Upper Owyhee Watershed Assessment

VIII. Water quality

Contents

The Oregon governor’s strategic initiative for ensuring sustainable water resources for Oregon’s future, Headwaters 2 Ocean, considers all water resources from the hilltops to the Pacific Ocean. The completion of the assessment of the upper Owyhee subbasin is consistent with the governor’s initiative. The upper Owyhee subbasin contains the headwaters of the Owyhee River and two of its principal tributaries, the South Fork Owyhee River and the Little Owyhee River.

VIII. Water quality

A. Introduction

The water in the upper Owyhee subbasin is a valuable resource. Not only does it provide natural beauty, both within and downstream from the upper Owyhee subbasin, but the water supports 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 upper 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. Regulatory background

The Federal Water Pollution Control Act (PL92-500, commonly known as the Clean Water Act) requires each state to develop a program to monitor and report of the status of its water quality. The 305(b) process evaluates the quality of all of the waters of the state. The 303(d) process identifies impaired waters. These are waters that the state classifies as too polluted or otherwise degraded to meet the water quality standards set by the states. A state develops Total Maximum Daily Loads (TMDLs) for these waters. A TMDL is a state's calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards.[8,9,10,33]

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.[19] It was developed "so that it minimizes adverse effects on economic growth and development and at the same time protects CWA goals."[11]

States are also responsible for establishing designated beneficial uses of a waterbody. In a way these uses are provisional, they are an initial 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]

In the past each state submitted two documents to the EPA: a list of impaired waters in the state (303(d)) and a report summarizing the status of all the waters of a state (305(b)). Now the two documents are combined into one document called an Integrated Report.

C. Naturally occurring conditions

The upper Owyhee subbasin is an extensive tract of land with extremely low population density. Developing information about the naturally occurring conditions relies on more limited information than is available in more densely populated areas.

1. Vegetation along water courses

a. Historical

Revisiting the descriptions in the historical section, the earliest Euro-Americans in the area noted a lack of any trees away from the Bull Run and Independence Mountains (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"[35] 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."[35] 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."[35]

Ogden stated "If this was a country of wood we might soon make a canoe . . . but we cannot even find willow to make a raft still less scarcely a sufficiency to cook our victuals."[63] He reiterated this in another entry. "The country [is] level, soil sandy, no wood to be seen excepting a few willow on the banks of the river and not even in abundance."[63] The next day they "encamped on a small river destitute of wood" and the following day "In hopes of finding grass we continued on till near night, but in vain, and encamped without wood, food for ourselves, and no grass."[63]

The willow which the trappers mention is not a tree but coyote willow. 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.[5,6]

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.

b. Flooding

High flows in the spring would send a river out of its banks. It could be a mile wide in some places when the water was high and cover vegetation not normally under water.[2] The high flows could carry ice and rocks and scour vegetation along the banks.[27]

2. Stream temperature

a. Stream flow

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

b. Climate

The discussion in the background section characterizes the air temperatures in the upper Owyhee subbasin (see the climate section of the background component of this assessment).

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

c. Topography

The lower reaches of the upper Owyhee River, of the South Fork Owyhee River, and of their tributaries frequently have cut and run through deep canyons. These canyons are generally 50 feet to 1300 feet below the level of the plateau.[44] 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.

3. Geological

Minerals which occur naturally in rocks can slowly leach and end up in river waters to be moved in solution. The minerals can also be carried in the rocks and sediment moved by the water.

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]

b. Arsenic

Arsenic is naturally associated with volcanic activity and the hydrothermal activity following volcanism. In the upper Owyhee subbasin, the principle source of arsenic in surface water and groundwater is volcanism and the subsequent hydrothermal activity that has deposited arsenic in the rocks and soil.

D. 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 the upper Owyhee subbasin 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.[60] 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."[60]

The result of using a mercury amalgam process to recover gold and silver was elevated mercury levels "in steams located near the processing sites."[60]

2. Copper

The Rio Tinto Copper Mine near Mountain City processed copper-sulfide ore. The processing and reprocessing of the ore had the potential of introducing pollutants into environment.

E. The upper Owyhee subbasin constituents

The area considered as the upper Owyhee subbasin for this assessment consists of the drainages of three rivers, the South Fork Owyhee River, the East Fork Owyhee River (or just Owyhee River), and the Little Owyhee River. The drainage of each of these rivers, respectively, defines the boundaries of a fourth-order HUC: the South Fork Owyhee HUC (17050105), the East Little Owyhee HUC (17050106), and the Upper Owyhee HUC (17050104) (Figure 2.2). For a discussion of 303(d) lists and Total Maximum Daily Loads (TMDLs) it is frequently convenient to refer either to a HUC or to a state or to the portion of a HUC within a state.

F. 303(d) listings

CWA Section 303(d) requires the identification of waters that do not meet water quality standards where a Total Maximum Daily Load needs to be developed. Each state develops a 303(d) impaired waters list of all waters that the state has identified where "required pollution controls are not sufficient to attain or maintain applicable water quality standards. . . Once states submit their 303(d) list to EPA, EPA then has 30 days to approve or disapprove the 303(d) lists. If EPA disapproves a state list, EPA has 30 days to develop a new list for the state; although historically, EPA has rarely established an entire list for a state. Sometimes EPA partially disapproves a list because of omission and adds waters to the state's list."[7] Table 8.1 includes only 303(d) streams in the upper Owyhee subbasin, not other 303(d) water bodies. The EPA 303(d) identified streams are those listed on the EPA website for each of the fourth order HUCs as of September 2010 (Table 8.1).[13,14,15,40]

In Nevada, the EPA has approved the listing of all or part of the South Fork Owyhee River, Jack Creek, Jerritt Canyon Creek, and Snow Canyon Creek in the South Fork Owyhee HUC. In the Upper Owyhee HUC, Owyhee River, Mill Creek, Badger Creek and Tomasina Gulch are listed. In Idaho, the South Fork Owyhee River is listed for the South Fork Owyhee HUC. Battle Creek, Beaver Creek, Camel Creek and Nickel Creek are listed in the Upper Owyhee HUC. Idaho DEQ also has recommended water bodies to include on the next 303(d) list and these are included in Table 8.1. There are no water bodies listed in the East Little Owyhee HUC. Although no Oregon section of the upper Owyhee subbasin is 303(d) listed, Oregon has included the Owyhee River starting at the Idaho - Oregon border on its 303(d) list (Figure 8.1).[13,14,15,20,27] The initial inclusion of a waterbody on a 303(d) list includes the pollutant of concern.

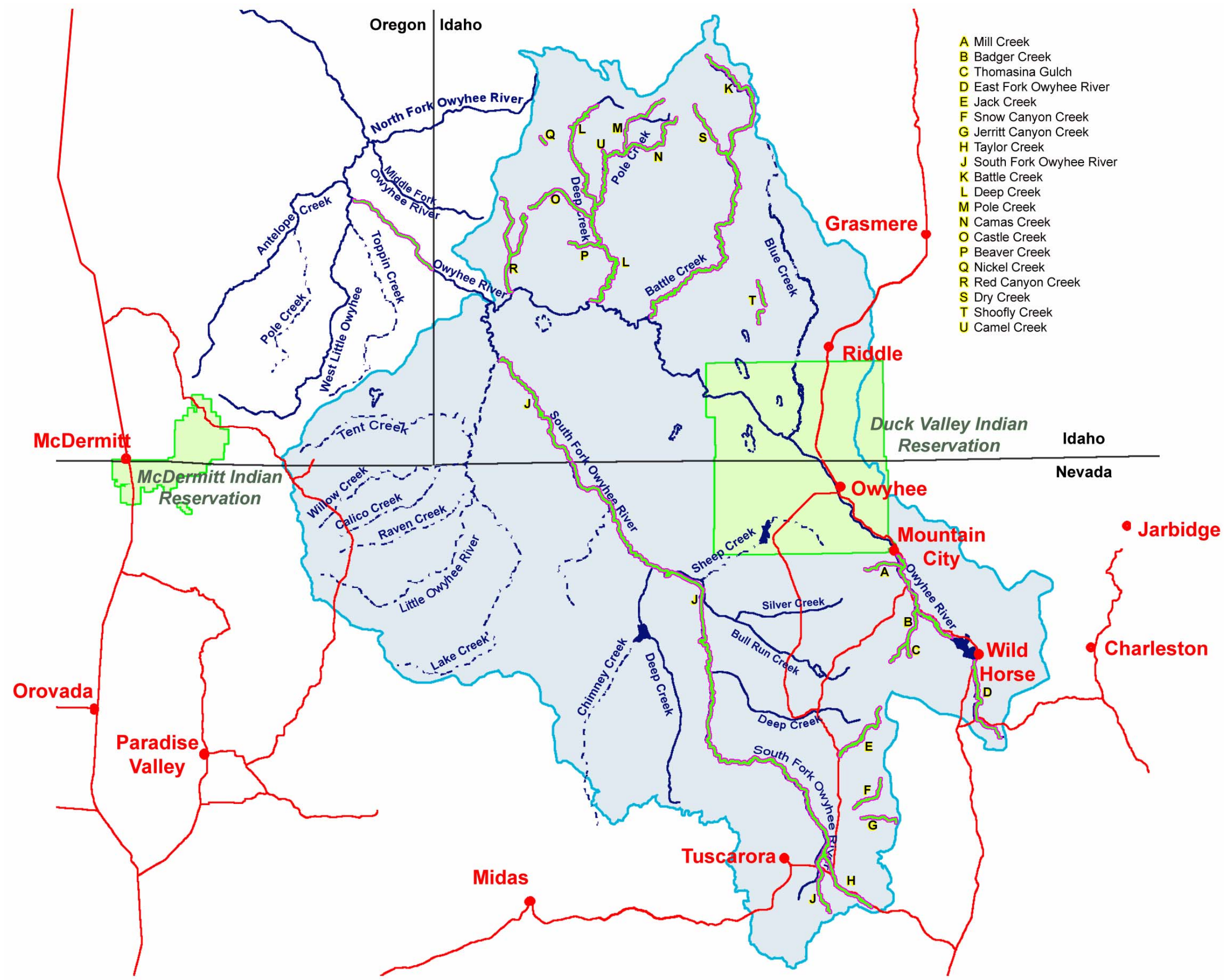

Figure 8.1. Streams in the upper Owyhee subbasin listed as 303(d) as of December 2010.

Table 8.1. Streams in the upper Owyhee subbasin listed on EPA and State 303(d) lists and existing TMDLs or regulations.[13,14,15,20,27]

Subbasin (4th order HUC) Stream name	State	EPA 303(d) listed	State 303(d) listed	State TMDL
South Fork Owyhee				
South Fork Owyhee River from its origin to the Nevada-Idaho state line	Nev	X		X
Jack Creek from its origin to its confluence with Harrington Creek	Nev	X		
Jerritt Canyon Creek from its origin to the national forest boundary	Nev	X		
Snow Canyon Creek from its origin to the national forest boundary	Nev	X		
South Fork Owyhee River Nevada-Idaho border to confluence with the East Owyhee	Id		X	X
Taylor Canyon Creek from its origin to its confluence with the South Fork of the Owyhee River	Nev			X
Upper Owyhee				
Owyhee River from Wildhorse Reservoir to its confluence with Mill Creek	Nev	X		X
Owyhee River from its confluence with Mill Creek to the border of the Duck Valley Indian Reservation	Nev	X		X
Mill Creek from the Rio Tinto Mine to the Owyhee River	Nev	X		X
Badger Creek from its origin to the Owyhee River	Nev	X		
Tomasina Gulch from its origin to Badger Creek	Nev	X		
Battle Creek from its headwaters to its confluence with Owyhee River	Id	X		
Beaver Creek	Id	X		
Camel Creek	Id	X		
Nickel Creek from its headwaters to Mud Flat Road	Id	X		X
Deep Creek From Mud Flat Road to its confluence with the Owyhee River	Id		X	X
Castle Creek from its headwaters to its confluence with Deep Creek	Id		X	X
Pole Creek from its headwaters to its confluence with Deep Creek	Id		X	X
Red Canyon Creek from its headwaters to its confluence with Owyhee River	Id		X	
Dry Creek	Id		X	
Camas Creek	Id		X	
Shoofly Creek from its headwaters to its confluence with Blue Creek	Id		X	
Subbasin (4th order HUC) Stream name	State	EPA 303(d) listed	State 303(d) listed	State TMDL

The EPA is in the process of collecting TMDL information from the states. Since these efforts are ongoing, the table above only shows that a state has developed a TMDL, not whether or not it has been approved. If a TMDL has been developed, that waterbody may no longer be included in the 303(d) list. A state may also have a 303(d) list which has not been approved by the EPA. In Nevada administrative regulations rather than a TMDL set standards for the South Fork Owyhee River.[27,34,40]

Although Oregon does not have any 303(d) listed waterbodies in the upper Owyhee subbasin, the Owyhee River at the border with Idaho is on the 2006 EPA 303(d) list.

The Idaho Soil Conservation Commission (ISCC) and Idaho Association of Soil Conservation Districts (IASCD) point out in the Upper Owyhee Watershed TMDL implementation plan for agriculture that the East Fork of the Owyhee River itself is not 303(d) listed. "This indicates that the tributaries to the river are not negatively impacting the water quality in the East Fork of the Owyhee River." The ISCC and IASCD assessment also points out that "other 303(d) stream segments are dry throughout most of the year with the exception of spring runoff during parts of May and June."[57]

G. Total maximum daily loads

The Clean Water Act mandates a water-quality based control program. Water quality standards define the goals for a waterbody by designating its uses and setting criteria to protect those uses. After a waterbody has been identified on the 303(d) listing as not meeting water quality standards, a Total Maximum Daily Load (TMDL) is developed. In the development of a TMDL the current condition of a waterbody is evaluated and, if needed, the amount of pollutant a water body can receive and still meet water quality standards is calculated. The TMDL attempts to assign part of the responsibility for improving the condition of the waters to each of the different contributing factors. Pollutants can either be attributed to a specific discharge into the water or they can be from nonpoint sources, sources with no one origin that can be pinpointed.[12,16,33,40]

Within a TMDL, the state either determines the most beneficial designated use of a particular water body or uses already established beneficial uses. After designating a waterbody's uses, water quality standards define goals for the waterbody, set criteria to protect those uses, and establish provisions to protect water quality from pollutants. To develop criteria protective of water quality, states are required to examine the effects of specific pollutants on plankton, fish, shellfish, wildlife, plants and recreational activities and determine the levels of pollutants that can exist without harming human and aquatic life.[12,16,24] When developing a TMDL for a waterbody, a state may not only establish limits for the pollutant initially identified when the waterbody was designated as 303(d) but may also set limits for other potential pollutants.

1. Existing TMDLs

The state of Nevada has written one TMDL for waterbodies in the upper Owyhee subbasin. The document presents the problems resulting in degraded water quality in the East Fork Owyhee River and Mill Creek and establishes amounts of pollutants those waterbodies can receive and still meet water quality standards. The TMDLs for those streams are detailed in Appendix F. In addition, standards set by proposed regulations of the State Environment Commission for the South Fork Owyhee River are included in the appendix. The remaining 303(d) listed streams in the upper Owyhee subbasin in

Nevada have the lowest priority on Nevada's prioritized list for developing TMDLs.[22,31,32,34]

The Idaho Department of Environmental Quality (DEQ) has conducted assessments and developed TMDLs for the Upper Owyhee Watershed subbasin and the South Fork Owyhee River subbasin. In addition to determining pollutant loads to meet water quality standards, the assessments looked at some of the characteristics of each watershed including the climate, geology, hydrology, land ownership and use, and fisheries.

Total maximum daily loads for previously listed 303(d) waterbodies in the Upper Owyhee hydrologic unit in Idaho are established in the *Upper Owyhee Watershed Subbasin Assessment and Total Maximum Daily Load*. The assessment also includes action items for the next 303(d) list and for future TMDLs (Appendix G). In 2009, the Department of Environmental Quality (DEQ) produced a five-year review of that TMDL. The *South Fork Owyhee River Subbasin Assessment and Total Maximum Daily Load* assessed the condition of the South Fork Owyhee in Idaho. These assessments provided the information used to develop Appendix G summarizing the Idaho TMDLs for the upper Owyhee subbasin.[20,27]

The State of Oregon has not developed any TMDLs for the Owyhee River and its tributaries.

2. Designated beneficial uses

Designated beneficial uses are assigned to a specific water body by a state. In designating beneficial uses, the Clean Water Act requires each state to include any existing uses, to consider the ability of the waterbody to support a future use, and to meet the basic goal of the Clean Water Act that all waters support aquatic life and recreation where attainable.[25]

Nevada considers the potential beneficial uses of a waterbody to be the watering of livestock, water supply for irrigation, habitat for fish and other aquatic life, recreation involving contact with the water, recreation not involving contact with the water, municipal or domestic water supply, industrial water supply, propagation of wildlife and waterfowl, extraordinary ecological or aesthetic value, and enhancement or improvement of water quality in any water which is downstream.[34]

Idaho's water quality standards establish the potential beneficial uses to be habitat for aquatic life, recreation, water supply, wildlife habitat, and aesthetics. The first three uses are further divided. Aquatic life includes cold water, salmonid spawning, seasonal cold water where coldwater aquatic life may be absent or tolerate seasonally warm temperatures, warm water, and modified "with aquatic life limited by one or more conditions that preclude attainment of reference streams or conditions."[22]

Recreational uses are divided into primary contact recreation in the water with a chance of swallowing water and secondary contact recreation with possible occasional ingestion of water. Water supply is further broken down to providing domestic drinking water, agricultural water for irrigation, drinking water for livestock, or industrial water.

Industrial water use as well as wildlife habitat and aesthetics are considered to apply to all of the surface waters of the state.[22]

The TMDLs for a waterbody identify the beneficial uses of that waterbody. For the Nevada streams these are included in Appendix F. For Idaho waterbodies, the beneficial uses are noted in Appendix G. Those identified by Oregon for the Owyhee River at the Oregon - Idaho border are included in Appendix H.

"Idaho presumes most undesignated waters will support cold water aquatic life."[22] In the Idaho administrative code, beneficial uses for the entire length of the Owyhee River, of the South Fork Owyhee River and of the Little Owyhee River are cold water aquatic species, salmonid spawning, and primary contact recreation.[19] In Oregon all of the waters of the Owyhee Basin are designated for redband or Lahontan cutthroat trout.[37]

3. Water quality assessment

The primary reason for including a waterbody on the initial 303(d) listings in Idaho was the probability that cold water biota and salmonid spawning might not be fully supported by existing conditions. Both assessments found that criteria established by the state as essential for the support of cold water fish and salmonid spawning did not exist in some of the streams considered.

The principal pollutants addressed in Idaho's *Upper Owyhee Watershed Subbasin Assessment and Total Maximum Daily Load* are temperature and sedimentation. Sedimentation is covered in the sediment sources section of this assessment. Only temperature is considered to be a pollutant in the *South Fork Owyhee River Subbasin Assessment and Total Maximum Daily Load.* All pollutants in both the Upper Owyhee HUC and the South Fork Owyhee HUC are identified by the Idaho DEQ as coming from nonpoint sources.[20]

A TMDL management plan allocates load reductions to different sources. In the Upper Owyhee HUC, the contributing factors, or "loads", are considered to be the different streams and the amounts of change which are required in each one, therefore some streams which are not listed as 303(d) have recommended shading requirements (Appendix G).

Idaho's 2010 integrated 303(d)/305(b) report attributed other pollutants to some of the waterbodies in the Upper Owyhee HUC. These included flow regime alterations, Escherichia coli, mercury, metals, organic enrichment, and inadequate dissolved oxygen. Additionally, bioassessments of aquatic plants and combined biota/habitat were included not as pollutants but as indicators of problems.[4,21,23]

In the *South Fork Owyhee River Subbasin Assessment and Total Maximum Daily Load* temperature was also determined not to support either cold water biota or salmonid spawning. Although it was concluded that "a total maximum daily load management plan for temperature is an appropriate vehicle for addressing temperature concerns in the South Fork Owyhee River," it also concluded that the "load" should include an "allocation as water enters the State of Idaho."[27] The assessment recognizes that the naturally occurring "flashy nature of flows in the South Fork Owyhee River appears to be the limiting factor for the presence of large woody vegetation."[27]

In Nevada, the *Total Maximum Daily Loads for East Fork Owyhee River and Mill Creek* addresses not only temperature, but also dissolved and total copper, total iron, total phosphorus, total suspended solids, turbidity, dissolved and total cadmium, dissolved oxygen, total iron, and pH (Appendix F). Although the Rio Tinto Mine area is identified as a contributor for several of the pollutants, other natural and anthropomorphic (human-caused) sources are considered including elements in the soils. These may enter the waterbodies by erosion that would occur naturally or that is increased by human activities. Since the TMDL identifies many of the pollutants as coming from nonpoint sources, "a gross load allocation that accounts for all these sources has been set" for those pollutants.[32]

Although no TMDL has been written for the South Fork Owyhee River nor its tributaries identified as 303(d) in Nevada, pollutant levels have been established in Nevada administrative regulations (Appendix F). Before establishing a TMDL for the South Fork Owyhee River, the Bureau of Water Quality Planning of the Nevada Division of Environmental Protection had concerns about standard appropriateness and conducted a preliminary temperature source assessment. In the observations at the conclusion of the assessment, R. Pahl states "The data show that the temperature standard (21 degrees C) is exceeded for extended periods of times during various flow conditions. . . Unfortunately, it is not possible to accurately determine what temperature levels could be achieved . . . *without spending significant funds for monitoring*."[43] "It becomes difficult for us to develop appropriate temperature standards and/or a TMDL."[43]

Although Oregon has not developed a TMDL for the Owyhee River, on the 2006 EPA 303(d) list the Owyhee River at the border with Idaho is listed for temperature and arsenic. Oregon's draft 2010 integrated report retains these two pollutants and adds phosphate, phosphorus, alkalinity, pH, ammonia, chloride, and dissolved oxygen as pollutants that may impair water quality and have an Oregon water quality standard which is not fully attained (Appendix H).[41]

H. Stream temperature

The principal pollutant of concern which has been identified in waterbodies in the upper Owyhee subbasin is water temperature based upon the beneficial use being cold water aquatic life or salmonid spawning. Water temperature is also identified as a pollutant where the Owyhee River leaves the upper Owyhee subbasin and enters the Middle Owyhee HUC in Oregon.

The East Fork Owyhee River and Mill Creek TMDL also includes temperature as a potential pollutant. However, there is also concern about the copper levels in these two streams below the old Rio Tinto copper mine.

1. Data collection locations

There are only a few locations in the upper Owyhee subbasin where water temperature measurements have been made and are readily accessed for analysis.

a. Upper Owyhee HUC in Nevada

Nevada has several Nevada Division of Environmental Protection (NDEP) sites on the East Fork Owyhee River in the Upper Owyhee HUC. Miscellaneous water temperature readings have been taken on the river below Wild Horse Reservoir, above Mill Creek, below Mill Creek, and below Slaughterhouse Creek. There is also a site at the southern boundary of the Duck Valley Reservation run by the Shoshone-Paiutes. On Mill Creek the NDEP has taken miscellaneous water temperature readings above the Owyhee River confluence, at Patsville, and above the Rio Tinto mine site.

b. Upper Owyhee HUC in Idaho

In Idaho the USGS does not have any sites with surface-water data in the upper Owyhee subbasin.[51] For the Idaho DEQ Upper Owyhee Watershed TMDL, water temperature data was based on available temperatures taken with recording thermographs from June 2000 through September 2001. Data was collected for Deep Creek at Mud Flat Road, at Castle Creek, and at Road Crossing. For Pole Creek it was collected near Mud Flat road, near Camel Creek, and upstream of Camel Creek. Water temperatures were also recorded for Castle Creek and Red Canyon Creek (Figure 8.2).

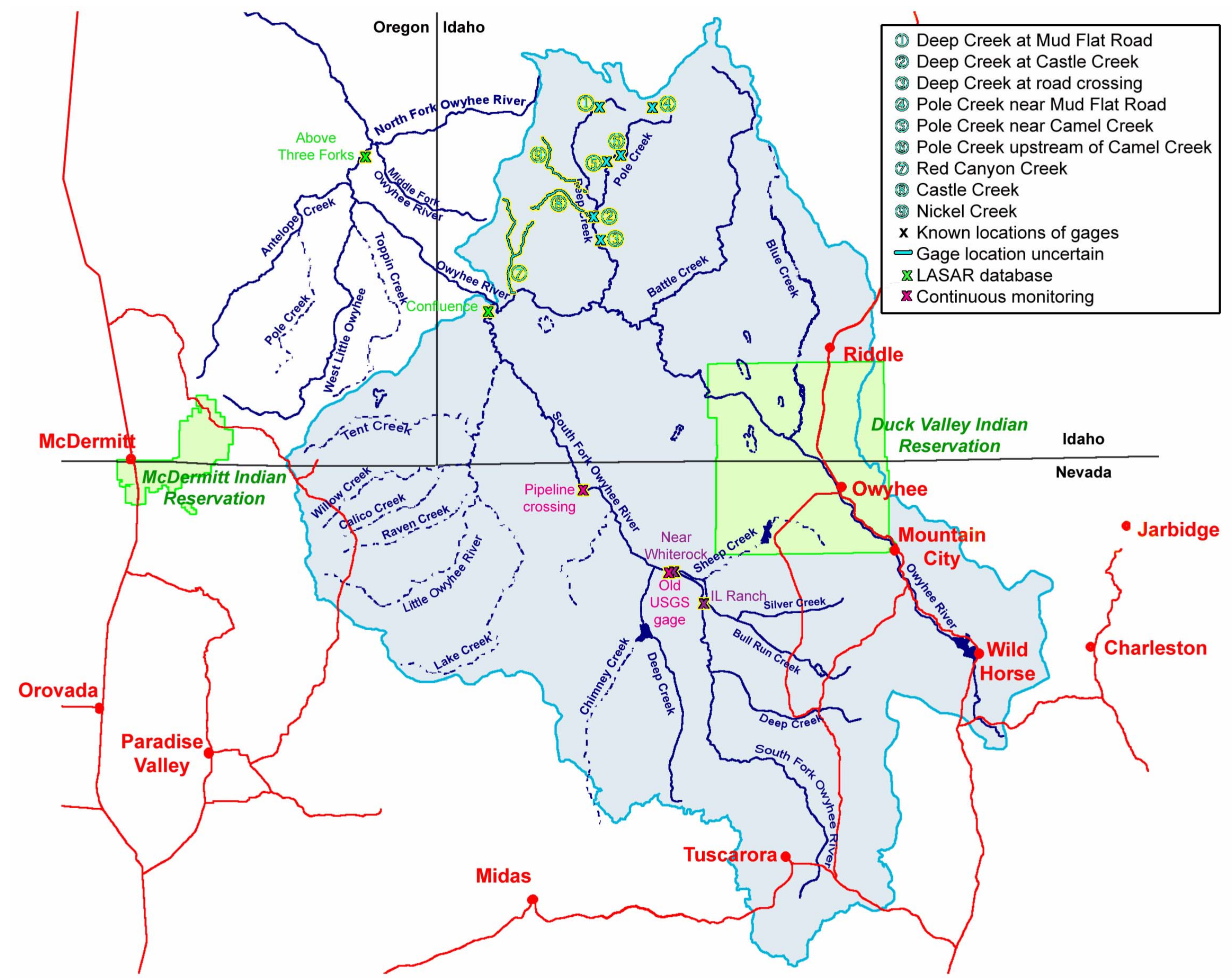

Figure 8.2. Location of prior water temperature monitoring sites in the upper Owyhee subbasin.

In the summer of 2004 the Bureau of Land Management (BLM) installed temperature loggers at six locations in the Upper Owyhee HUC. There was one logger on Nickel Creek, one on Pole Creek, two on the East Fork Red Canyon Creek, and one each on the West Fork Red Canyon Creek and on Red Canyon Creek.

c. South Fork Owyhee HUC in Nevada

In 1999, a water temperature monitoring site was set up at the El Paso Pipeline Crossing in Nevada at river mile 36.8 from the Idaho-Nevada border. The water temperature of both the South Fork Owyhee at this site and at the old USGS gage upstream was recorded in 1999, 2000, and 2001, with only the old USGS gage recording in 2002 and only the pipeline gage with 2003 records. These data and miscellaneous temperature readings near Whiterock and at the IL Ranch were included in the preliminary temperature assessment of the South Fork Owyhee River in Nevada (Figure 8.2).

d. South Fork Owyhee HUC in Idaho

For the South Fork Owyhee TMDL in Idaho the data from the monitoring site at the El Paso Pipeline Crossing in Nevada was used. In addition, water temperature was monitored at the 45 Ranch in Idaho. Samples were collected at these two sites in June, July, August and September of 1999 (Figure 8.2).

e. Oregon

The Oregon DEQ operates a database of information on air and water quality monitoring data, the Laboratory Analytical Storage and Retrieval (LASAR) database. The information entered in the database comes from over 100 different entities as diverse as state agencies, watershed councils, BLM offices, the Idaho DEQ and the Denver USGS.[39] The database contains the record of continuous 2001 temperature readings on the South Fork Owyhee River above the confluence with the East Fork in Idaho and on the Owyhee River above Three Fingers in Oregon (Figure 8.2).[38]

2. Recorded temperature data

In the upper Owyhee subbasin, the measurements of water temperature are usually made in degrees Celsius (°C). Most Americans outside of scientific fields are accustomed to thinking in degrees Fahrenheit (°F). A five degree change in degrees Celsius is equal to a nine degree change in Fahrenheit. Complexity in converting a temperature from one scale to the other is introduced by 0°C equaling 32°F. Where comparisons are made between stream water temperature and criteria, the criterion for Oregon is 20°C (68°F), the criterion for Idaho is 22°C (71.2°F), and the criterion for Nevada is 21°C (69.8°F).

a. Upper Owyhee HUC in Nevada

The water temperatures in the East Fork Owyhee River and in Mill Creek were measured at the same time that water samples were taken from these waterbodies. The data represent discrete moments in time. The data were collected over a number of years. Some of the data have the time of day that the sample was made recorded, but the majority do not (Table 8.2).

Table 8.2. Sample water temperature data in the Upper Owyhee HUC in Nevada from the *Total Maximum Daily Loads for East Fork Owyhee River and Mill Creek*

Sample location	Years	Number of discrete samples	Number of samples over 21°C (69.8°F)	Maximum recorded temperature	
				°C	°F
East Fork Owyhee below Wild Horse reservoir	1996 - 2003	15	1	25.3	77.5
East Fork Owyhee above Mill Creek	1967 - 2003	81	11	25.0	77.0
East Fork Owyhee below Mill Creek	1995 - 2003	51	7	24.9	76.8
East Fork Owyhee at the south boundary of Duck Valley Indian Reservation[a]	1999 - 2003	10	0	18.3	64.9
Mill Creek above Rio Tinto	1995 - 2003	20	2	26.1	79.0
Mill Creek at Patsville	1997 - 2003	9	5	31.0[b]	87.8
Mill Creek above the East Fork Owyhee River confluence	1995 - 2003	23	4	25.7	78.3

[a] All the temperature measurements were taken before 1:30 in the afternoon.

[b] Taken during a period of low flow. 26°C was the second highest temperature recorded.

b. Upper Owyhee HUC in Idaho

The Idaho DEQ's TMDL for the Upper Owyhee Watershed did not present continuous data for water temperature at the monitored sites but only a tabular analysis of the 2000 and 2001 data without the inclusion of data other than the extreme high temperatures observed for the time period recorded (Table 8.3).

Table 8.3. Water temperature data analyses for the Upper Owyhee HUC in Idaho from the *Upper Owyhee Watershed Subbasin Assessment and Total Maximum Daily Load*.

Location of the thermograph / Dates considered, year	Maximum water temperature °C	Maximum water temperature °F	Days with maximums over 22°C (71.2°F)
Deep Creek at Mud Flat Road			
June 23 thru Aug 31, 2000	27.5	81.5	90%
June 1 thru Aug 12, 2001	26.3	79.3	
Deep Creek at Castle Creek			
June 23 thru Aug 31, 2000	29.1	84.4	98%
June 1 thru Aug 31, 2001	28.3	82.9	
Deep Creek at Road Crossing			
June 22 thru Aug 31, 2000	31.1	88.0	85%
June 1 thru Aug 31, 2001	29.6	85.3	
Pole Creek near Mud Flat Road			
June 23 thru Aug 31, 2000	25.5	77.9	Went dry
June 1 thru Aug 12, 2001	24.9	76.8	Went dry
Pole Creek near Camel Creek			
July 12 thru Aug 31, 2000	25.6	78.1	90%
Pole Creek upstream of Camel Creek			

	July 12 thru Aug 31, 2000	22.7	72.9	16%
Castle Creek				
	June 23 thru Aug 24, 2000	31.1	88.0	100%, went dry
	Not included 2001			Went dry
Red Canyon Creek				
	June 23 thru Aug 31, 2000	25.2	77.4	47%, went dry
	Not included 2001			Went dry

Each maximum shown in table 8.3 represents only one day's reading and provides little information. However, more information can be gleaned from the inclusion of the percentage of days with the maximum water temperature over 71.2°F. For all the reaches of Deep Creek, the maximum water temperature exceeded 71.2°F on at least 85% of the days between June 23 and August 31, 2000. Castle Creek and Red Canyon Creek went dry. Pole Creek went dry above the confluence with Camel Creek. The water temperature in a drying stream would tend to rise as the flow diminished.

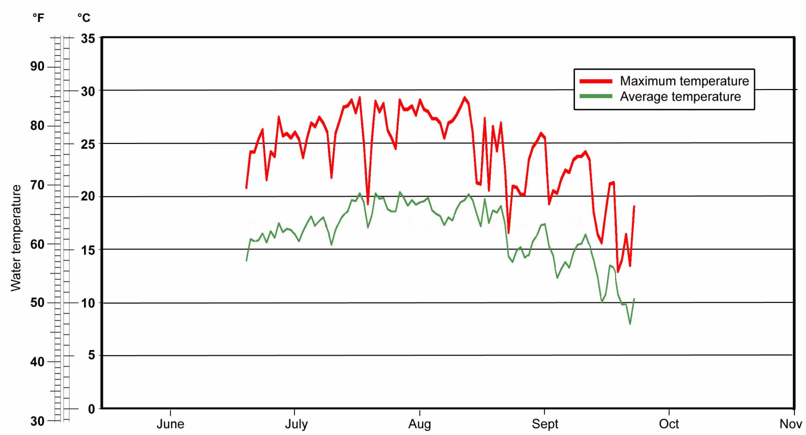

Figure 8.3. Daily maximum and average water temperatures in upper East Fork Red Canyon Creek, Idaho in 2004.

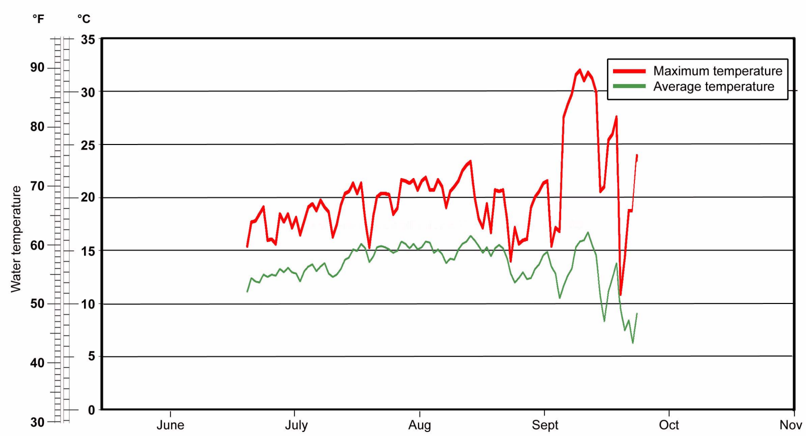

Figure 8.4. Daily maximum and average water temperatures in lower East Fork Red Canyon Creek, Idaho in 2004.

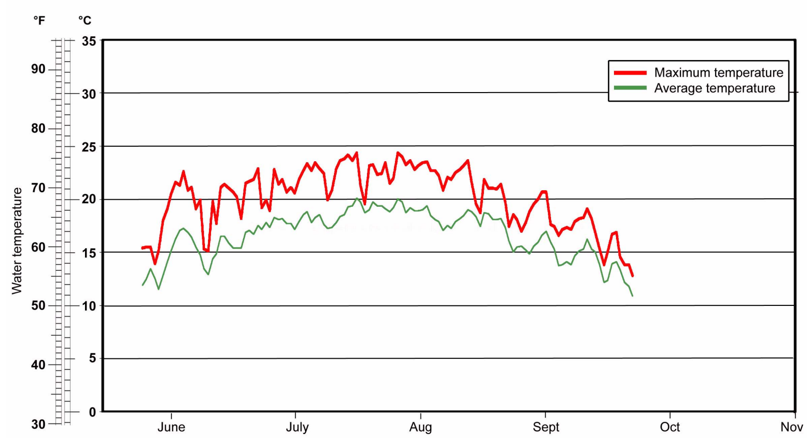

Figure 8.5. Daily maximum and average water temperatures in lower Red Canyon Creek, Idaho in 2004.

The results of water temperature measurements made by BLM in the summer of 2004 are graphed in the five year review of the Upper Owyhee TMDL. These graphs show the maximum daily water temperature and the average daily water temperature. The minimum daily water temperature is absent.[46] Four of the monitored locations were in the Red Canyon Creek drainage.

From upper East Fork Red Canyon Creek (Figure 8.3) to downstream in lower East Fork Red Canyon Creek (Figure 8.4), the temperature loggers

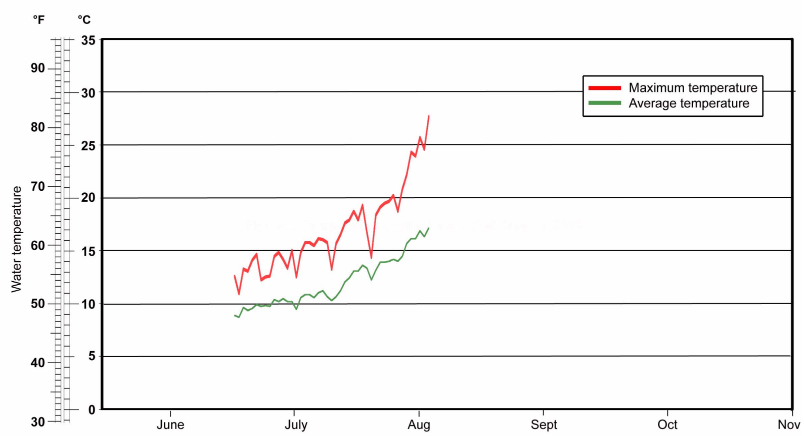

Figure 8.6. Daily maximum and average water temperatures in West Fork Red Canyon Creek, Idaho in 2004.

show a general decrease in water temperature. In the upper creek they tended to peak above 70°F and many of the maximum temperatures were over 77°F, up to 85°F. In lower East Fork Red Canyon Creek, most of the maximum water temperatures were between 60 and 70°F. Further downstream in lower Red Canyon Creek (Figure 8.5) the water temperatures tended to be slightly higher than in lower East Fork, but not as high as in the upper East Fork. The data for West Fork Red Canyon (Figure 8.6) span a much shorter time period, but during this time period the maximum water temperatures are also lower than downstream in lower Red Canyon Creek. The spikes in temperature at the end of July on the West Fork (Figure 8.6) and in September of the lower East Fork (Figure 8.4) were consistent with the creeks going dry.[46]

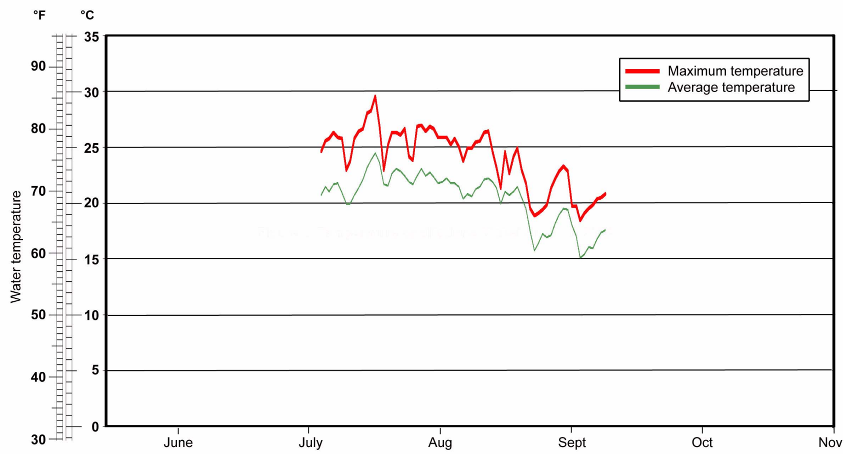

Figure 8.7. Daily maximum and average water temperatures in Nickel Creek, Idaho in 2004.

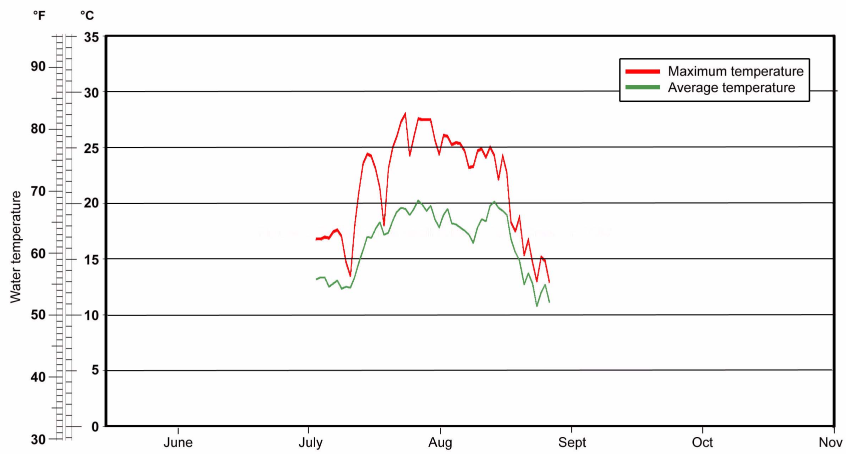

Figure 8.8. Daily maximum and average water temperatures in Pole Creek, Idaho in 2004.

Data that is included in the five year review of the Upper Owyhee TMDL from the temperature loggers in Nickel Creek (Figure 8.7) and in Pole Creek (Figure 8.8) represent only about two months of monitoring at each location. The maximum water temperatures spike in each of these creeks in July. The large difference between the maximum water temperature and the average water temperature at Pole Creek indicates significant drops in temperatures at night, as much as 32°F.

c. South Fork Owyhee HUC in Nevada

Sporadic readings of the water temperature were made on the South

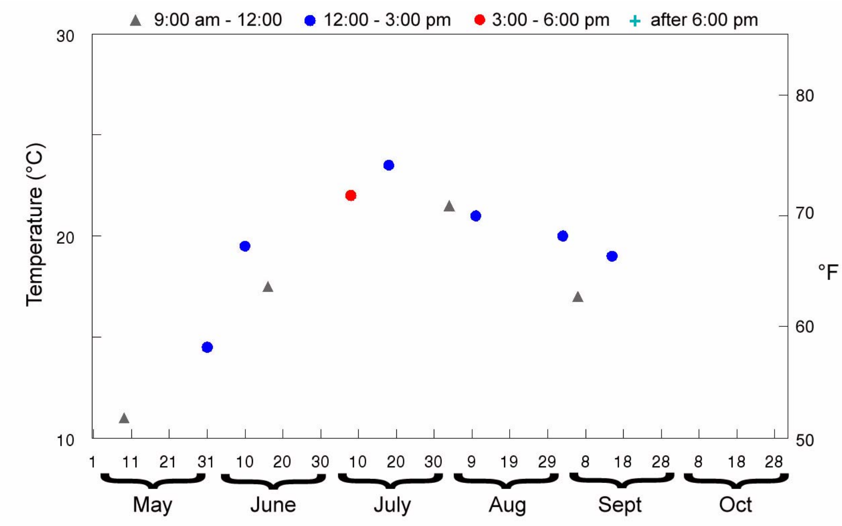

Figure 8.9. Miscellaneous water temperature readings on the South Fork Owyhee River near Whiterock, Nevada between 1977 and 1981.

Fork Owyhee River between 1977 and 1981 near Whiterock (Figure 8.9) and between 1966 and 1995 on the IL Ranch (Figure 8.10). Near Whiterock, these spot checks of water temperature in July or August were all above 19.5°C (67.1°F). One of these temperatures, 70.7°F, was recorded in the morning at 9:35 am on August 3, 1978.

The spot checks for the water temperature of the South Fork at the IL Ranch were made over a larger number of years than those near Whiterock. Of the sixteen readings made sometime in either July or August, only three were below 20°C (68°F). Of these three, two were made in the morning.

In Nevada, the old USGS gage on the South Fork Owyhee River is upstream from the El Paso pipeline gage. The data from these two gages was recorded on the same graph in 1999, 2000, and 2001 (Figures 8.11, 8.12, and 8.13). The lines represent continuous data. Due to the compressed nature of the graph and the overlaying of two sets of data, the small differences within a day are not visible. The peaks show the maximum water temperature for a day and are followed by a dip to the minimum water temperature the next night. To visualize these graphs as graphs of maximum daily temperatures like those in Figures 8.3 to 8.8, imagine a line connecting the peaks.

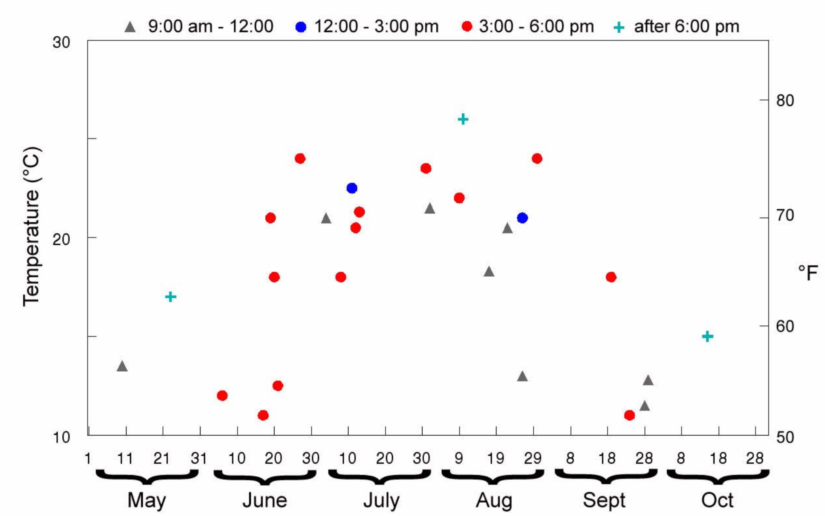

Figure 8.10. Miscellaneous water temperature readings on the South Fork Owyhee River at the IL Ranch, Nevada between 1966 and 1995.

At both the old USGS gage and the pipeline gage, there is a considerable difference between the daytime maximum water temperature and the nighttime minimum water temperature. The fluctuations in water temperatures at the two gages

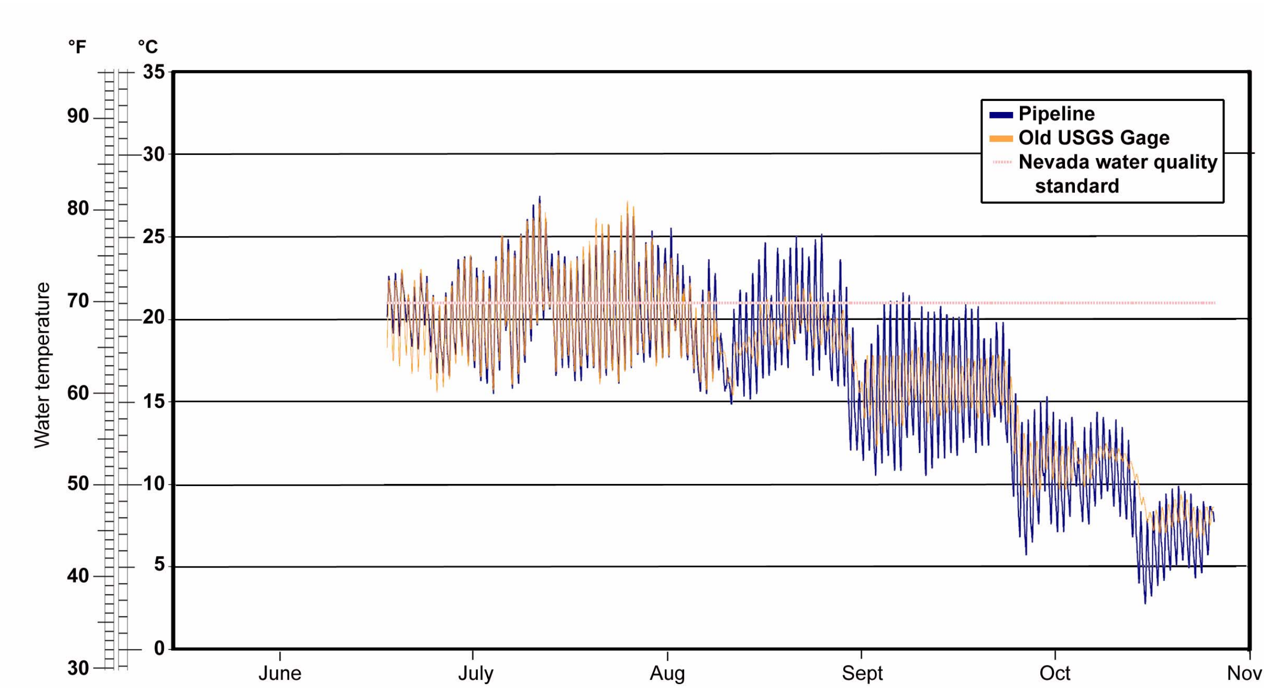

Figure 8.11. Water temperature fluctuations at two gages in the South Fork Owyhee River, Nevada in 1999 .

tend to have a similar pattern. At the end of summer and in the fall In 1999 the temperature of the water passing the pipeline gage was hotter during the day and was colder at night than the water upstream at the old USGS gage which maintained a more constant temperature. In 2000 and 2001 the water temperatures at the two gages accompanied each other more closely.

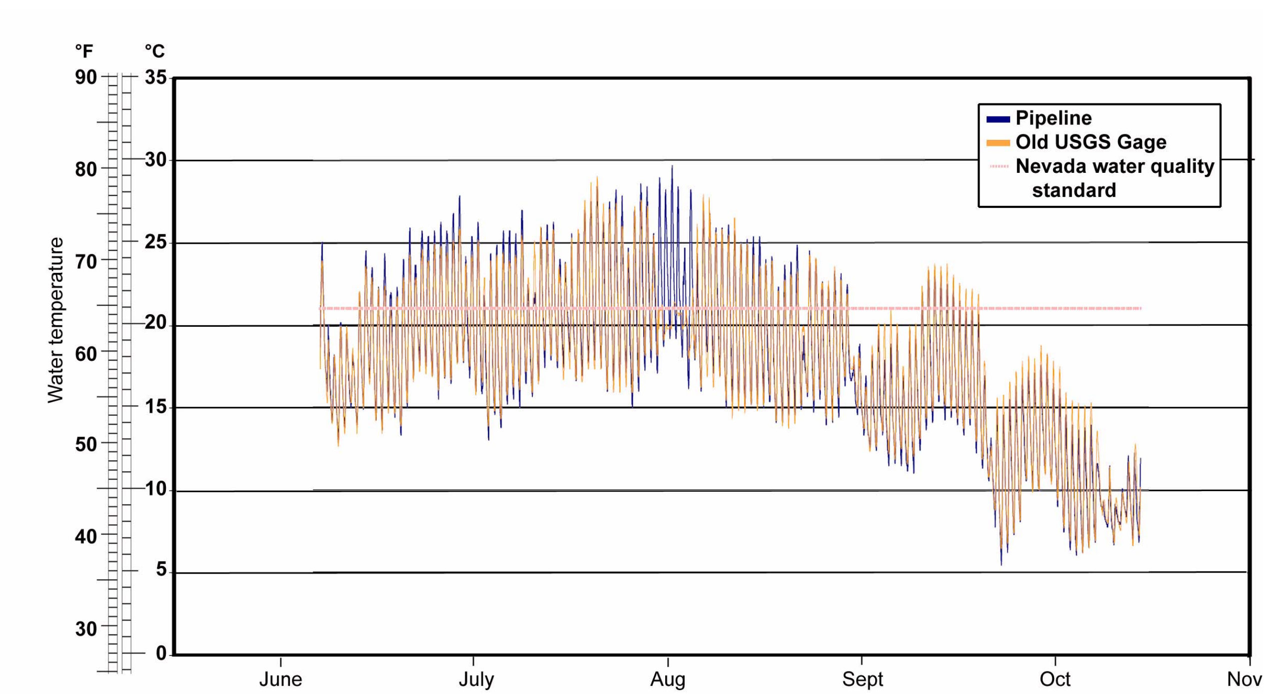

Figure 8.12. Water temperature fluctuations at two gages in the South Fork Owyhee River, Nevada in 2000.

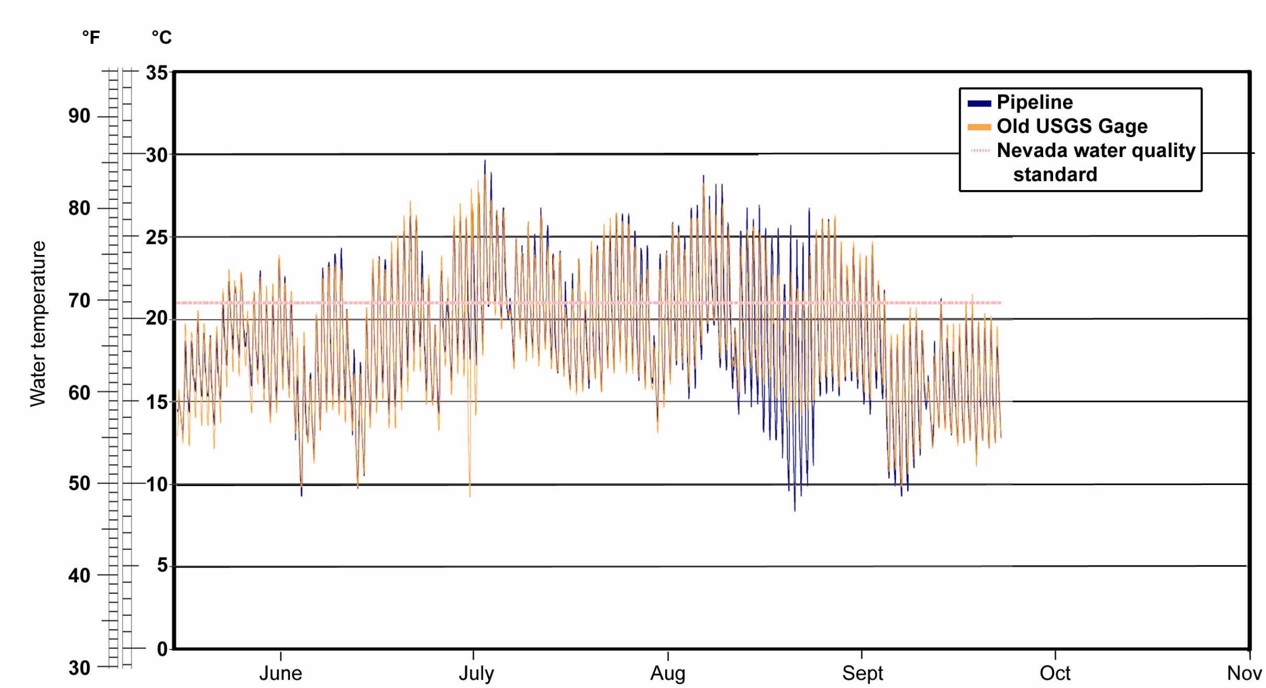

Figure 8.13. Water temperature fluctuations at two gages in the South Fork Owyhee River, Nevada in 2001 .

Only the data for the old USGS gage was available for 2002 (Figure 8.14). For 2003, only the water temperature data for the El Paso pipeline gage was available (Figure 8.15). Maximum daily temperatures in July and August of all reported years were constantly above the Nevada water quality standard of 21C (69.8°F).

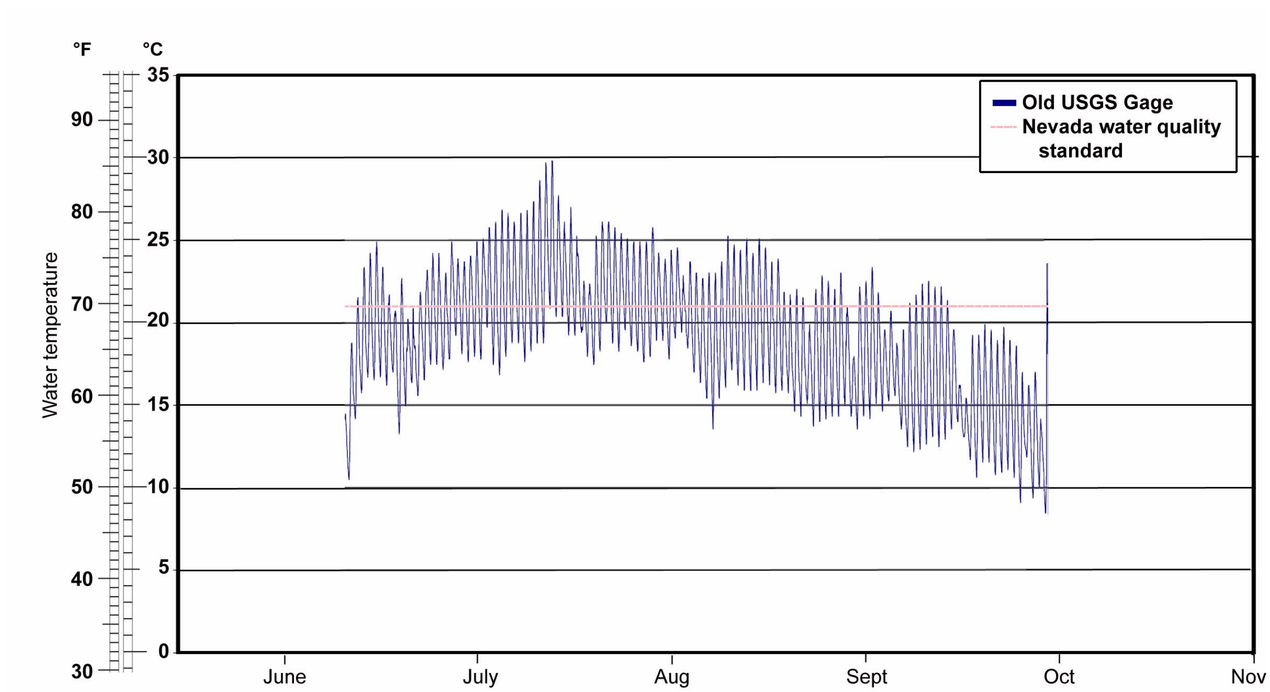

Figure 8.14. Water temperature fluctuations at the old USGS gage in the South Fork Owyhee River, Nevada in 2002 .

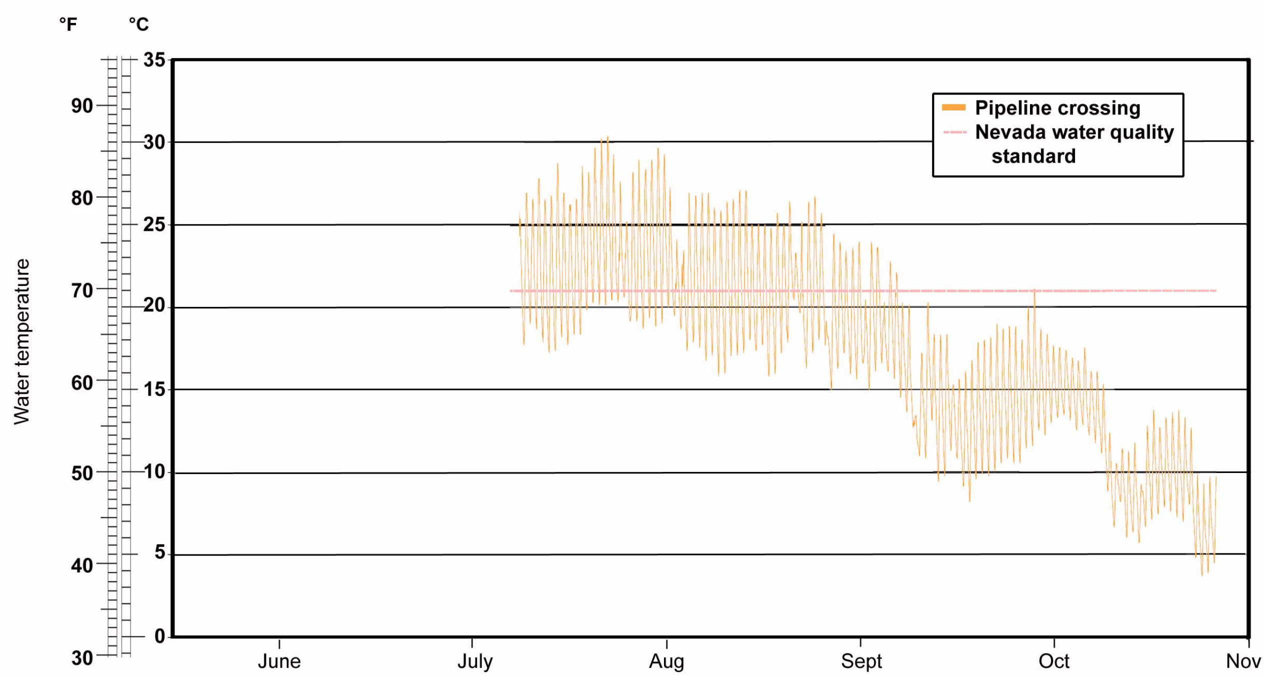

Figure 8.15. Water temperature fluctuations at the pipeline crossing gage in the South Fork Owyhee River, Nevada in 2003.

d. South Fork Owyhee HUC in Idaho

In 1999, the water temperatures at the 45 Ranch on the South Fork Owyhee at the confluence with the Little Owyhee River in Idaho were compared to the recorded data from the El Paso pipeline site in Nevada. "Average maximum daily temperatures were similar at the 45 Ranch and the El Paso Pipeline sites." Regression analysis also showed that there was "a strong correlation between water temperatures entering Idaho and those recorded in Idaho at the 45 Ranch."[27] At the 45 Ranch, the diurnal (change between daily maximum and minimum) water temperature changes were less than upstream at the pipeline site.

In Idaho, just before the South Fork Owyhee River joins the Owyhee River, water temperature data was continually monitored during 2001 (Figure 8.16). During 2001 the water temperature was also monitored on the Owyhee River in Oregon above Three Forks (Figure 8.17). Above the confluence with the Owyhee River, the daily fluctuations in water temperature in 2001 were smaller than upstream at the pipeline site (Figure 8.13) . Farther downstream at the Three Forks site, the daily fluctuations were even less. Observing the graphs of the water temperatures at the pipeline site and at the Owyhee confluence, there doesn't seem to be much difference in temperatures.

Figure 8.18 shows the maximum daily water temperatures at the three successive downstream locations, the South Fork Owyhee River at the El Paso pipeline in Nevada, the South Fork Owyhee River above the confluence with the Owyhee River in Idaho, and farther downstream on the Owyhee River upstream from Three Forks in Oregon. The maximum water temperatures at the pipeline gage and above the confluence mirror each other fairly closely with the maximum temperatures at the pipeline gage being slightly higher than those downstream above the confluence. Over

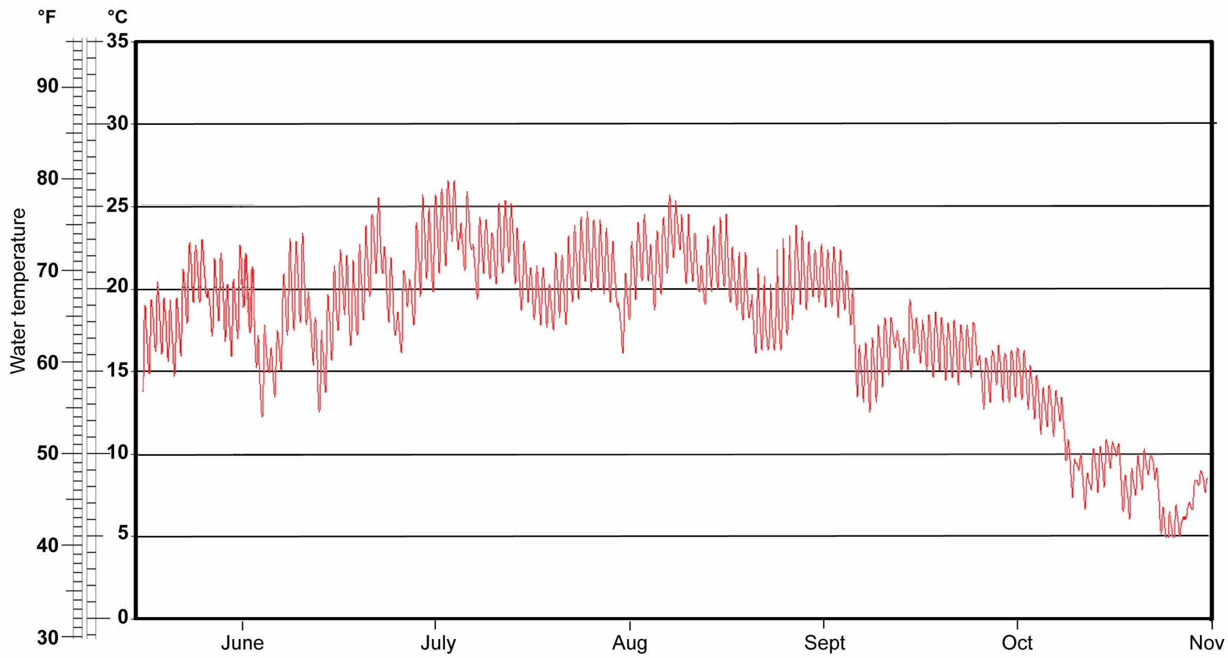

Figure 8.16. Water temperature fluctuations in the South Fork Owyhee River above the confluence with the East Fork Owyhee River, Idaho in 2001.

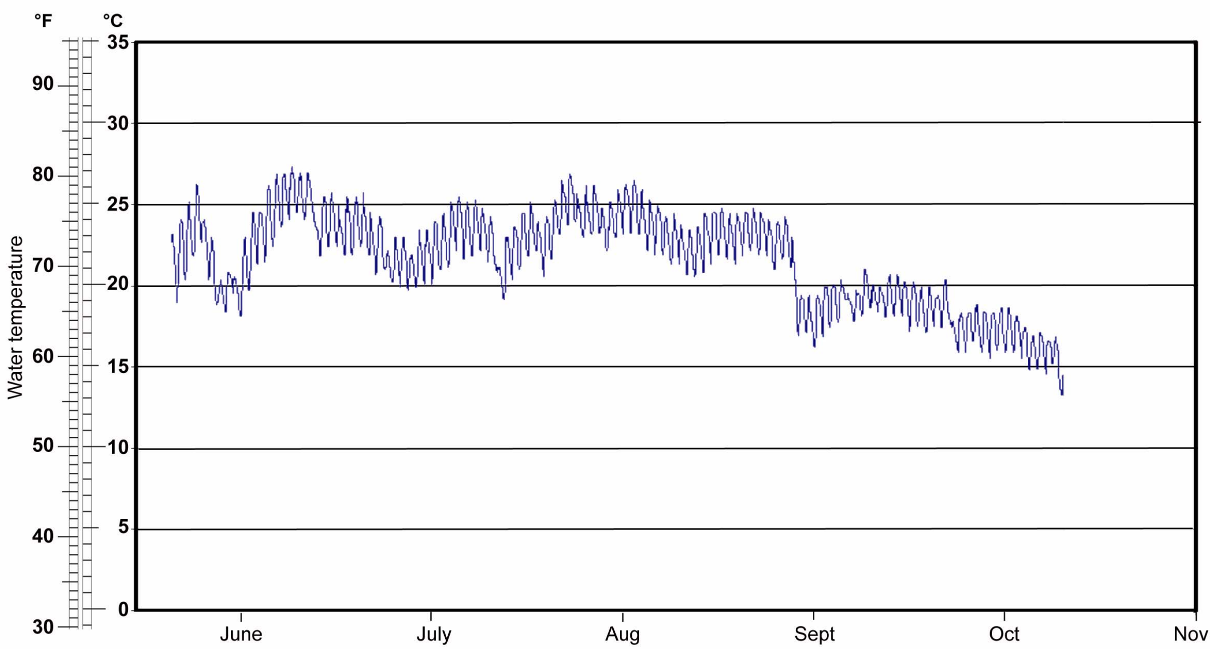

Figure 8.17. Water temperature fluctuations in the Owyhee River above Three Forks, Oregon in 2001.

the recorded season, the maximum water temperatures above Three Forks tended to be higher than the those at the other two sites. However, during some time periods the pipeline gage maximums were higher than at either of the other two sites. It would be difficult to determine to what extent the increase in water temperature and the decrease

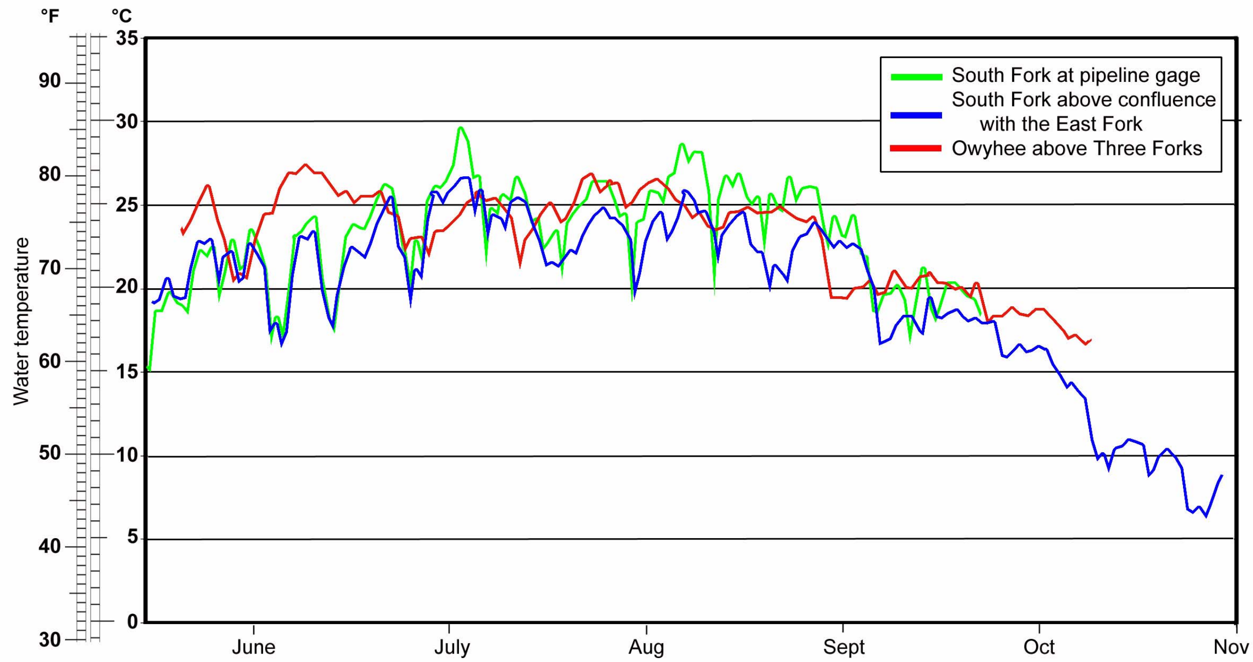

Figure 8.18. Maximum daily water temperature at three successive downstream locations (Nevada, Idaho, Oregon) in 2001.

in daily temperature fluctuations at the Three Forks site was due to the addition of the waters of the Owyhee River to the waters of the South Fork Owyhee River.

3. Discussion of stream temperature

Based upon the beneficial uses established for waterbodies in the upper Owyhee subbasin, temperature is identified as the major pollutant of concern. The most restrictive beneficial use assigned to the upper reaches of the Owyhee river in Oregon is redband and Lahontan cutthroat trout. In Idaho, Deep Creek, Pole Creek, Castle Creek, Red Canyon Creek, and South Fork Owyhee River are designated for cold water aquatic life and salmonid spawning. In Nevada the South Fork Owyhee River is considered habitat for redband trout, brook trout, and whitefish. East Fork Owyhee River and Mill Creek are designated for aquatic life. The standards established for the maximum water temperature for the designated use is 20°C (68°F) in Oregon, 22°C (71.6°F) in Idaho, and 21°C (69.8°F) In Nevada.

a. Summary of existing data

The available data on current water temperatures in the streams of the upper Owyhee subbasin substantiate the fact that the water temperatures in those reaches frequently exceed the established standard. Twenty one percent of the temperature samples taken on Mill Creek were over 21°C. On the East Fork Owyhee River in Nevada, 13% of the samples showed temperatures over 21°C. In Idaho, during July and August of 2000, Deep Creek's maximum daily temperature exceeded 22°C over 85% of the time. In 2001, at the pipeline gage in Nevada and at the gage at the confluence of the South Fork Owyhee River with the Owyhee in Idaho, only four days recorded maximum water temperatures less the 20°C and most of the readings were above 22°C during July and August 2001. By the time the waters of the Owyhee reached the gage above Three Forks in Oregon, during July and August 2001, not only did the maximum water temperature remain above 20°C, but the minimum temperature only dipped below 20°C a couple of times.

The months of July and August have the highest water temperatures in the upper Owyhee subbasin. During these months the diurnal changes in water temperature at the 45 Ranch, at the South Fork - Owyhee confluence, and upstream from Three Fingers were relatively small compared to other sampled sites, frequently less than 15°F.

b. Attainability

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 ***attainable,*** to achieve water quality . . ." The italics and bold attributes are from the EPA document. In examining the water quality in the rivers within the upper Owyhee subbasin it is essential to first consider what is attainable. If the realities of the situation are not taken into consideration, meeting the goals is doomed to failure.

Some of the assessments already conducted in the upper Owyhee subbasin express doubts about the attainability of the established water quality criteria. In his five year review of the Upper Owyhee TMDL, Stone says, "Originally, the targets for full support of beneficial uses were the temperature criteria in the water quality standards. These criteria are not appropriate for the sparsely flowing desert streams of the Upper Owyhee River watershed. A pristine stream in this area would probably still violate water quality criteria at certain times of the year."[46]

In the TMDL for the South Fork Owyhee River in Idaho, Ingham concludes "One of the influences on water temperature in the South Fork Owyhee River is ambient air temperature. With warm water temperatures originating from Nevada and the ambient air temperature, the South Fork Owyhee River may not ever have an opportunity to cool itself enough to meet State of Idaho water quality criteria for cold water biota and salmonid spawning."[27]

Not only does the East Fork Owyhee River and Mill Creek TMDL suggest that more monitoring might be appropriate, but it includes the statement that "Mill Creek temperature standards should recognize the ephemeral nature of the stream. Current temperature standards are “single value” standards, without any consideration of duration."[32]

c. Stream flow

There are tremendous natural variations in water flow in the Owyhee River. These variations include both flooding and diminution of the water flow to almost a trickle and cause scouring of the banks. Downstream in Oregon, since 1950, the minimum flow at Rome was 42 cubic feet per second (cfs) on four different dates.[49] Gene Stuntz states that before the construction of the Owyhee Dam the amount of water in the Owyhee varied, dwindling to a small trickle in the hot summer time.[47] Before reservoir development in the watershed, Chesley Blake who also lived in an area now inundated by the Owyhee Reservoir remembers that when the river level went down the water would get warm, and the children would swim in the river.[3]

The hydrology section of this assessment discusses the stream flows in the upper Owyhee subbasin in greater detail. With naturally decreased flows, streams in the subbasin would be expected to experience heating similar to or greater than that recorded downstream on the Owyhee River.

d. Effect of climate

How does climate affect the water temperatures in the upper Owyhee subbasin? The discussion in the background section characterizes the air temperatures in the upper Owyhee subbasin (see the climate section of the background component of this assessment). The greater part of the subbasin lies between 5000 feet and 5500 feet in elevation. Meteorological stations within and adjacent to the subbasin that are located between these elevations and might most closely represent a larger area are Il Ranch at 5203 ft, Owyhee at 5397 ft, and Grasmere at 5144 ft. In July, the respective average maximum air temperatures at these three stations are 88.1°F, 85°F and 87.7°F.

In 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.[29] Carr et al. also found that climatic factors, including air temperatures, were the dominant factors in stream temperature patterns.[4]

In the Truckee River at Reno, the stream temperature could be predicted using maximum air temperature and average daily flow as variables.[61] The Truckee River at Reno is also in a semiarid desert. Since maximum air temperature of the Truckee River at Reno was a large factor in predicting the stream temperature, it is quite probable that the maximum air temperatures in the upper Owyhee subbasin are major indicators of the expected water temperatures in the streams. 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.[48] Conversely, as the streams of the upper Owyhee subbasin carry less water in the summer, they would heat more during the day and cool more during the night than if they had greater flow. Meays et al. related the stream temperature to both the velocity and the distance. The more slowly the water traveled and the greater the distance that it traveled, the closer the stream came to achieving an equilibrium with mean air temperatures.[29]

The Malheur Experiment Station near Ontario, Oregon has recorded soil temperatures as well as air temperatures. Compared to air temperatures, the maximum soil temperature rises and falls in a similar pattern, but doesn't quite reach temperatures as high as the air temperatures. However, although the minimum soil temperatures follow a similar curve, they remain considerably higher than the minimum air temperatures (Figure 8.19).[52,56] Except for the maximum temperatures each day, the soil temperature is above the air temperature for much of the time.

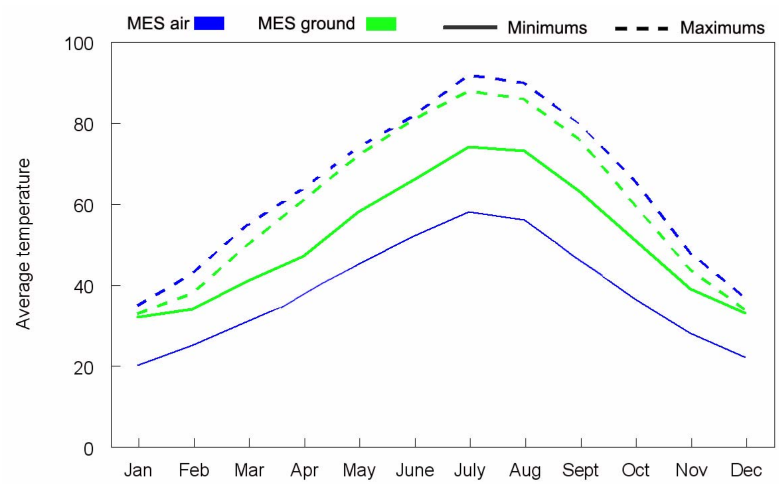

Figure 8.19. Average maximum and minimum air temperatures from 1942 to 2005 at Malheur Experiment Station Ontario, Oregon, compared to average maximum and minimum soil temperatures from 1967 to 2005 at 4-inch depth at the same location.

The histogram in Figure 8.20 indicates how often a combination of a specific air temperature and soil temperature occurred between 1992 and 2007. Shading of the dots on the graph 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. At the Malheur Experiment Station Agrimet weather station the soil temperature is higher than the air temperature more of the time.[56]

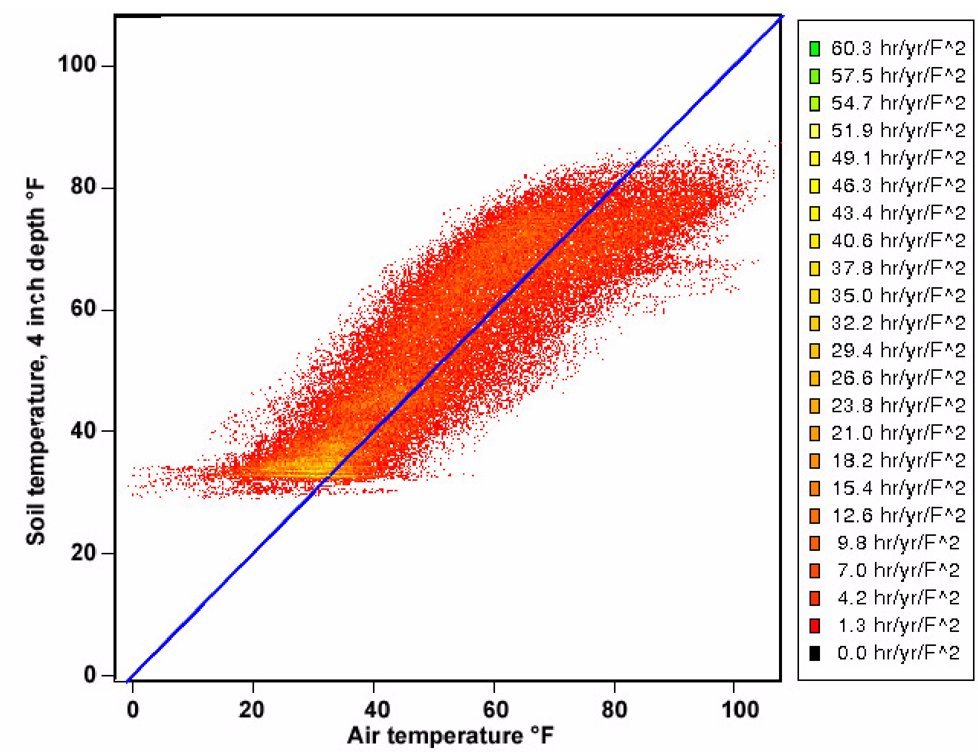

Figure 8.20. Histogram of the soil temperature at 4 inch depth vs. the air temperature at the agrimet weather station, Ontario, Oregon from 1992 to 2007.

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. In the upper Owyhee subbasin, no well developed understanding of the physics involved in stream heating has been used to determine stream temperature standards. It is possible that stream temperature standards have been established that violate physical principles of heating and cooling.

e. Effect of shading

In Idaho DEQ's 2003 TMDL, Deep Creek, Pole Creek, Castle Creek, and Red Canyon Creek were judged to be water quality limited due to temperature. Therefore shade requirements were established for the different stream segments to achieve the predetermined temperature standards. Depending on the stream segment, the shading requirement ranged from 52% to 95% shade for July and 57% to 67% shade in August (Appendix G). No data have been developed that indicate the amount of shade that is feasible given the natural precipitation regime, natural vegetation types, natural scouring frequency, and natural fire frequencies.

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."[28] Similarly Meays et al. found that canopy cover alone was not sufficient to prevent water temperature from trending toward equilibrium with air temperature.[29] Carr et al. concluded that shade functioned in a subordinate role to climate in affecting stream temperature.[4]

i. Vegetation

The primary way that more shade could be provided along a waterway would be to increase the amount of vegetation growing on the banks.

The present vegetation currently along the river banks seems to be similar to what it was at the time of the first entry of Euro-American trappers into the upper Owyhee subbasin 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 streams outside of the Bull Run and Independence Mountains (see the at contact section of the history component of this assessment).

The woody species which exist at higher elevations in the Bull Run and Independence Mountains do not naturally extend to lower elevations. There is not enough precipitation on the Owyhee plateau to support these species. Even along the streams, these species would have difficulty obtaining adequate water during many years of lower flow. In addition, a large portion of the stream banks 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.

There is evidence that any woody vegetation which starts to develop along the banks has been periodically scoured away by flooding. In the Idaho South Fork Owyhee River TMDL, Ingham states that on the South Fork, "This flashy flow is the predominant cause for lack of established large woody vegetation."[27] Moseley explains that the snow accumulation zone for the South Fork "constitutes a small percentage of the South Fork basin, however, with most of it being arid lowlands of the plains. There is virtually no snow pack on the plains and streams tend to be intermittent and ephemeral, largely flowing during winter and spring and in summer only during storms. This makes for a very flashy hydrologic regime where the river rises rapidly and dramatically in response to spring snow melt patterns and episodic storm events, quickly returning to near base flow."[30] Although the USGS gage near Whiterock recorded a high discharge of 3200 cfs in 1957 (Figure 5.18), in 1993, the "USGS gauging station at Rome, Oregon, recorded a flow of nearly 48,000 cfs. On quick observation, the hydrographs for the Rome and South Fork stations appear similar. If this is (statistically) true, the 1993 discharge on the South Fork was around 9300 cfs, three times greater than the recorded high in 1957."[30]

ii. Models

In the Upper Owyhee TMDL, both the temperature standard established and the amount of shade required to achieve the standard were calculated using the Stream Segment TEMPerature model (SSTEMP). A wide variety of data is needed for the SSTEMP.* Due to the relatively few meteorological stations in the upper Owyhee subbasin, particularly in Idaho (Figures 5.1 and 5.2) and to the lack of stream gages for flow (Figure 5.15), many of the underlying parameters used can not be specific to a stream. To utilize the model for the TMDL, assumptions must have been made about the parameters for which no data is available.

If there are assumptions about vegetation distributions in the subbasin which are significantly different than those species found at present, they would be not be based of actual specie distributions but on the theoretically generalized site potentials and hypothetical ranges of native species. The primary limiting factor to the actual existence of a specie is rainfall.

f. Geology

A factor affecting the temperature of the South Fork Owyhee River and possibly stretches of other streams in the upper Owyhee subbasin is the underlying geologic material. "The South Fork Owyhee River meanders through volcanic material of either basalt or rhyolite. Both materials are dark in nature and have high heat absorbing capability. These factors may impact the ability for cooling to occur both within the water column and the ambient air temperature."[27]

g. Conclusion

Major causes of the high water temperatures in the upper Owyhee subbasin are water scarcity and heat load from solar and other ambient sources. Riparian shading is naturally limited by precipitation, scouring, and fire frequency. Objective thermal potential studies have not been made for the upper Owyhee subbasin.

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* Data and parameters needed for SSTEMP:[50]

Average stream width, elevation, and slope; streambed thermal gradient; shade factor or site latitude and azimuth, vegetation height, offset, density, and crown measurement if the shade model is used.

Average daily discharge at upstream boundary; average daily tributary inflows and outflows; average daily lateral inflows and outflows.

Latitude, elevation, mean annual air temperature at a representative meteorological station; average daily relative humidity, average daily relative sunshine; average daily wind speed; average daily extraterrestrial solar radiation; average daily solar altitude; (optional) observed solar radiation at ground level.

Average daily temperature at upstream boundary.

Average daily dust and ground reflectivity coefficients.

I. Other pollutants

In addition to temperature, each of the states has a different list of pollutants or candidate pollutants (Appendices F, G, and H). Where the waters enter Oregon, currently only arsenic is considered an additional pollutant. Since aquatic life is the primary beneficial use of the Owyhee River in Oregon at the Idaho border, in the 2010 integrated report, Oregon also included other factors thought necessary for aquatic life. Phosphate phosphorus, alkalinity, ammonia, chloride, dissolved oxygen, and pH were all listed as being of potential concern or only attaining some criteria.

The East Fork of the Owyhee River in Idaho at the border with Oregon is not 303(d) listed for any pollutant. There is a political dilemma introduced by a river with water quality criteria that change as the river crosses the border between states.

1. Historic anthropogenic activities

Underground mining of copper-sulfide ore was conducted at the Rio Tinto Mine from 1932 to 1947. The mine sits above Mill Creek about 2.5 miles south of Mountain City. Since the underground operation closed, old tailings have been reworked and there has been leaching of both stockpile ore and of the underground workings. Acid mine drainage has degraded the water quality of Mill Creek and the East Fork Owyhee River.[32]

This legacy mining is believed to be a "major contributor of cadmium loads to Mill Creek" and is "a known contributor of copper loads to Mill Creek and the East Fork Owyhee River."[32]

2. Geologic sources

a. Iron

In Nevada, iron is a fairly common constituent of rock and soil. Throughout Nevada, waterbodies show fairly high concentrations of iron introduced by natural run-off and seepage. Anthropogenic activity at the Rio Tinto Mine site may be a significant contributor to iron in the Mill Creek drainage.[32]

b. Arsenic

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

c. Mercury

There are many natural mercury deposits in the upper Owyhee subbasin (see the background section). Mercury occurs naturally in the environment and the occurrence of mercury is not an issue of concern. Only concentrated levels of mercury are of concern because there is an increased likelihood of mercury release by natural or human processes.[216]

Mercury has not been a major problem in the upper Owyhee subbasin. However, it is listed as a possible impairment in Shoofly Reservoir in Idaho's 2010 Integrated §303(d)/§305(b) Report.[23]

Mercury is a problem when it ends up in fish tissue. Although larger amounts may affect adults, small amounts of mercury can damage a child's brain resulting in behavioral and learning problems.[42]

3. Dissolved oxygen

Oxygen solubility in water is inversely related to temperature. In other words, as water temperature rises, the solubility of oxygen is reduced.[18] The reaches of the streams of the upper Owyhee subbasin where the temperature is high can be expected to also have lower levels of dissolved oxygen than are recommended for fish.

Although concentrations of oxygen rise during the day when algae are creating oxygen as a byproduct of photosynthesis, algae uses oxygen at night so the concentrations go down.[18] Since the temperature of the river is a product of the natural conditions in the upper Owyhee subbasin, the amount of dissolved oxygen is controlled, at least in part, by water temperature fluctuations.

4. Phosphorus

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 overabundance 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.[26]

Volcanic ash, lava flows, or basalt often contain relatively high concentrations of phosphorus as compared to many other rocks.[18] Some western SRP lavas contain anomalously high concentrations of phosphate.[54] Many soils in the upper Owyhee subbasin are believed to be naturally high in phosphorus.[32]

Where Idaho has monitored phosphorus in water samples, it has not found high phosphorus concentrations in the upper Owyhee subbasin that would indicate impairment of beneficial uses.[20,27] An anomaly exists on Nickel Creek. The system seems to be phosphorus deficient, limited by low phosphorus concentrations. The creek is spring fed, and "it would appear that phosphorus would be limited since natural bioavailable forms of phosphorus in ground waters are usually found in very low concentrations."[20]

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 BLM. The water at each site was sampled once each in April 2001 and April 2002.[18]

Figures 8.21 and 8.22 show graphical comparisons of the sediment and phosphorus in the water of the Owyhee River at seven sampling sites progressively downstream. OR7 is at the Idaho border, OR6 above the confluence with the West Little Owyhee River, OR5 at Three Forks, OR4 at Rome, OR3 below the Crooked Creek confluence, OR2 at Bull Creek, and OR1 at Birch Creek.[18]

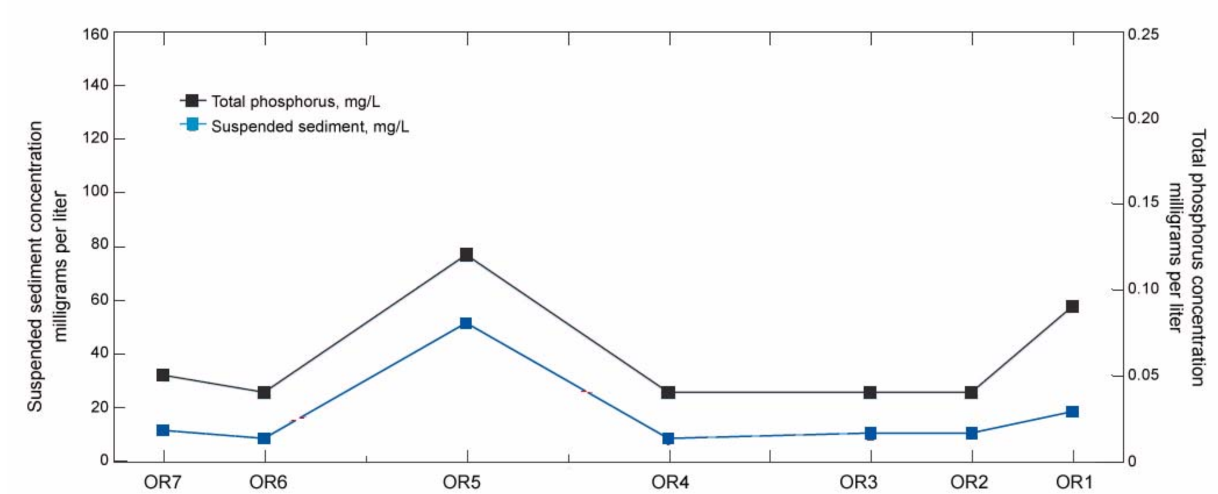

Figure 8.21. Comparison of phosphorus concentrations and suspended sediment concentrations in the Owyhee River, April 2001

An analysis of the data shows a linear relationship between the amount of sediment and the amount of phosphorus. 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.[45] We infer that the largest phosphorous loads being carried by the Owyhee River occur at times of peak flow.

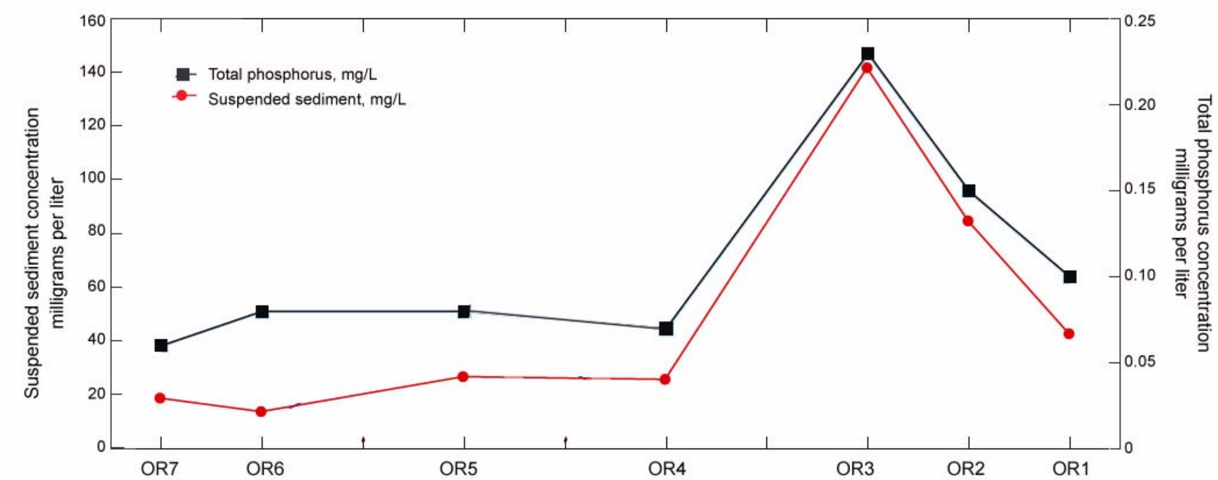

Figure 8.22. Comparison of phosphorus concentrations and suspended sediment concentrations in the Owyhee River, April 2002

Phosphorus loads may be originating from naturally occurring watershed and stream bank erosion. Other disturbed land may also be more subject to erosion. However, identifying the exact sources and pathways of phosphorus enrichment is difficult due to lack of detailed data.

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.[18]

Sulfides such as those found in the area of Mountain City-Patsville-Owyhee may also affect the pH. Calcium carbonate is widespread in the upper Owyhee subbasin and causes the waters to generally have a pH above 7.

J. Beneficial uses

Since cold water aquatic life and salmonid spawning were beneficial uses assigned to Deep Creek, Pole Creek, Castle Creek, and Red Canyon Creek, in the Idaho 2003 TMDL, the DEQ judged these streams as being water quality limited due to temperature. The temperature criteria used in the TMDL for cold water aquatic life was less than a maximum of 22°C (72°F).

In their 1996 survey of streams of the upper Owyhee subbasin in Idaho, Allen et al. did not find any redband trout in the Little Owyhee River, the South Fork Owyhee River, Blue Creek, Little Blue Creek, or Shoofly Creek. Four redband trout were found on the Owyhee River above Crutcher's Crossing.[1] In 1993 and 1997 no redband trout were found in Deep Creek, although a 1977 survey had found redband trout. The 1997 survey found a low density of redband trout in Red Canyon Creek and in the Owyhee River near the mouth of the creek. Floating the Owyhee River in July 1997, five fish biologists "extensively fished the river while paddling downstream, and only one redband trout was captured by angling in the Idaho reaches of the Owyhee River."[2]

Desert redband trout inhabit streams which appear to have unusually high temperatures.[59] Several studies have investigated the possible mechanisms which the subspecies employs to deal with these high temperatures. In northeast Oregon stream reaches, when the afternoon stream temperatures were highest, 10-40% of the redband trout occupied thermal refugia.[58] “However, whether individual redband trout respond to summer temperature extremes by moving sizable distances has not been investigated.”[59]

Although there are redband trout in some of the streams of the upper Owyhee subbasin, designating cold water aquatic and salmonid spawning as beneficial uses needs to be site specific and will not apply to many of the streams of the subbasin. Even in those streams with redband trout, they may be retained in stream reaches by isolated cold water refugia and cold water aquatic life may be an inappropriate designation for the whole stream.

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.

K. Need for water standard based on natural conditions

The basis of the temperature standards is rooted in opinions of what the temperature should be, not based on the environmental potential to provide cool and cold water.

The Idaho Division of Environmental Quality 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"[17] 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.[17]

Redband trout "appear to have the capability to adapt to adverse conditions, such as low or intermittent flows, and water temperatures greater than 28^{o}C."[27] In his preliminary assessment of the South Fork in Nevada, Pahl states that "According to NDEP files, the current temperature standard was set to protect rainbow trout. Under the current standards review process, the [actual] needs of the redband trout should be considered."[43]

The redband trout of the desert basins of the western states are thought "to have evolved adaptation to live in harsh environments characterized by extremes in water temperature and flow." They have been observed feeding at water temperatures of 28.3^{o}C in Chino Creek, a Nevada tributary of the Owyhee River.[43]

There are inland redband trout in the upper Owyhee subbasin. The stream temperatures in the subbasin frequently exceed the criteria established for redband trout. 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 to set water quality targets and allocate loads."[36] However, if the narrative standards are composed of unrealistic expectations of stream shading, an unattainable criteria of shade could be substituted for unattainable temperature standards. Realistic narrative standards could be based existing knowledge of geology, historic information including early accounts of vegetation and streamflow, and the last century's records for air temperatures and streamflows.

New temperature standards for the streams of the upper Owyhee subbasin need to be developed that take into account the natural condition of the water and the climate of the upper Owyhee subbasin. They also need to take into consideration the biological adaptations of species present in the environment.

L. Conclusion

Immense data gaps exist in determining whether the streams of the upper Owyhee subbasin meet the goals of the Clean Water Act. What are the naturally occurring conditions of the subbasin? How do these conditions determine whether designated uses are actually attainable or are only an idealized vision of what would be desirable? Will establishing standards result in economic hardships directly contravening the CWA statement that "regulations are not intended to result in standards that are so stringent that compliance would cause severe economic impacts."[11]

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