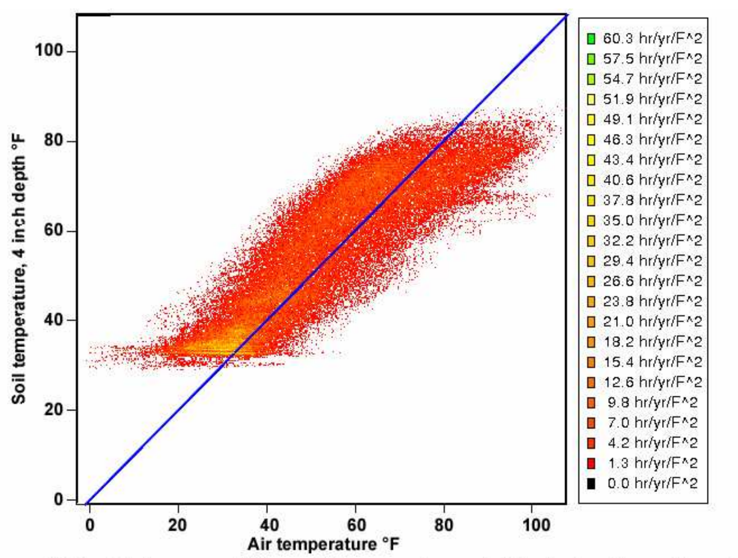

Figure 15.5. Histogram of the soil temperature at 4 inch depth vs. the air temperature at the agrimet weather station, ONTO, from 1992 to 2007.

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]

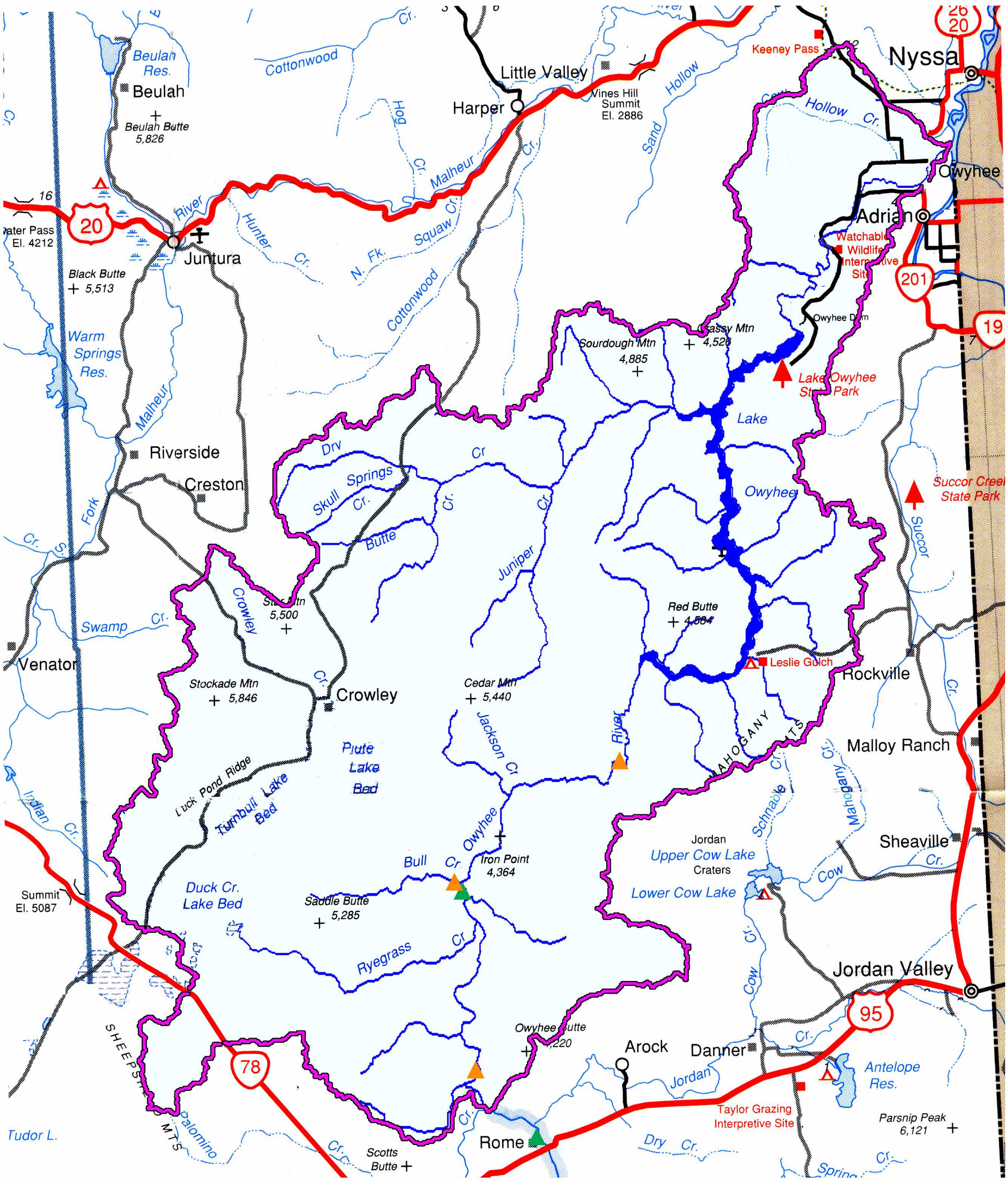

Figure 15.6. Water quality sampling locations in the lower Owyhee subbasin.
▲ USGS ▲ ODEQ

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	Sedimenta-tion	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.

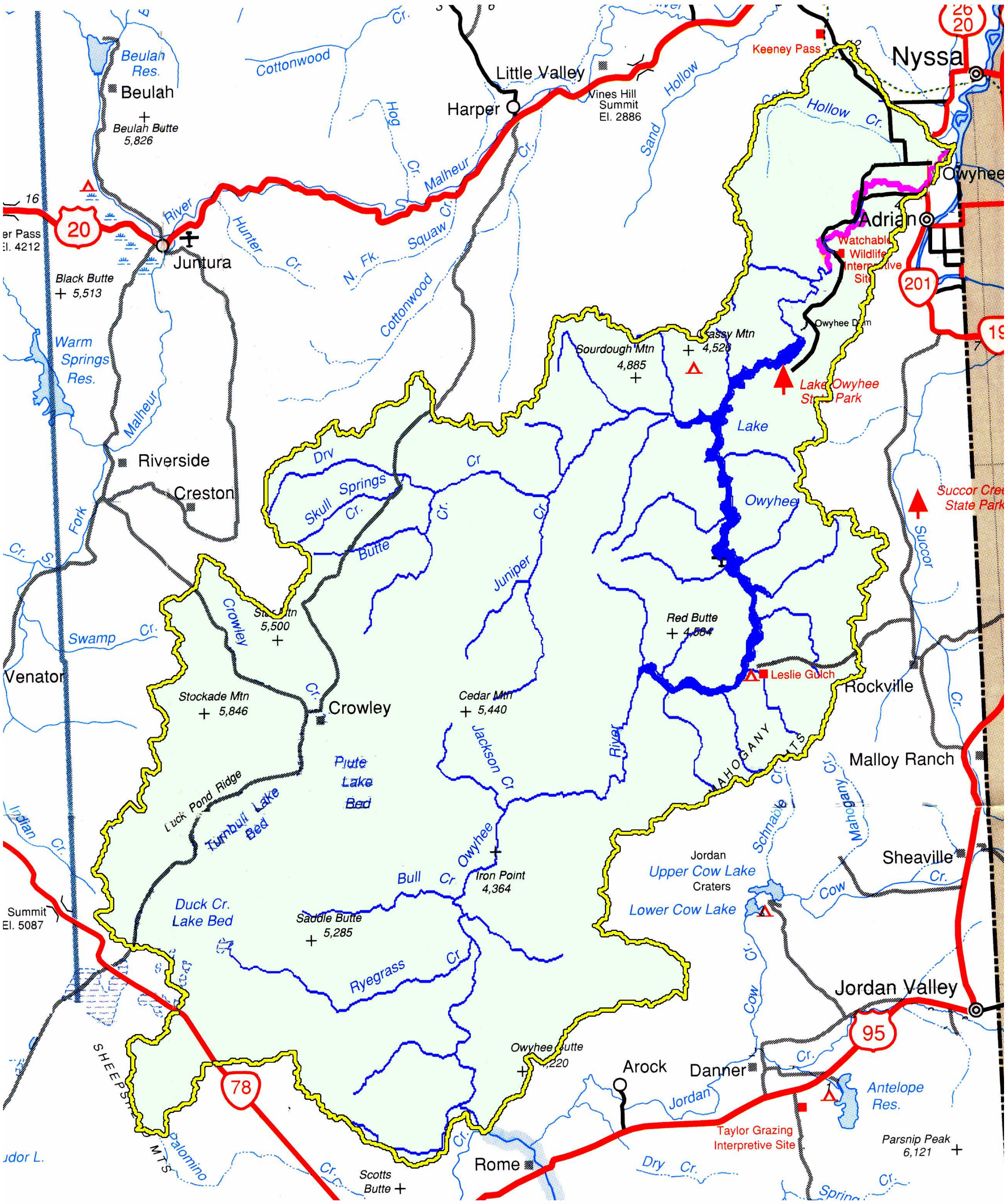

Figure 15.7. Stream segments in magenta in the lower Owyhee subbasin are listed as 303d streams due to fecal coliform, chlorophyll a, DDT, and Dieldrin.

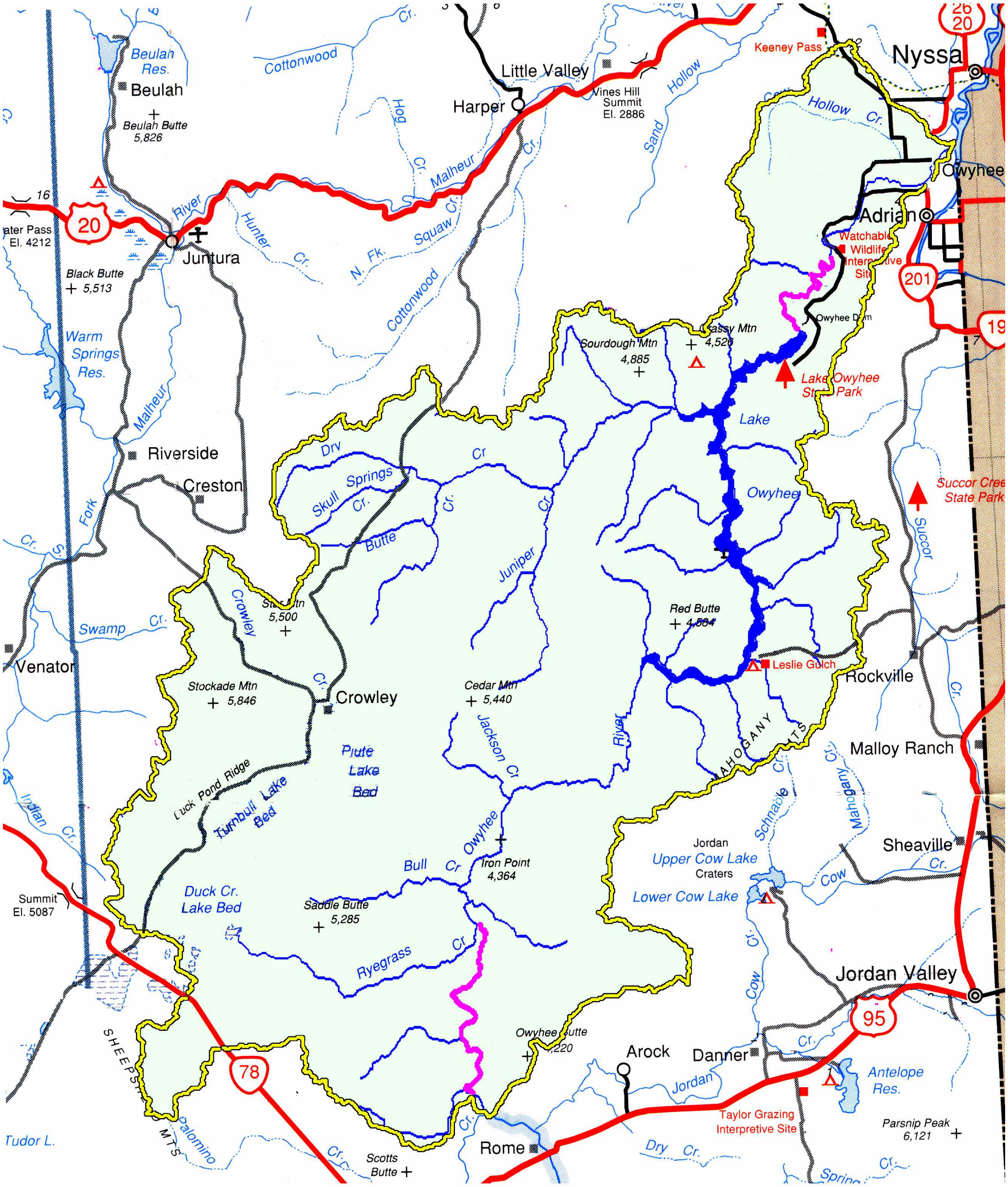

Figure 15.8. Stream segments in magenta in the lower Owyhee subbasin are listed as 303d streams due to low dissolved oxygen.

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

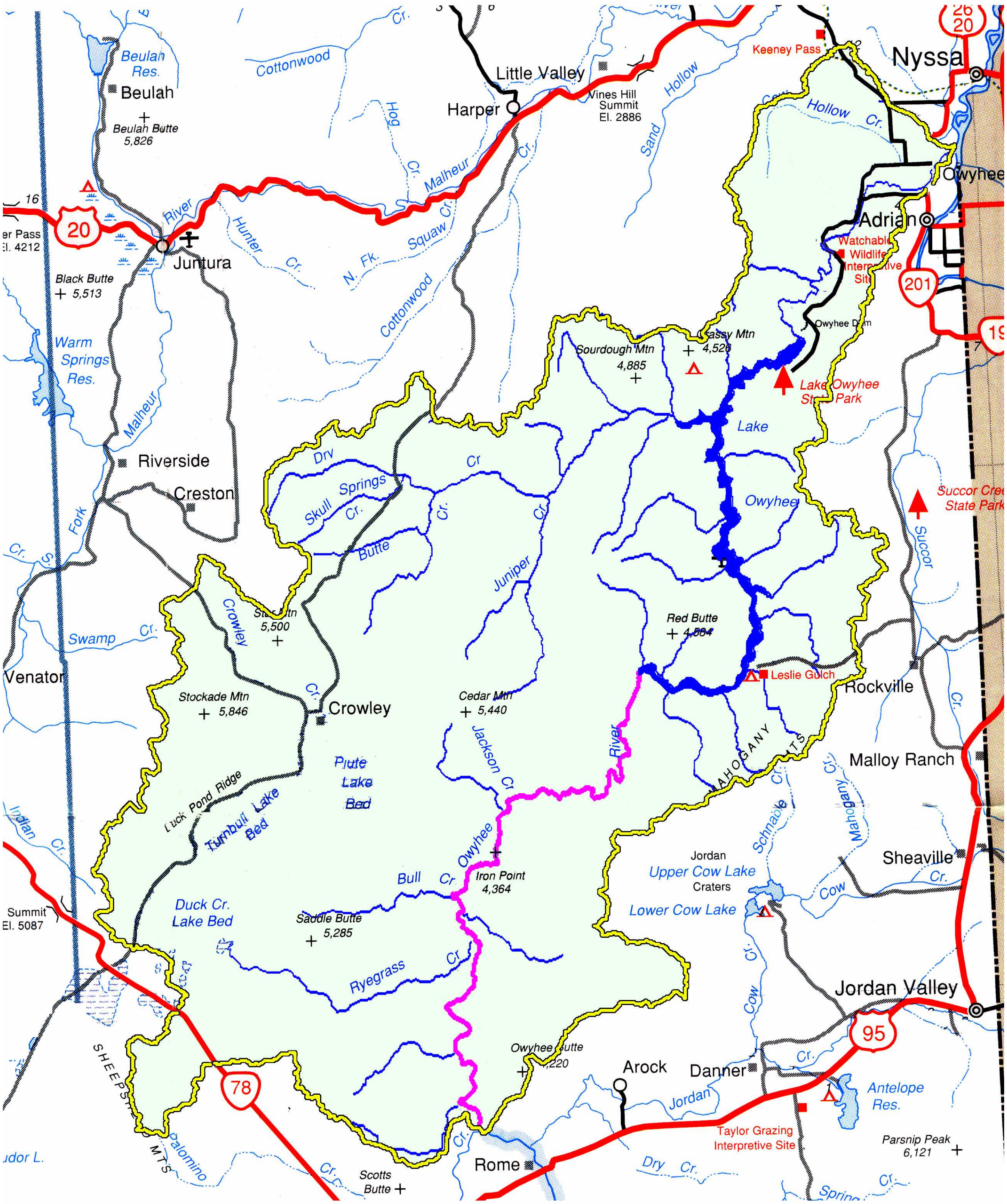

Figure 15.9. Stream segments in magenta in the lower Owyhee subbasin are listed 303d streams due to mercury, temperature, and arsenic.

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

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]

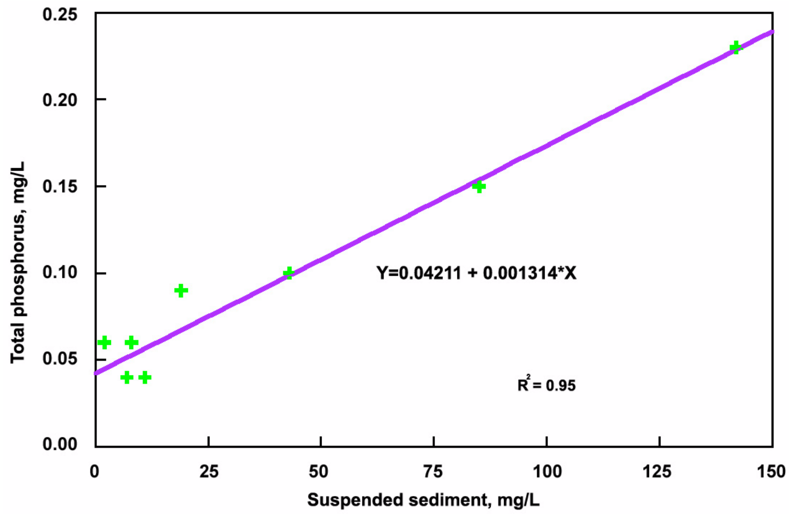

Figure 15.10. Relationship of total phosphorus to suspended sediment in the Owyhee River between Crooked Creek and Birch Creek, 2001 and 2002.

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.

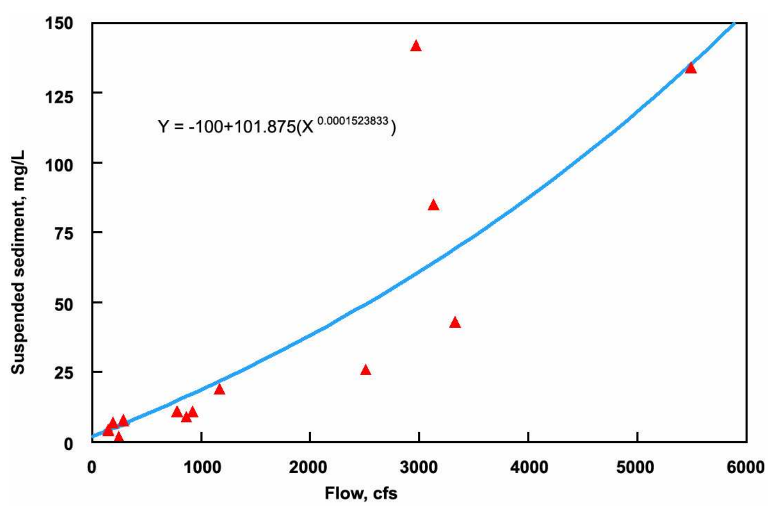

Figure 15.11. Relationship of suspended sediment to flow in the Owyhee River between Rome and Birch Creek, 2001 and 2002

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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