Upper Owyhee Watershed Assessment

IV. Historical Conditions

Contents

IV. Historical conditions

Forward: This account relies on many sources. For the ease of reading, please note that ellipses, . . . , indicate a word, phrase, or short section has been omitted from a quote. Clarifying additions by the editor have been added in brackets, [ ]. Where trappers' or settlers' words are quoted verbatim, some of the spelling and punctuation may have been changed but the words and word order are the original. To avoid confusion, the place names used are the current names for locations, except within verbatim quotations.

A. Pre-contact

Historical characterization of the landscape and conditions at the time of contact is an attempt to understand the 'pre-European' state of a river drainage and region that was influenced by Native American inhabitants for at least 10,000 years prior to European settlement. Archaeological research allows for an understanding of the prehistory which cannot be derived from historic documents. The Great Basin area of eastern Oregon, Nevada, and southern Idaho has been inhabited for more than 12,000 years.[2] The upper Owyhee subbasin lies within this area. In Idaho, Clovis projectile points have been found near the Bruneau and Snake Rivers.[51] These projectile points date to between 11,500 and 11,000 BP (before the present). Projectile points archaeologists find on the surface of the ground suggest people were living in the area. However, the only sure way to document habitation is by dating charcoal left in fire pits where people lived and this requires excavation by archaeologists. There have been very few excavations of archaeological sites in the Owyhee uplands so the available record is sparse (Figure 4.1). Around 9,500 years ago, people inhabited the Dirty Shame rock shelter in the Owyhee uplands.[51] This rock shelter is a few miles downstream from the upper Owyhee watershed. The earliest dated habitation within the upper Owyhee watershed comes from around 6000 BP at Nahas Cave.[51,70,71]

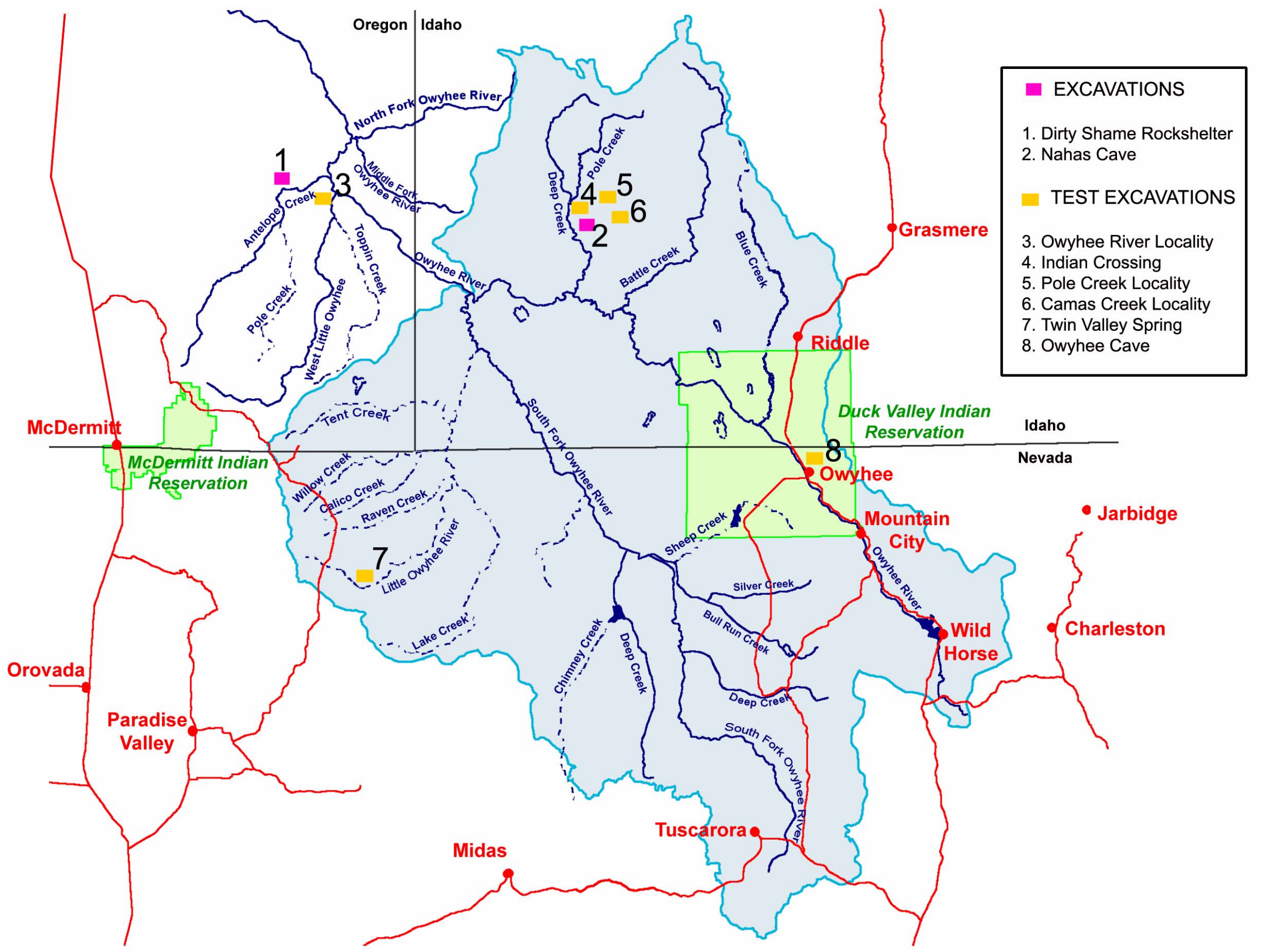

Figure 4.1. Location of archaeological excavations and test excavations in the upper Owyhee subbasin

Since the Owyhee uplands are currently semiarid and of recent geological formation, there is little soil formation. Most archaeological sites are on the surface of the land and the artifacts left by Native Americans are visible to hikers. These artifacts include flaked stone, ground stone, projectile points, petroglyphs, rock alignments, and some pottery. Plew surveyed along Pole and Battle Creeks in the subbasin and documented 700 archaeological sites.[71] The survey included the creek valleys to 100 meters beyond the rimrock and a few walked transects across the open desert (Figure 4.2). "Most [archaeological] sites are located along alluvial fans and terraces in canyon bottoms, on bench terraces and talus areas and along and near rim rock."[71:57] In fact only scatters of flaked stone were common in the open areas between the creek drainages. This suggests an importance of the watercourses, possibly for water, to prehistoric inhabitants. On the basis of 700 sites in this portion of the upper Owyhee subbasin and the variety of projectile point types found it is clear that the region was inhabited by Native Americans for a long duration.[71]

Archaeological sites within caves provide more detailed records of prehistoric habitation. Nahas Cave in Idaho provides such a record. Excavated in 1979 and 1980, Nahas cave is a lava bubble that measures three meters across and 12 meters deep.

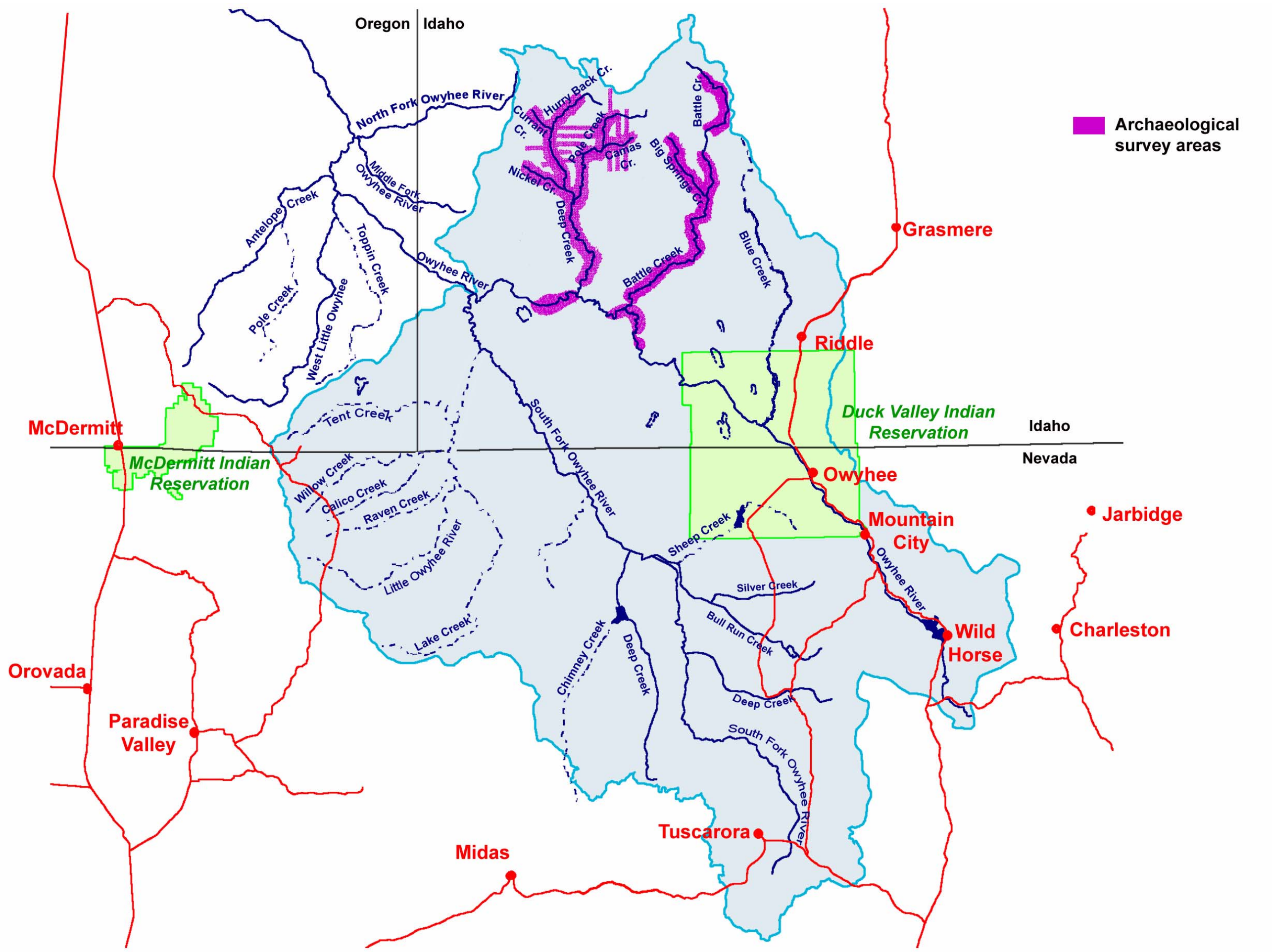

Figure 4.2 Location of archaeological surveys conducted by Mark Plew in the upper Owyhee subbasin.

The sediments fill was created by human garbage and windblown dust. Nahas cave was probably occupied as a hunting camp. The most recent Native American occupants left a few fragments of pottery in addition to the flaked stone projectile points and household garbage. Each successive layer of soil that was excavated showed older habitations and the changing styles of projectile points. The layers were also dated with eight radiocarbon dates.[70] "The earliest date of 5990 ± 170 BP . . . is associated with a fire hearth and mortar and pestal."[70:98] In addition to hunting, "a limited groundstone assemblage suggests that some edible seeds and berries were consumed."[70:98] The remains from Nahas Cave include seeds of chokecherry and hackberry.[70,71] The animal remains are of antelope, deer, ground squirrel, muskrat, jack rabbit, woodchuck, cottontail, badger, porcupine, and unidentified birds.[70] For fish there are, "the remains of six individuals of the sucker family, Catostomidae, possibly *Catostomus comlumbianus*, Bridgelip Sucker, and one individual of the Cotidae, possibly *Cottus bairdii*, Mottled Sculpin . . . [and] the remains of three individuals of *Salmo gairdnerii*, the Steelhead Trout. A fourth individual tentatively identified as *Salmo gairdnerii* may be *Salmo clarkii*, the Cutthroat Trout."[72:129-130]

How much anadromous fish, like steelhead and salmon, were part of the Native American diet has been a highly debated topic. The importance of these fish runs varied by region. Native American populations along the Snake River in the Boise area were reported at contact as exploiting the yearly runs of anadromous fish.[92,87] The ethnographic records for the Owyhee uplands are less detailed, so research has turned to archaeology. Nahas Cave yielded three (or possibly four) bones of steelhead trout from layers dating between 3000 and 500 BP.[70] The find was considered important because of how far the fish would have had to travel to make it to Pole Creek (Figure 4.1). However these three bones should be taken in context: 8,230 bone fragments were excavated at Nahas cave, of which six hundred were identifiable. The importance of these fish in the diet of Native Americans in the Owyhee uplands is unknown.[70,71,72] In addition, the findings are qualified by the probability that only in early springtime would there have been enough water in Pole Creek for steelhead trout runs.[71] Another archaeologist has cautioned that the fish runs would be unreliable as "the Western Snake River Basin represents the upstream limits of the Columbia River anadromous fishery in the southern Plateau."[51:67]

The Native American inhabitants of the region were people who adapted to the environmental situation in which they lived. Like all resourceful people, they attempted to modify the environment for their advantage. While we do not have a clear picture at present of the degree to which Native American inhabitants were altering the Owyhee environment, archaeological research in the Owyhee uplands indicates that they were doing so.[83] These 'pre-European' land use practices could have been either beneficial or harmful to mammal populations, fish populations, and vegetation communities. "That prehistoric and early historic humans occupying Montana, Idaho, Washington, and Oregon influenced the abundance of game animals by their hunting practices is indisputable."[46] Great Basin Native Americans are known to have taken massive rabbit populations, employed fish traps, nets, weirs and dams, and burnt range lands.[45,88,89] One of the Native American practices was promotion by propagation of economically important plant species, which would in turn affect the composition of vegetative communities, whether they were those of upland soil, wetlands, or riparian zones. "Wild seeds were sown broadcast in central Nevada but neither irrigated nor cultivated. ... All groups burned brush to facilitate growth of wild tobacco and sometimes of other wild-seed plants."[87] Plants that may have been propagated include, but are not limited to, great basin wild rye, sunflower, wild tobacco, currant, biscuit root, bitter root, wild onion, sego lily, chokecherry, and wild rose. These plants currently grow in the upper Owyhee subbasin.

B. Native Americans at contact

When Europeans moved across the western US, they found the lands occupied by various Native American groups. The upper Owyhee subbasin crosses the divide between traditional Northern Paiute, Western Shoshone, and Northern Shoshone territories (Figure 4.3).[54,89,89,92] While Paiute and Shoshone peoples had different languages, they were not culturally isolated from one another. Anthropologists have

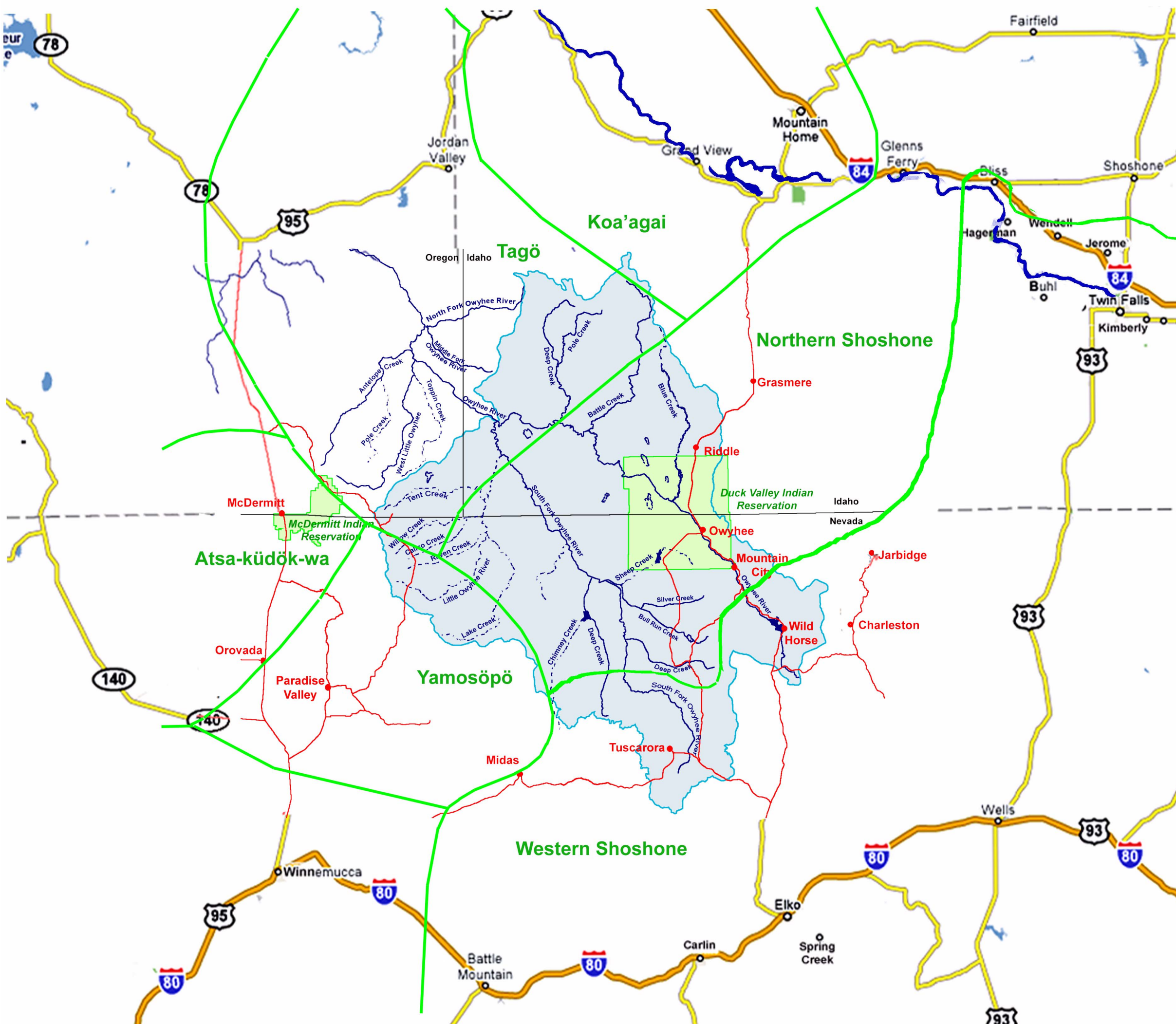

Figure 4.3. Traditional Northern Paiute, Western Shoshone, and Northern Shoshone territories at the time of Euro American contact.

noted that there was a zone of bilingualism and intermarriage between the Shoshone and Northern Paiute, in some places as much as 100 miles wide.[52] Both Northern Paiute and Shoshone who used resources in the upper Owyhee subbasin at contact with European settlers shared cultural practices and diet since the region was marginal, with few available resources.

During the 1920s and 1930s the oldest surviving members of these groups were interviewed by anthropologists. The information these individuals provided from their own experiences as well as their grandparents' stories helps us understand who was living in which areas in the past as well as the ways of life between approximately 1800 and 1850.

In the west, the Northern Paiute bands of the Tagö-Töka and Yamosöpö tuviwarai inhabited the upper Owyhee subbasin. Tagö-Töka means "eaters of *Lomatium* sp. roots"[19:468] which are more commonly known as biscuit root. Omer Stewart interviewed Tagö-Töka who were residing at the Duck Valley Indian Reservation.[89] He did not interview any of the Yamosöpö tuviwarai band whose name means "dwellers of Paradise Valley."[19] While Great Basin bands were often named for foods that they were known to eat, there were many regions without dietary specialization. The upper Owyhee subbasin would have been one of these areas, as it lacks any single extremely influential food resource. "In these areas, subsistence pursuits were about equally divided among the taking of small game and large game, numerous seeds, berries, and some roots, upland game birds and occasional waterfowl, insects, and sometimes fish. The details of the regimes varied by area, but little resource specialization was apparent." [19:438-439]

Julian Steward interviewed one Shoshone living near Elko and one from the Snake River, but no one in the area in-between.[89,92]. Neither of these informants was native to the upper Owyhee subbasin. One Nevada Western Shoshone band is discussed as inhabiting the North Fork of the Humboldt River, a location closer to the subbasin, but no information is given on their way of life as they followed the general pattern for inhabitants of the broader region.[92] By contrast the Northern Shoshone of the Snake River plain were in greater contact with white immigrants and had changed culturally during the 1700s and 1800s. They had adopted horses for travel and engaged in long distance yearly moves between salmon, camas and bison resources. However, these strategies did not work in areas with dispersed and low density resources like the Owyhees. "A ... dispersed Shoshone population was found south of the Snake River, between the watershed separating the Owyhee and Bruneau rivers and the area of Bannock Creek. This area was also roamed over by mounted Shoshone and Bannock from the east, but the resident population was mostly unmounted until after 1850. The people subsisted on salmon, small game, occasional deer, roots, and berries."[54:289] This unmounted, resident population was studied in greater depth by Harris.

Jack Harris and his wife Martha spent time on the Western Shoshoni Reservation at Owyhee, Nevada speaking with the *Tosawi* or White Knife Shoshoni.[29] The European name derives from the camps in the vicinity of Tuscarora and Battle Mountain where the white colored flint is found. "The White Knives practiced no agriculture; their rivers yielded no vast quantities of fish; buffalo were too far east to be hunted. In fact, they lacked any dependable or regularly recurring source of food, and were forced to utilize for sustenance every aspect of an unfavorable habitat."[29:40] "The chief but scanty sources of animal food were the rabbit, antelope, deer and mountain sheep. . . . Insects such as crickets and ants formed a substantial item of diet, but the bulk of food consisted of numerous roots, seeds, plants and berries."[29:40] Food shortages forced the White Knives to cover a much wider range of territory than their northern neighbors along the Snake River who had salmon.[29] "The summer months found the White Knives' camp groups ranging over an area which extended from southern Idaho to east central Nevada, roughly 25,000 square miles. Of course, not every camp covered this area but each group followed a more or less well-defined orbit, ranging from twenty-five to one hundred miles from its winter base."[29:44] The preferred area for winter camps was along the banks of the Humboldt River where a larger population could gather. Based upon the summer range, the population density of these Shoshone is estimated to be between one person per ten square miles and one person per fifteen square miles.[29,71]

Photo 4.1. Mormon crickets swarming near Mountain City in the upper Owyhee subbasin

1. Native Americans following contact

Following contact with European settlers, the Native Americans living within the Owyhee uplands made major changes to their ways of life. Some of these changes were voluntary while others were forced upon them by circumstance. Harris chronicles these events for the White Knife Shoshone.[29] While most of the following events were centralized along the Humboldt River, the White Knife population affected were native to the upper Owyhee subbasin.

Northern Nevada and southwestern Idaho were not heavily traveled by European Americans until gold was discovered in California in 1848 and Nevada in 1849. The California migrations wrought a great ecological disturbance in northern Nevada. The decade of 1850-60 was eventful for the White Knives. "Even during this late period of 1850, it seems that the White Knives did not yet have horses. Mules and horses were stolen, it was true, but they were not used for transportation, but to supplement the meager food supply which had already been diminished by the activity of the fur-trappers . . . and intensified by the passing of the emigrant trains."[29:75] It wasn't until

1854 that horse were noted being used as a pack animal by the White Knives, but soon after, in 1859, the horse had changed the tribe's dynamics as they transported food and camped in larger groups. "As early as 1855 and again in 1859, some Indians, with government aid, attempted to do some farming. However, these first farms were unsuccessful and abandoned."[29:81]

The 1860s brought another set of changes to the White Knives. From the establishment of large groups, they started raiding European wagon trains and settlers. These hostilities ended in 1863 with a treaty that promised them money as well as the hope of a reservation.[29] However no reservation was established until 1877 and the fourteen intervening years were hard for the White Knife population. "When some of the Indians were successful in raising crops, the Whites [Euro-Americans] dispossessed them from the fertile land. This was done by due legal process. . . . In 1875, Farmer Gheen reported: 'Some of the Indians who are engaged in farming, are compelled to rent land from the whites, nearly all of the tillable land being claimed by the white settlers . . . The whites are rapidly settling this country, and in many cases the Indians are compelled to give up their little farms. In other cases, the necessary water used by the Indians in irrigating their small patches was diverted from the streams above the Indian farms by White ranchers, thereby rendering the land valueless."[29:81-82] Between their failure as farmers, the loss of native food supplies, and delays to receiving a reservation, "the White Knives could no longer forage as self-sufficient camp units and so resume their former mode of life. Thoroughly discouraged by their failure to compete with the Whites as farmers, disheartened by the exploitation and their distrust of Whites, many Indians completely gave up the fight to gain their livelihood from the land. . . . Their solution was to attach themselves . . . to mining towns, ranches and railroad towns. Their new attempt at adjustment was to eke out what existence they could by doing wood-cutting, herding, washing clothes, [and] odd jobs."[29:82]

In 1877 a reservation was established at Duck Valley for the Western Shoshonean groups.

C. At contact

Characterization of the landscape and conditions at the time of contact must rely on the observations of the few individuals who kept records, primarily diaries, of their journeys. From these observations of small sections of the landscape, we can extrapolate to conditions in the upper Owyhee watershed.

1. The fur trade

We do not know whether the fur trade that existed on the coast had already affected the area by encouraging the taking of animals for fur by the Native Americans. In the last decade of the 1700s, "a healthy 'ship based' fur trade flourished."[36] The editor of Robert Stuart's narratives notes that "Seafaring folk who, hailing principally from Boston and Salem, Mass., had for years been accustomed to triangular voyages in which they laded their ships with trading goods beloved by Indians, exchanged these goods for furs among the . . . [people] on the Pacific coast, bartered these furs for tea, nankeens, and silk in China, and then with their precious oriental cargo returned to their home port."[90]

It didn't take long after the journey of the Corps of Discovery across the US before the exploitation of the western region of the continent expanded. One member of the Lewis and Clark expedition, John Colter, remained in the West as a fur trader. The fur trade spurred the initial exploration of the region by nonnative peoples. By 1809 there were 25 Russian colonies along the Pacific coast of North America, extending as far south as California.[69]

Groups of trappers were some of the first people to make written records of the conditions in southeastern Oregon, southwestern Idaho, and northeastern Nevada at the time of contact. Two principal trapping companies exploited the region.

One company exploiting the region had been granted a Royal Charter in 1670. The Governor and Company of Adventurers of England Trading into Hudson Bay was better known as The Hudson's Bay Company.[49] A group of trappers had formed another company, the North West Company or Nor'Westers, in the late 1770s. Their competition with the Hudson's Bay Company for control of the northern fur trade motivated exploration into the North American interior. Twelve years ahead of American explorers Lewis and Clark, Alexander Mackenzie, a Scotsman, had crossed Canada and reached the Pacific.[48] The fierce rivalry which developed between the Nor'Westers and the Hudson's Bay Company led to the expansion of trade into new territories, particularly by the North West Company.

New competition for the British companies came from Americans. John Jacob Astor, one of the world's richest men, saw dollar signs. He formed the Pacific Fur Company in 1810 intending to establish a fur-trading base of operation at the mouth of the Columbia River. Fort Astoria was established In 1811.[69] Wilson Price Hunt, sent by Astor to find a convenient overland route to the Oregon coast, kept sketchy notes on his journey westwards to Astoria in 1811 to 1812. Robert Stuart, sent back to the east to gain help from Astor, kept more complete notes on his eastward journey from Astoria in 1812. Both these men, like other early travelers, found routes which followed the Snake River from what is today Wyoming to Farewell Bend, Oregon (Figure 4.4).

During the war of 1812 between Great Britain and America, the British controlled the seas and could arrive at any time and seize Astoria and its properties by force. Therefore the Pacific Fur Company sold its interest in its forts in the northwest to the North West Company. When the war ended in 1814, the treaty provided for the return of all captured property. However, Astor did not get Fort Spokane or his other posts back because they had not been captured but sold.[15,66]

The North West Company was overextended and unable to sustain its network. In 1820 they merged with the Hudson's Bay Company. Now the Hudson's Bay Company controlled almost three million square miles.[48]

By the mid-1820s, independent American traders were trapping along the Snake River. George Simpson, the Hudson's Bay Company governor felt this was an invasion of the western fur country. He decided on a scorched earth policy. Oregon and the West would be trapped clean. Not a single beaver would be left alive. He stated that "strong trapping expeditions should be sent south of the Columbia. These may be called the 'Snake River Expeditions.' While we have access we should reap all the advantage we can for ourselves, and leave it in as bad a state as possible for our successors."[47]

2. The journals

There are virtually no early records specifically of the Owyhee Watershed. The records which exist are journals of the trappers and later of early travelers and settlers. They recorded what was of concern to them. The trappers kept track of the number of beaver harvested, of the condition of their horses, of encounters with Native Americans, and of hunger and hardship. The records of the emigrants traveling along the Snake River or the Humboldt River dealt with sickness and death in their trains, disputes among members of the parties, and lists of places where they stopped. Neither set of chroniclers set out to describe the countryside. From information gleaned from different writers, we can get an idea of the conditions in the upper Owyhee watershed at the time of contact.

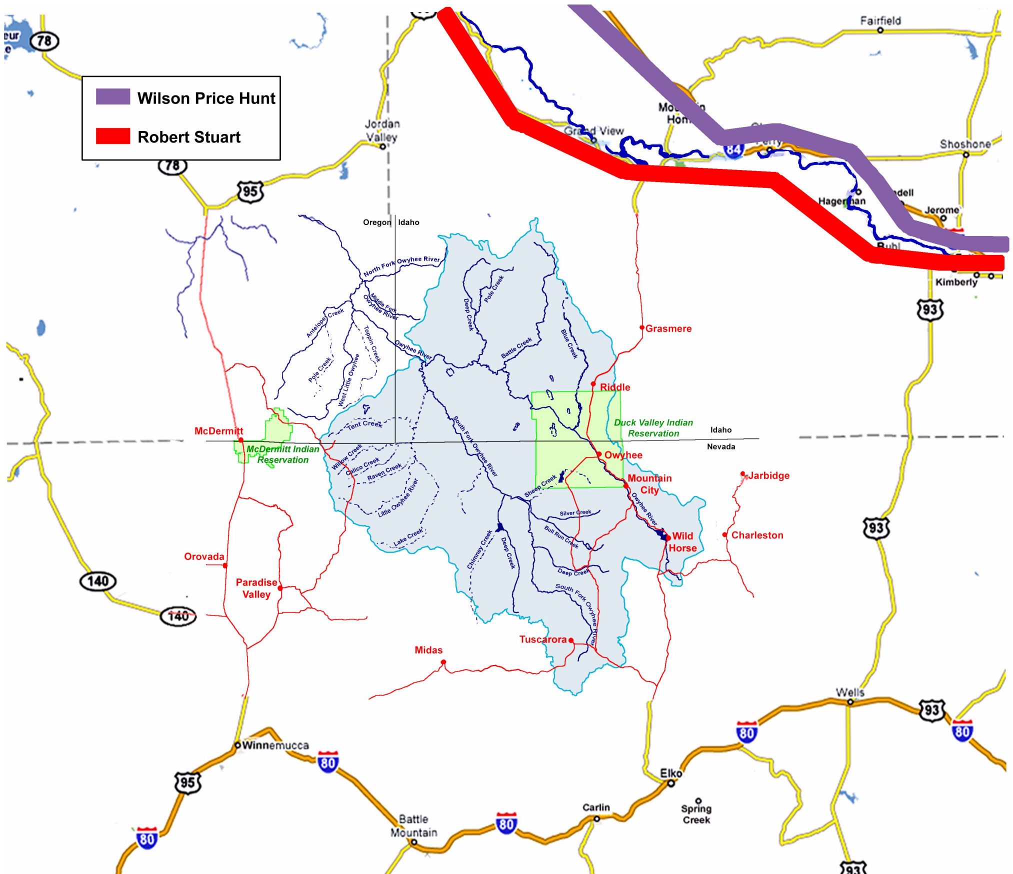

Figure 4.4. Wilson Price Hunt and Robert Stuart's routes along the Snake River near the upper Owyhee subbasin.

a. The brigades.

The Hudson's Bay Company sent out brigades of trappers in the 1820s that included anywhere from 50 to 200 men, women, and children. Besides trappers, there were hunters, spouses, and families.[57] John Work's brigade consisted of 115 people. The 21 men and one slave were probably armed. Most of the 29 women were probably Native American wives of the trappers. They cooked, packed and unpacked the equipment, skinned beaver, and cleaned and stretched the hides. The 22 boys and 23 girls shared the work. They gathered wood, built fires, and helped keep track of the horse herd which consisted of 272 head at the beginning of the trip. Work's brigade started with 337 beaver traps.[33] The Snake River Brigade under Peter Skene Ogden used 200 horses for riding and carrying supplies, traps, and furs.[104]

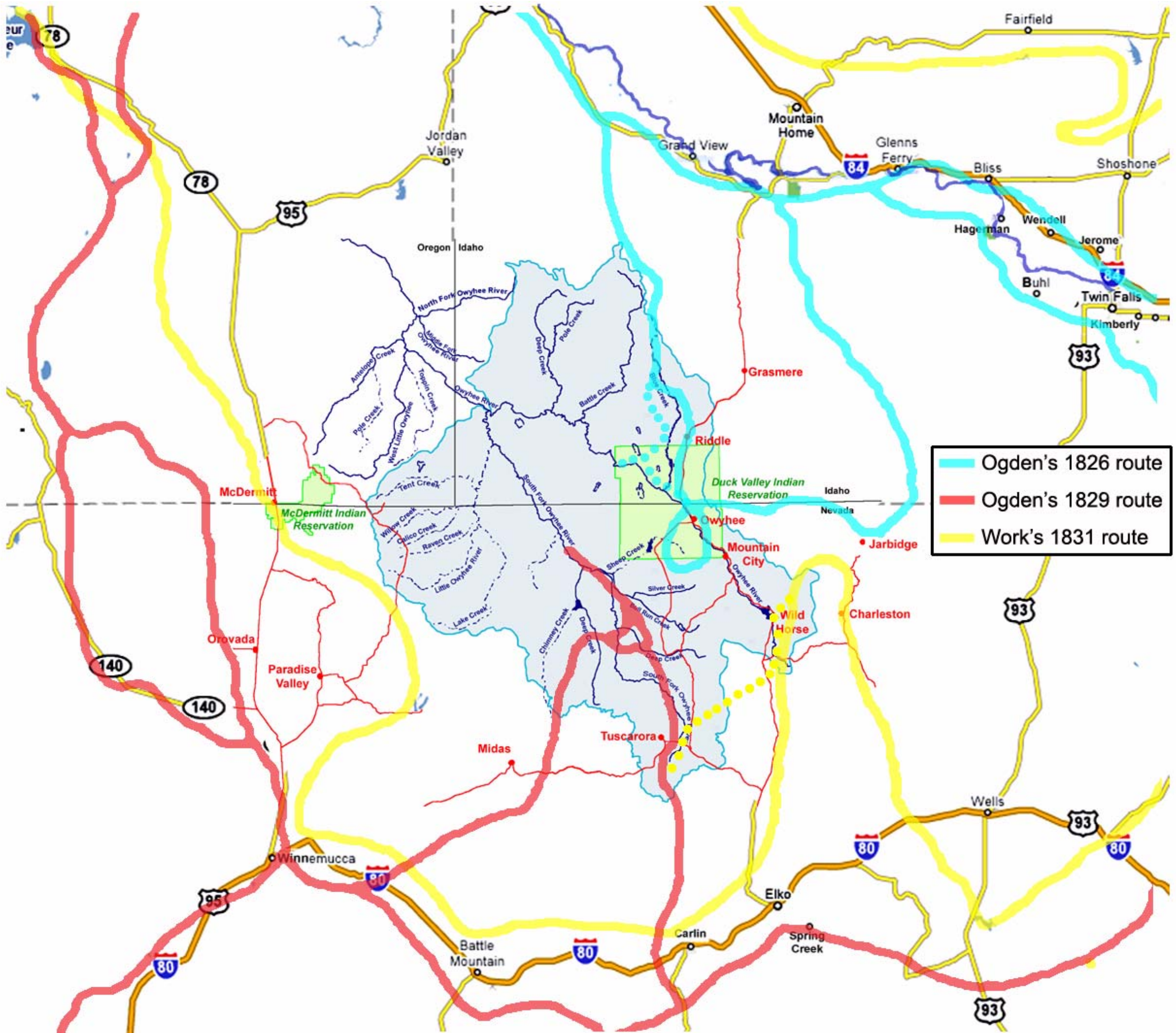

Figure 4.5. The routes of trappers Peter Skene Ogden and John Work. The dotted lines are the author's determination based on the original journals.

Two of Ogden's trapping expeditions took him into the upper Owyhee subbasin. John Work's first Snake Country expedition on behalf of the Hudson's Bay Company, after taking over that region's trapping operations from Peter Skene Ogden, also took him into a small section of the upper Owyhee subbasin (Figure 4.5).

b. The effect of trapping on conditions

Peter Skene Ogden kept diaries of trapping trips from 1825 to 1829 while leading the Snake River Brigade of the British Hudson's Bay Company.

Already by 1826, Ogden was noticing a change in the condition of the countryside. There weren't as many beaver. In February of 1826 he noted changes on two rivers. After sending trappers up the Malheur River he wrote "Trappers who have been some distance up this river . . . report there are but few beaver. . . . It is rather strange for in 1819 this stream was well stocked in beaver and from its not having been trapped since, I had hopes of finding some more."[63] He found a similar situation on the Payette River, "it was then [1819] rich in beaver but now destitute."

Later in the journey when he was within the upper Owyhee watershed, he laid the blame first on "American traders [who were]. . . exerting themselves to ruin the country as fast as they can and this they will soon effect,"[63] and on the Native Americans "The fork we left this morning from was not many years since well stocked in beaver but the Snakes have destroy'd all not leaving one."[63]

Ironically a short while after blaming the Americans for a lack of beaver, his diary written near the northwest corner of Duck Valley Indian Reservation reads "This day 11 beaver 1 otter. We have now ruined this quarter. We may prepare to start [leave]."[63]

In 1829, Ogden recognized that the Hudson's Bay Company trappers were largely responsible for the elimination of beaver. Soon after Ogden had entered the upper Owyhee subbasin from the south, he wrote, "It is scarcely credible what a destruction of beaver by trapping this season, within the last few days upwards of fifty females have been taken and on an average each with four young ready to litter. Did not we hold this country by so slight a tenure it would be most to our interest to trap only in the fall, and by this mode it would take many years to ruin it."[64]

c. General description of the upper Owyhee subbasin

The topography of the upper Owyhee subbasin has not changed since Euro-American entry into the area. Therefore, we can expect that at the time of contact, there were similar differences caused by elevation. The higher areas of the Bull Run and Independence Mountains would be cooler and experience more rainfall. Like today, the climate would be highly variable.

One member of Wyeth's 1832 party, John Ball, kept notes which he later edited. He had been traveling with a group of trappers on the Humboldt. When some of them went westward, Ball, with 12 others, turned north and traveled down the Owyhee River to the Snake River.

> "Our aim was to get back on to the Lewis [Snake] river and follow that to its junction with the Columbia. And I now presume we were on the headwaters of the Owyhee, the east boundary of Oregon. And the next day and for days we kept on the same or near. We pursued it till so shut in that we had to leave it by a side cut and get onto an extended plain above, a plain with little soil on the basaltic rock, and streams in the clefts or canyons. One day we traveled 30 miles and found water but once, and in the dry atmosphere our thirst became extreme. On approaching the canyon we could see the stream meandering along the narrow gorge 1,000 feet down, and on and on we traveled not knowing that we should survive even to reach it to quench our thirst. Finally before night we observed horse tracks and that they seemed to thicken at a certain point and lead down the precipitous bluff where it was partially broken down. So by a most difficult descent we reached the creek, dismounted and [went] down its banks to quench our thirst. And our horses did not wait for an invitation, but followed in quick time. The bluffs were of the burnt rock, some places looking like an oven burned brick kiln, and others porous."[4]

Since the beaver that the trappers sought lived along waterways, the trappers tended to travel in river and stream valleys.[104] The main camp was usually established along the river with trapping up subsidiary tributaries. Both Ogden and Work used "road" to mean the route which they chose for moving the whole camp. This was seldom right next to the river, but on the land to the side or above the river.

Photo 4.2. The canyon of the east fork of the Owyhee River.

Ball's description of expanses of nearly barren basaltic rock was echoed by numerous entries written by John Work in his journal. "The road very hilly and rugged . . . The country has a bare appearance." "The road is very hilly, rugged and stony." "The road hilly and uneven and in places stony," or "stony and generally gravelly and hard, which much wears down the horses' hoofs and renders their feet sore."[101]

Ogden expressed similar sentiments when he wrote that "we had a level road but a stoney one," and on a different day that they "had no cause to be pleased with our road still less our poor horses for it was one continued stone from the time we started to our encampment." One day they didn't move the camp since "the horses that were on discovery yesterday from the effects of the stones can scarcely crawl this day." He also commented on the lack of stones when the route was "very hilly but fortunatly not stoney."[47]

In addition to stony land, both Ogden and Work also found deep gullies or canyons which impeded their passage. Although Work had described part of his travel as being on a road which was "very hilly and rugged, being over a number of deep gullies," his expedition did not attempt to continue to follow "one stream which runs to the N. W. through a narrow channel bordered by steep, impassable rocks [Wild Horse]."[101]

Ogden encountered the same problem along the Owyhee. On June 12th, 1826, his scouts found that "the river is closed in by high cut rocks simalar to those we saw on Riviere au Bruneau and no doubt equal in length[.] they ascended a high hill and as far as the eye could reach it was one continued rock." The next day some Indians "gave our men to understand that . . . it was impossible for us to follow the river." After checking in another direction, on June 16th he wrote "I am at a loss what course to take to extricate ourselves . . . I sent Mr. Dears but he returned late in the evening and gives us no hopes from the quarter he has been in as far as the eye could reach one continued rock and stone[.] We must before we start tomorrow examine another quarter."[63]

Three years later, following the South Fork of the Owyhee, Ogden's camp "were obliged from both sides of the river being so rocky to leave it and ascend some high hills. We had not proceeded far when again our progress was stopped by steep gullies of cut rocks, and by winding up and down until near sunset we advanced not more than eight miles, and had some difficulty in reaching the river." The next day he wrote, "So far as they [trappers] have been are one continued rocks . . . I sent three men on discovery late in the evening. They returned having reached the main branch seen by me in 1826, they also saw the mountains on the south side of the South Branch. They followed the two streams to their junction and as far as the eye could reach one continued rock, and from the time they started to their return could not reach the river. . . . . . .I must now retrace back my steps.[64]

i. Plains

Although Ogden and Work both described much of the countryside through which they are passing as rock or stony, they also encounter more hospitable areas. John Work wrote that, "this little valley is about 20 miles long and 15 wide."[101]

Peter Ogden wrote "after so long traveling over stones and gravel we were rather surprised to find the banks of this river composed of good rich soil." However, some playas on what is today the Duck Valley Indian Reservation had filled with water and he recorded that "we cannot proceed far on this side there being a lake and swampy country which will take us a day to go round."[63]

Leaving the Humboldt watershed and entering the Owyhee watershed, Ogden wrote that they had "Crossed the mountains and encamped at 12 a.m. at the commencement of a large plain." Farther north he recorded that is was "nearly two miles [of] one continued hill and rock, still the river fine, we then reached a fine level plain about six miles in length."[64]

ii. Mountains

Both Ogden and Work comment briefly on the Independence and Bull Run Mountains, impressed by the amount of snow still on them. In

Photo 4.3. Snow covered peak in the Bull Run Mountains on June 1

June 1826, Ogden wrote that “we are surrounded by lofty mountains on all sides well covered with snow as in the middle of winter.”[63] Work wrote that there “is still a good deal of snow in large banks in the mountains” and “to the westward there is a high rugged mountain covered with snow.”[101]

iii. Climate

John Ball noted that "in the dry atmosphere our thirst became extreme"[4] Although neither Ogden nor Work comment on the lack of humidity, Wilson Price Hunt's party, being the first Euro-Americans to utilize a path along the Snake River was not prepared for the arid nature of the region and the resulting need for water away from streams so "several Canadians had begun to drink their urine."[34] In the surrounding regions of Idaho and Nevada, the lack of water was also mentioned by trappers and others when they were cutting across country.[82]

Both Hudson's Bay brigade leaders into the upper Owyhee subbasin noted variations in temperature in the Nevada section of the subbasin within the space of a few days. In April of 1829 near Tuscarora, Nevada, Ogden complained that it was “very sultry equal to the heat in June.” Ten days later somewhere on Bull Run Creek, possibly at a higher elevation, “it commenced snowing and continued all day. Nearly a foot has fallen.”[64]

South of Wild Horse Reservoir, Work wrote that “These nights past we have had sharp frost, but here the weather is sultry” and later that it was “cloudy, sultry weather in the morning, which was succeeded by thunder and heavy rain and hail, raw, cold weather afternoon.”[101]

Ogden also noticed differences in temperature between years. In June of 1826 near present day Owyhee, Ogden’s party “found nearly three feet of snow but this only for a short distance[.] here it was plainly visible to all the vegetation is very backward [season wise] . . . the summer heat has not been great this season and indeed this day we experience no inconvenience from our winter dress nor have we since the spring commenced”.[63] A few days later he wrote, “It froze a quarter of an inch in thickness”.[63]

3. Vegetation

What was the vegetation in the upper Owyhee subbasin prior to the advent of Euro-American settlers into the area? The trappers' sketchy descriptions are probably the best records we have. Most of the trappers’ observations were terse and mentions of vegetation were usually only an aside.

Except for Ogden and Work, the other trappers skirted the upper Owyhee subbasin, but their writings paint similar pictures of the area. The principal routes utilized between trapping areas were along the Humboldt River to the south of the upper Owyhee subbasin and along the Snake River to the north of the subbasin.

a. Few Trees

i. Snake River Plain

Within the Snake River plain, there were few trees. Slightly to the east of Boise, Wilson Price Hunt recorded in his diary that "The country was devoid of wood".[34] Both

Captain Nathaniel Wyeth and Ogden mentioned the lack of trees as a deterrent to building rafts or canoes for river travel. Wyeth "took a ride up the river to find a camp where timber, fit for a raft which we propose to build to carry some of the loose baggage and some men who are on foot can be found, [but] found none."[103]

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]

By contrast to the other rivers, the Boise River had timber along it and this was frequently noted. Wyeth,[103] Hunt,[34] Stuart,[90] and Col. Fremont[105] all note the atypical vegetation along the Boise River.[82]

ii. Humboldt River Plain

Peter Skene Ogden's expedition of 1829 was the first known exploration by a non Native-American along the Humboldt River. He also noticed the lack of trees and wrote "the river is scarce in wood." In another entry he stated “Wood very scarce, only a few willows on the banks of the river." Elsewhere he also found “willows in abundance."[64]

John Work traveled a similar path to Ogden’s along the section of the Humboldt River directly south of the subbasin. He also noted the willows and wrote "The river here has a good deal of willows on its bank."[101]

The other record we have of early trappers along the Humboldt is an account of an expedition of American trappers led by Joseph R. Walker in 1833.[79] Walker roughly followed Ogden’s route from Elko west. Zenas Leonard kept a journal on the trip and later published a chronicle of the trip. He wrote that they followed “a large stream [Humboldt River]; and to which we gave the name of Barren River — a name which we thought would be quite appropriate, as the country, natives and every thing belonging to it, justly deserves the name. — You may travel for many days on the banks of this river, without finding a stick large enough to make a walking cane. — While we were on its margin, we were compelled to do without fire, unless we chanced to come across some drift that had collected together on the beach.[44]

iii. Within the upper Owyhee subbasin

The total number of entries into their journals made by the trappers within the upper Owyhee subbasin is quite limited. In 1826 Ogden’s brigade were trapping within the subbasin for only 12 days. In 1829 they were there for 19 days. John Work was only in the subbasin for 13 days.

Ogden wrote in 1826 that they “saw yesterday . . . a fork of Owyhee River but from all appearances destitute of . . . wood, there being but a few willows and thinly scattered.”[63] And willows are again mentioned when he wrote “this stream certainly looks well, well lined with willows."[63] Work also commented on the presence of willows along stream banks. "The different forks in the valley have some willows on the banks."[101]

Photo 4.4. Willows and a beaver dam on Trent Creek in the upper Owyhee subbasin.

No other entries specifically mention a lack of wood. However, some of the observations on the general appearance of the countryside might be assumed to support this. In 1829 Ogden stated that "we had this day a level country, but a most barren one, covered with worm wood [sage brush] as is generally the case, travel in any direction you please."[64] Likewise Work wrote "The country has a bare appearance."[101]

Probably even more indicative of the lack of trees along the waterways is the fact that their presence is noted along specific streams. Where Burns Creek enters the South Fork of the Owyhee from the mountains to the east, Ogden wrote that they had "crossed over the plain and reached the junction of the different forks which forms a fine stream, well wooded."[64] As they are leaving the subbasin he has scouted ahead and found Chimney Creek. The next day he wrote "We reached the creek seen by me yesterday . . . its being well wooded and deep."[64]

South of Wild Horse, John Work noted "a branch [tributary] of Ogden's river where it issues from a steep, snow covered mountain. This stream is well wooded with poplar and willows." Then when Work ""Crossed the mountains . . . The road was in places nearly barred with burnt fallen wood. The little fork, where we are encamped is well wooded with poplar and willows."[101]

As brigade leaders, neither Work nor Ogden followed the smaller streams up into the mountains as that was the job for their trappers. Therefore, where they were noting some trees along streams flowing out of the mountains, it might not be too much of a stretch to infer that other streams in the mountains might have trees along their banks. Just before leaving the subbasin John Work wrote that "some of the men visited the head of the river to the mountain, and two forks that fall in from the eastward to near the same, and though they are well-wooded and apparently well adapted for beaver, yet scarcely a mark of them is to be seen."[101]

b. Willows

In the previous section several citations mention willows. Similarly, John Work noted that "The part of the river we passed today is well-wooded with willows"[101] Aren't willows trees? The willow which the trappers mention is generally not a tree. 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.[13,14]

Willows were important to trappers because they provided building materials for the beaver dams and houses. Willows are often the most available species in much of the beaver's range and favored by the beaver. In addition to willows, beaver might use sagebrush, driftwood, aquatic plants, or other debris in construction of a dam. Bark, leaves, and growing tips of willow also make up a large portion of beaver diet in many areas.[3,7] Willows also provided a building material for Native Americans[82] and John Work. Near McDermitt, John Work "Proceeded up the river three miles . . . and succeeded in crossing it by means of a bridge of willows."[101]

c. Other vegetation

The records remaining are only accounts of trapping expeditions on the eastern side of the upper Owyhee subbasin. There are no journals of any observations on the western side. There may have been few streams with willows or other conditions which beckoned trappers into the area.

Both Ogden and Work passed to the west of the subbasin (Figure 4.5). Near McDermitt, two of the men in John Work's party spotted "a small Indian camp, but [they] fled on our appearance and concealed themselves among the wormwood [sagebrush]."[101] A couple of days later, Work also noted lots of sagebrush, "The road good but in places stony and embarrassed with wormwood."[101] Further to the west of McDermitt, Ogden said they were traveling "over a plain covered with worm wood."[64]

Photo 4.5. A large "plain . . . covered with worm wood" near the Idaho - Nevada border in the upper Owyhee subbasin

South of the subbasin near Elko, Ogden also wrote that the large plain was "covered with worm wood."[64]

Since the trappers' horses required grass, the condition of the grass in an area was important. In the subbasin Ogden had written in 1826 that "our horses being greatly fatigued and having been nearly two days without grass we encamped early on a small brook."[64] The presence of grass could affect plans. As Ogden left the subbasin and recognized the terrain, he wrote "We encamped an hour earlier than usual knowing well if we advanced farther our horses would be without grass."[63]

South of the upper Owyhee subbasin a number of entries in Ogden's 1828 journal concern the need for grass. "Grass very scarce and our horses so weak." "For the preservation of our horse . . . from want of grass . . . are in a low state." One time he moved camp "with the hopes of finding grass for our horses". In the next camp he wrote "although grass scarce here . . . I did not raise camp."

As contrasted to the relatively bleak impression of the subbasin given by mentions of sagebrush plains and lack of grass, Ogden also wrote that he had seen "in this country certainly a fine variety of flowers, many known and many unknown to me. A strange sight to see red clover in abundance but not more than an inch in length. In this days journey a botanist would have had full employment and probably would have many additions to his stock."[63] Also, the many references to the Native Americans digging roots would indicate that the plants producing these roots were abundant around Duck Valley. Ogden also referred to one area as "fine pasture".[63]

At the time of Euro-American entry into the region, much of the landscape of the upper Owyhee subbasin probably had vegetation similar to that described in these fragments gleaned from the trappers' journals. Sagebrush plains, areas with little grass, and expanses of rocky ground predominated. Some streams' banks had willows along them and parts of the swampy areas of Duck Valley had more verdant vegetation.

4. Game

Both Peter Skene Ogden and John Work mentioned times of starvation. This shortage of food is particularly amazing since the trapping parties did eat the beaver which they trapped. Also, the large groups were accompanied by hunters whose sole function was to provide the rest of the party with meat. Joe Meek explained this aspect of trapping.

> "It was the custom of a camp on the move to depend chiefly on the men employed as hunters to supply them with game, the sole support of the mountaineers. When this failed, the stock on hand was soon exhausted, and the men reduced to famine. This was what happened to Sublette's company in the country where they now found themselves, between the Owyhee and Humboldt Rivers. Owing to the arid and barren nature of these plains, the largest game to be found was the beaver, whose flesh proved to be poisonous, from the creature having eaten of the wild parsnip in the absence of its favorite food. The men were made ill by eating of beaver flesh, and the horses were greatly reduced from the scarcity of grass and the entire absence of the cotton-wood."[38]

a. Scarcity of animals

Within the upper Owyhee subbasin, John Work noted that "There are some cranes in the valley" following his statement that "Several of the people were out hunting, but with little success, which I regret as provisions are getting pretty scarce in the camp." Still on the east side of the Independence Mountains, he wrote "Not an animal except a chance antelope to be seen." However, after crossing the mountains to the west side and still within the subbasin, he recorded that "This seems to be a miserably poor country, not even an antelope to be seen on the plains."

Photo 4.6. Sandhill cranes in the Mountain City valley.

After leaving the basin Work wrote that "The best hunters are out, but as usual did not see a single animal of any sort."[101] Likewise, Ogden stated that there was "not a trace of an animal to be seen in any direction . . . makes our situation the reverse of being pleasant."[63]

Joe Walker's expedition experienced a similar lack of game. Zenas Leonard wrote that "having traveled through a poor, sandy country extending from the buffaloe country of the Rocky Mountains, to our present encampment, a distance of about 1200 miles,. . . and so poor and bare that nothing can subsist on it with the exception of rabbits — these being the only game we had met with since we had left the buffaloe country, with the exception of one or two antelopes. Notwithstanding these plains forbids the support of animals of every description."[44]

b. Substitution of roots

Ogden also mentions the lack of game when commenting on the Native-Americans' use of wild plants. In the upper Owyhee subbasin he wrote "This appears to be the season of roots in this quarter for all we see are busily employed in collecting them . . . if providence had not given them roots to subsist on 6 months in the year they would soon perish for want in such a barren country. They have no other resource to prevent them from dying."[63]

Five days later he commented that "all along our [route] this day the plains were covered with women digging roots [.] at least ten bushels were traded by our party."[63] His own party took advantage of the fact that "the Camass root was to be seen in abundance and a considerable quantity was collected by the women of the camp."

Photo 4.7. Flowering camas in the upper Owyhee subbasin. Camas bulbs were one of the staple roots harvested from the upper Owyhee subbasin.

Earlier he had complained that "we must as we have done content ourselves with a dish of roots in lieu of buffalo or beaver." A group of Indians which they encountered further along the route "were busily employed collecting roots [.] a considerable quantity were traded from them[.] indeed two thirds of the camp subsist entirely on them, they far from being unpleasant in taste of flavour, but to me as well as others cause severe pain in the bowels with other unpleasant effects I shall not here mention." Obviously unhappy with the diet since "almost any thing would be preferable to the roots we now subsist on", he must also have rejoiced when "All our trappers came in and our success this day amounts to 44 beavers[.] This enables all once more to feast."[63]

John Work also traded with Indians within the subbasin. "Some Indians visited us with a few roots to trade . . . The small quantity of roots they bring . . . provides several people with a meal occasionally which is very acceptable to them as provisions . . . scarce among us."[101]

As Ogden was leaving the subbasin he observed that "We well know that neither summer or winter are they any [deer] to be seen from River Malade (Sickly River) to Burnt River and this certainly, I am convinced, is the principal and only cause which obliges the Natives to go to buffalo [west of Yellowstone] otherwise many would perish from want . . . those who unfortunately for them who have no horses pass their lives without ever tasting meat."[63]

c. Sacrifice of horses

The extent to which Ogden and Work's brigades sometimes lacked game is shown by the sacrifice at times of their own animals although loath to do so. As Ogden left the basin in 1826, he recorded his worries. "I trust we will preserve them [horses] with the exception of those [which] should we not procure salmon will inevitably fall for the kettle . . . a more wretched country was never seen and which I cannot prevent."[63] His worry was warranted as a little later he wrote "when we last passed here a horse was then killed for food and the same [h]as again been acted here this day."[63]

Just after leaving the subbasin, John Work wrote "I much regret finding the river so high that it cannot be hunted as the people's last reliance was upon the few beaver which they expected to take in it in order to make up the hunt, but, more particularly, for food. The most of them are becoming very scarce of provisions, and they have now no other recourse but to kill horses."[101] A couple of days later, "Two of the men, J. Troupe and G. Rocque, killed a horse having nothing to eat, the provisions being all gone." And, "One of the men, P. O'Brien, was under the necessity of killing one of his horses to eat. Thus are the people in this miserable country obliged to kill and feed upon these useful animals, the companions of their labors."[101]

Near Paradise Valley, Ogden also was worried and wrote "we are now nearly destitute of food, the three horses found have been killed for food, and should we not soon find beaver, many more will soon fall."[64]

d. Antelope (pronghorn)

However, the countryside was not entirely devoid of game. Antelope were occasionally mentioned by both Ogden and Work. Although trained hunters accompanied the party, they weren't always successful.

In 1826, two days before entering the upper Owyhee subbasin Ogden commented that "an antilope was seen also near our encampment." Antelope were mentioned again only the day before the brigade left the subbasin, "Our hunters seeing tracks of antelopes lost no time following them. They saw six, fired but without effect. A fresh meat would be very acceptable to all and to none more so than myself." The next day Ogden wrote "Our hunters joined us as we reach'd the encampment. Only one antilope was seen by them and fortunatly killed and still more so as it so happen by my hunter."[63]

Twice in the few days before the brigade entered the upper Owyhee subbasin, Work discussed the results of hunting expeditions. "Some of the people were out hunting. F. Payette and L. Kanotti killed each an antelope. These are the only animals to be seen here, and they are so shy that it is difficult to kill any of them. Several of the people are getting short of provisions." "Some of the people were hunting antelopes, which are the only animals to be seen here, but only one was killed." On the day they entered the subbasin, he wrote "Not an animal to be seen but antelopes and but few of them, and even these are so shy that it is difficult to approach them."[101]

The day they left the subbasin, Work wrote, "Some of the people are out hunting but without success. A chance antelope is the only animal to be seen." Once they were traveling along the Humboldt River, "They saw a small herd of antelopes in the plain, but they could not be approached." "This is really a miserable, poor country, not even an antelope to be seen." After they had traveled clear across to the base of the Steens mountains, Work wrote, "Two antelopes were seen yesterday, which was a novelty."[101]

e. Bison

Throughout the region west of the Rockies, the records of various trappers record little game.[82] Although there is no doubt that there were some deer and pronghorn, in none of the journals is there any mention of bison. Ogden wondered "why buffalo should be confined to certain tract of country"[63] since some of Duck Valley was an equally appropriate habitat. Daniel Montgomery wrote later, "So far as I know, there has never been a trace of buffaloes found west of the main range of the Rockies, except one report that I got thirty or forty years ago from a pioneer named Jonathan Keeney. In 1843-4 he wintered near the sink of Lost River, in central Idaho, near where . . . Mackay now stands. He told me a bunch of thirty or forty head perished there that winter."[21] Examining reasons for the lack of bison west of the Rockies, Daubenmire[107] says that the phenomena was first remarked by Zenas Leonard. In 1832 Leonard "wrote in his diary that the failure of bison there seemed 'somewhat singular, as the country is just the same, if not better as to grass.'"[44] Lyman and Wolverton[46] review a number of different hypotheses for the "paucity of bison in southern Idaho (and areas west and north) throughout the last 10,000 years."[46]

f. Native consumption of game

The variety of game eaten by the different tribes who roamed into the upper Owyhee subbasin is consistent with a general scarcity of game. The Tagötöka interviewed by Omer Stewart were willing to both hunt and consume small animals such as mice and chipmunks. In addition to eating deer, antelope, elk, buffalo (from trips east of the Rockies), and mountain sheep, the Tagötöka ate porcupine, jack rabbit, white rabbit, cottontail rabbit, pocket gopher, kangaroo rat, field mice, muskrat, wood rat, woodchuck, squirrel, ground squirrel, chipmunk, raccoon, bobcat, badger, and beaver.[89] In addition a number of bird species were taken as food. Jack Harris's White Knife informants said that in addition to an occasional pronghorn, deer or mountain sheep that "Insects such as crickets and ants formed a substantial item of diet, but the bulk of food consisted of numerous roots, seeds, plants and berries."[29:40]

5. Seasonal water flow

There are a few mentions in Work and Ogden's journals that could be interpreted as indicating fluctuations in water flow due either to season or to upstream storm events. Ogden recorded two instances of a creek or river rising or falling in a very short period of time. On June 8th, the trappers "found many of their traps high and dry the water having fallen nearly 1 foot perpendicular."[63] Another time he commented that "Horse thieves had certainly a favourable night for stealing but did not think proper to make the attempt, the water having risen nearly one foot perpendicular."[63]

Seasonal variations were indicated by Work when he was traveling near Wild Horse; "The water has been lately very high and all the plain overflowed, . . . but is now subsiding."[101] Another day he stated "The river here has been lately very high, and overflowed its banks, but the waters are subsiding, and river about 10 yards wide. Have fallen a good deal."[101] As Ogden was leaving the subbasin to the south, he wrote "we reached a fine large stream [probably Rock Creek] . . . but in the fall little or no water remains in it".[64]

6. Conclusions

What sort of picture emerges from the writings of the trappers while traveling in and skirting around the upper Owyhee subbasin? Predictably, the observed climate was very similar to what we would note today. The summer days were hot with almost no rain. Away from the mountains, there were expanses of sagebrush, stretches of rocky ground, areas with little grass, and verdant valleys.

Except for the main rivers and the streams of the Bull Run and Independence Mountains, there were few easily accessible water sources in the summer. Some water courses in the area were also noted as varying in flow at different seasons. There were even observations of overnight fluctuations both up and down.

The vegetation along the rivers in the area was generally willows similar to the coyote willow and other shrubby willows present along the river banks today. Even the willows were not always abundant along river banks. There were trees along mountain streams.

Perhaps the most amazing observation is the generalized severe scarcity of big game, game birds, and rabbits.

D. California and Oregon Trail travelers

The California Trail passed south of the upper Owyhee subbasin while the Oregon Trail passed to the north (Figure 4.6). In 1836, Narcissa and Marcus Whitman traveled along the Snake returning to their mission in Walla Walla.[99] However, the first wagon train is considered to be the Peoria Party in 1839.[25] The first travelers along the California Trail were the Bartleson-Bidwell party of 1841.[5,78] They roughly followed the later route of the trail. Other small parties of emigrants used the trail until the discovery of gold in California in 1848 when suddenly there were massive parties of emigrants traveling the route along the Humboldt.[11] At the same time, the Oregon Trail along the Snake River also became a heavily used route.[67]

Because both trails were somewhat remote from the upper Owyhee subbasin, no attempt has been made to utilize the diaries kept by emigrants along either trail to describe conditions in the upper Owyhee subbasin.

E. Early settlement

1. Discovery of gold

Rich deposits of placer gold were found along Jordan Creek in Idaho in 1863 followed by the discovery of quartz ledges where hardrock mines could be developed.[98] Miners and gold seekers moved to the area from Idaho and elsewhere. With both placer and hard rock mining, there were "two hundred fifty mines recorded from 1863 to 1865."[27] The towns which grew up to supply the mines, Booneville, Ruby City, and Silver City, were the first permanent settlements in the Owyhee watershed. These towns were located just to the north of the upper Owyhee subbasin in the middle Owyhee subbasin. However, the development of thriving communities in the middle Owyhee did not lead to settlement in the adjacent areas of the upper Owyhee.

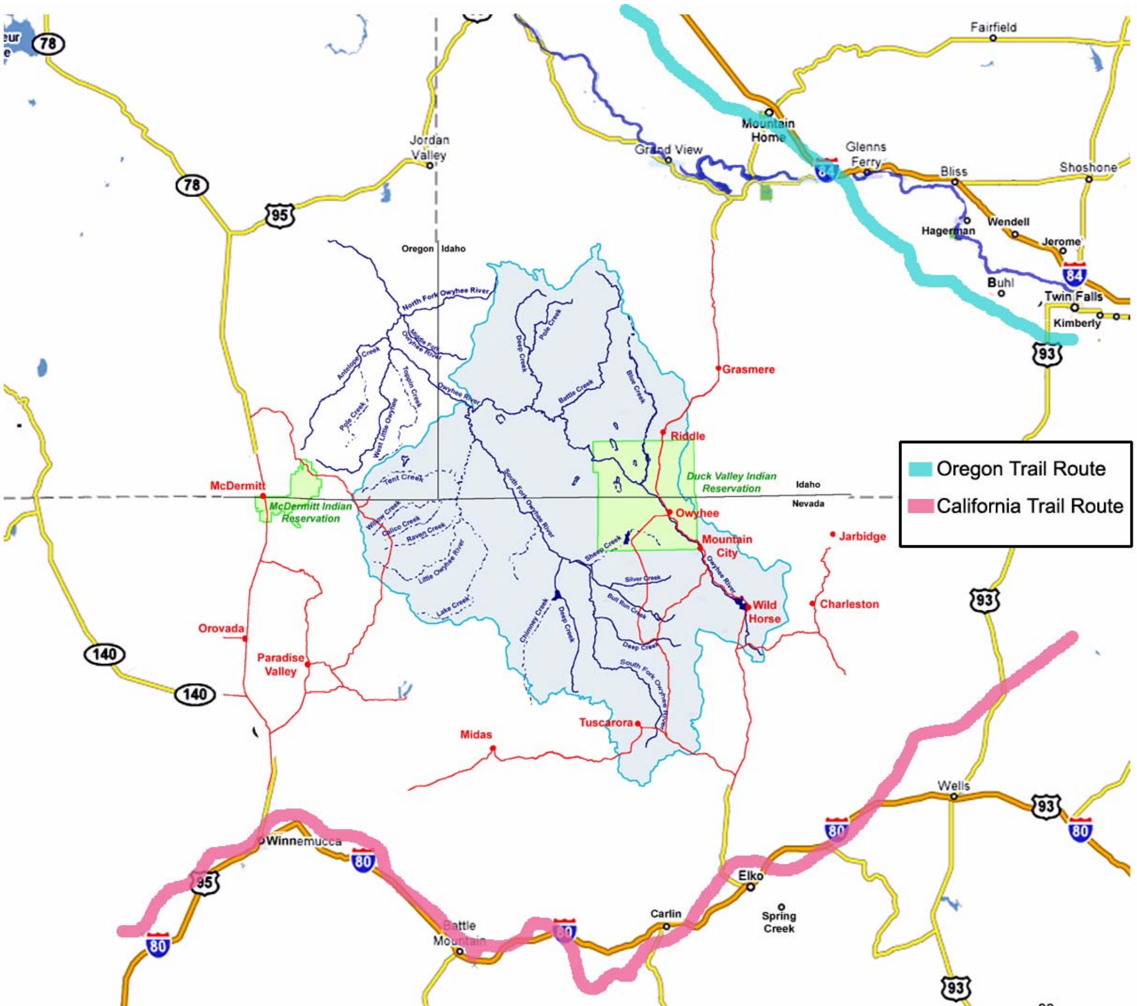

Figure 4.6. The routes of the California and Oregon trails around the upper Owyhee subbasin[68]

Placer gold was discovered in the upper Owyhee subbasin along McCann Creek in Nevada in 1867.[24] The area was called Tuscarora and the discovery of gold led to an influx of prospectors into the subbasin. Gold discoveries were made in other areas of the subbasin and by 1868 there were the beginnings of mining towns at Mountain City and Columbia. The original homestead on Jack Creek also was established at that time.[26] Throughout the 19th century other towns were started near new gold or silver mining (Figures 4.7 and 4.8).

2. Development of towns

After the discovery of gold at Tuscarora, gold was found in nearby districts. Following the initial strike in any district, there was an influx of miners. Rich mine fields like that around Tuscarora attracted not only the prospectors and hard rock miners but also the gamblers, the promoters, and the adventurers. The first discoveries were rapidly followed by the development of a sizable camp of men and women.[97] Even small towns such as Blythe City (Blue Jacket mine) might have a justice of peace or constable.[26]

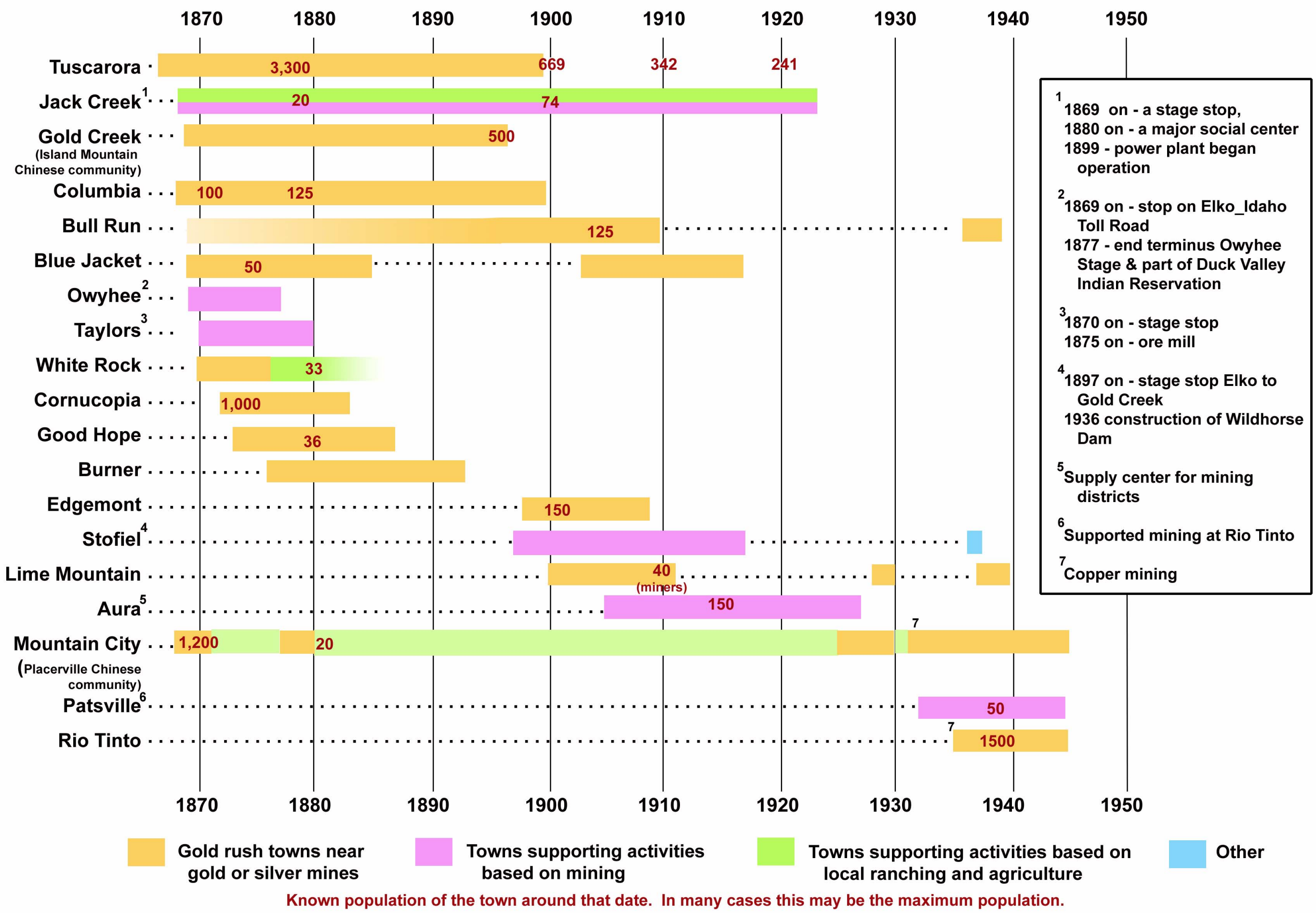

Figure 4.7. Periods of activity of towns in the Nevada section of the upper Owyhee subbasin.

Cornucopia demonstrates the rapid development of an area following the discovery of gold. Placer gold was located near Cornucopia in 1872, and by August 1873, 1,000 people lived in town. In addition to the hotel, boarding house, and dry goods store, town included three saloons, two restaurants, two butcher shops, a bakery, a blacksmith shop, and a small school. For entertainment there were horse races and dances. In 1875 one of the saloons was issued the first gaming license in Elko County.[26] Although the original gold found was placer gold, later gold discoveries were lode deposits and hardrock mines were developed.[26]

Tuscarora grew to be the largest town in the upper Owyhee. The initial placer operations were labor intensive, and Euro-American miners hoping to get-rich-quickly became discouraged.[26] In 1869 the Central Pacific Railroad had been completed; Chinese laborers dismissed from the railroad were drawn to Tuscarora.[26,59] When disgruntled whites sold claims to the Chinese, the Chinese organized into companies for high-volume placer operations. By 1870 only fifteen white prospectors were left and 104 Chinese. The discovery of rich silver lodes located close to town caused another rush of both white and Chinese prospectors.

Photo 4.8. Gold veins occurred in the quartz deposits near Cornucopia

At one point Tuscarora had the largest Chinatown outside of San Francisco. There were two tongs, immigrant societies organized for mutual business and social support, in Tuscarora. Each year the "election" of the "president" of Chinatown provided spectator sport for most of the silver camp's population. A rocket shot into the air carried a bomb. Whichever tong could retrieve the bomb and place it on the steps of their house could keep it. The only rule in the free-for-all was no pigtail pulling. Inside one of the 20 bombs stuffed with presents, candy, and cookies was a gold ring. The candidate from the tong that found the ring was Chinatown's president for the next year.[32] However with the influx of people, the Chinese eventually became not only a segregated, but frequently a despised, minority.[26]

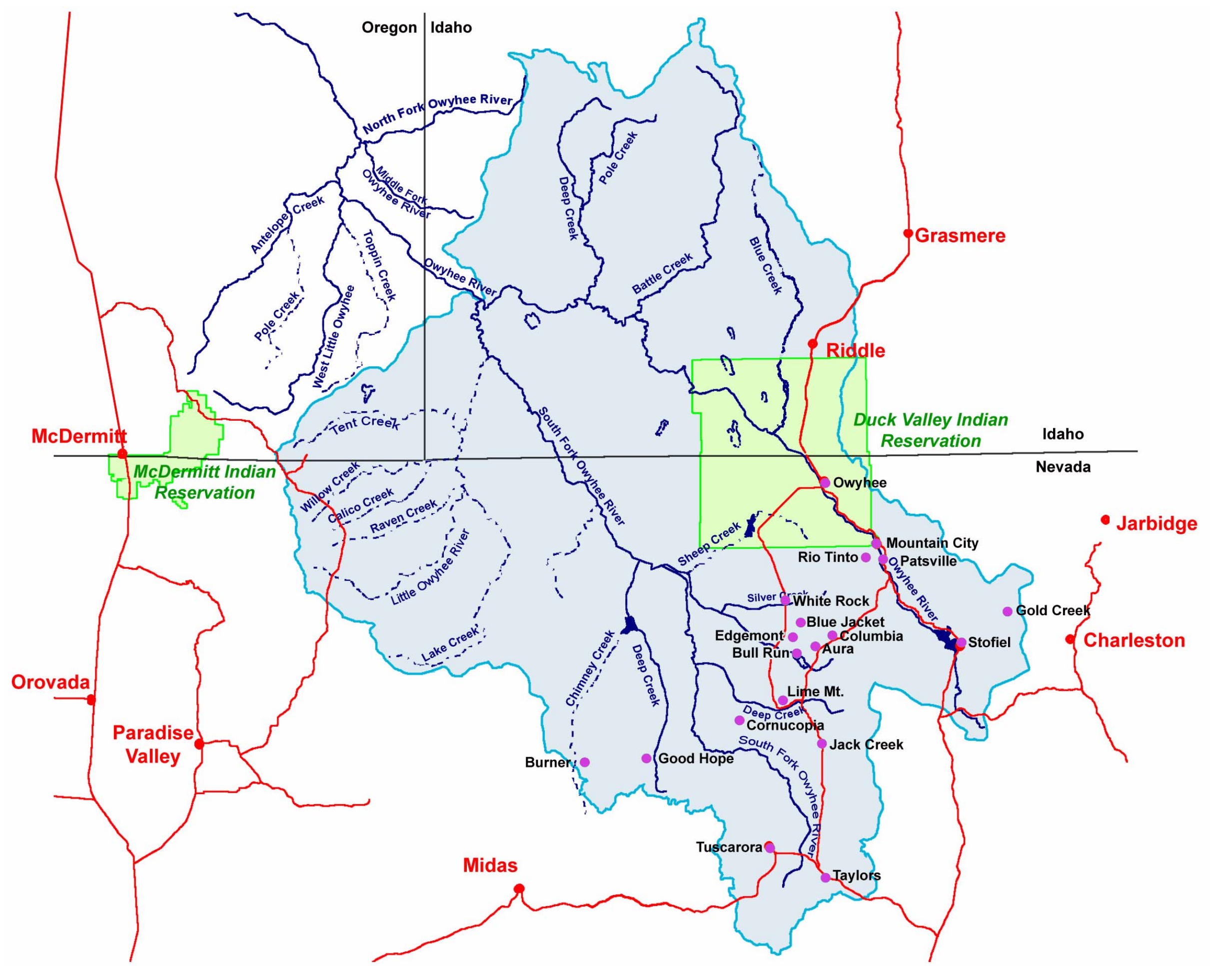

Figure 4.8. Mining era towns (●) in the upper Owyhee subbasin

During Tuscarora's heydey there were around 3,300 residents. David MacLain lived in Tuscarora about 1880. In 1938, he recalled that "there were two large boarding houses in the place, two good-sized hotels, several general stores, saloons, a drug store, a jewelry store, a gun shop, and enough houses to comfortably care for the population.[97] There were also two breweries, several attorneys, two newspapers, service clubs, bands, the Tuscarora baths, a racetrack, and a baseball team. Educational institutions included not only the Tuscarora Polytechnic Institute but also ballet and ballroom dancing academies, and an elocution school. [26,59]

A new ore discovery not only led to people rushing into an area, but a stage line was quickly established. Passengers, freight, and mail were carried on the stage lines. Nearly all these stages carried mail which was eagerly awaited by prospectors and pioneers. Stage lines were scheduled runs. A few ran daily, some weekly, and others twice or three times a week. Tuscarora, Cornucopia, and Mountain City within the subbasin all had stage lines connecting them in various directions.[17,26,102] Many of the roads on which the stages ran were toll roads, constructed by individuals who ran them for profit. Cornucopia's residents' only roads out of town were toll roads.[26]

Photo 4.9. One of the remaining houses in Tuscarora.

In addition to towns that developed close to mining, other towns in the upper Owyhee subbasin were primarily stops on stage routes. A stage stop might be slightly more than a ranch house or develop into more of a town around a hotel. Jack Creek, Taylors, White Rock, Stofiel, and Owyhee Meadows all served largely as stage stops (Figure 4.8).[26, 41,65]

In 1877, Rutherford B. Hayes established the Duck Valley Indian Reservation. Recognizing that the Duck Valley Tribal Council operates as a sovereign entity, the history of the lands and towns of the reservation presented in this assessment terminates in 1877.

3. Mining

Mining was not limited to solitary miners. Development of the larger lodes necessitated more labor. Miners and mill operators were hired and most of the larger mines were owned by a company rather than an individual.[26]

a. Mining Districts

When the discovery of gold brought an influx of miners into an area, it was frequently beyond the reach of effective government. Miners began to organize a local mining district to provide some form of government for the mines.[96] In 1931 Ricketts defined a mining district as

> ". . . a section of country usually designated by name, having described or understood boundaries within which mineral is found and which is worked under rules and regulations prescribed by the miners therein. There is no limit to its territorial extent and its boundaries may be changed. . . . The organization of mining districts is entirely optional with the miners, as there is no law requiring such organization."[76]

When the miners began pouring into the upper Owyhee subbasin, the General Mining Act of 1866, and later the Mining Act of 1872, stated that local rules should be recognized and confirmed. Even with effective government in an area, miners continued to organize mining districts.[96] Reuben Riddle, whose family later were some of the first settlers in Duck Valley, had a background in both surveying and mining. After he moved to Mountain City in 1870, he was asked to help formulate new laws for each of the mining districts.[62]

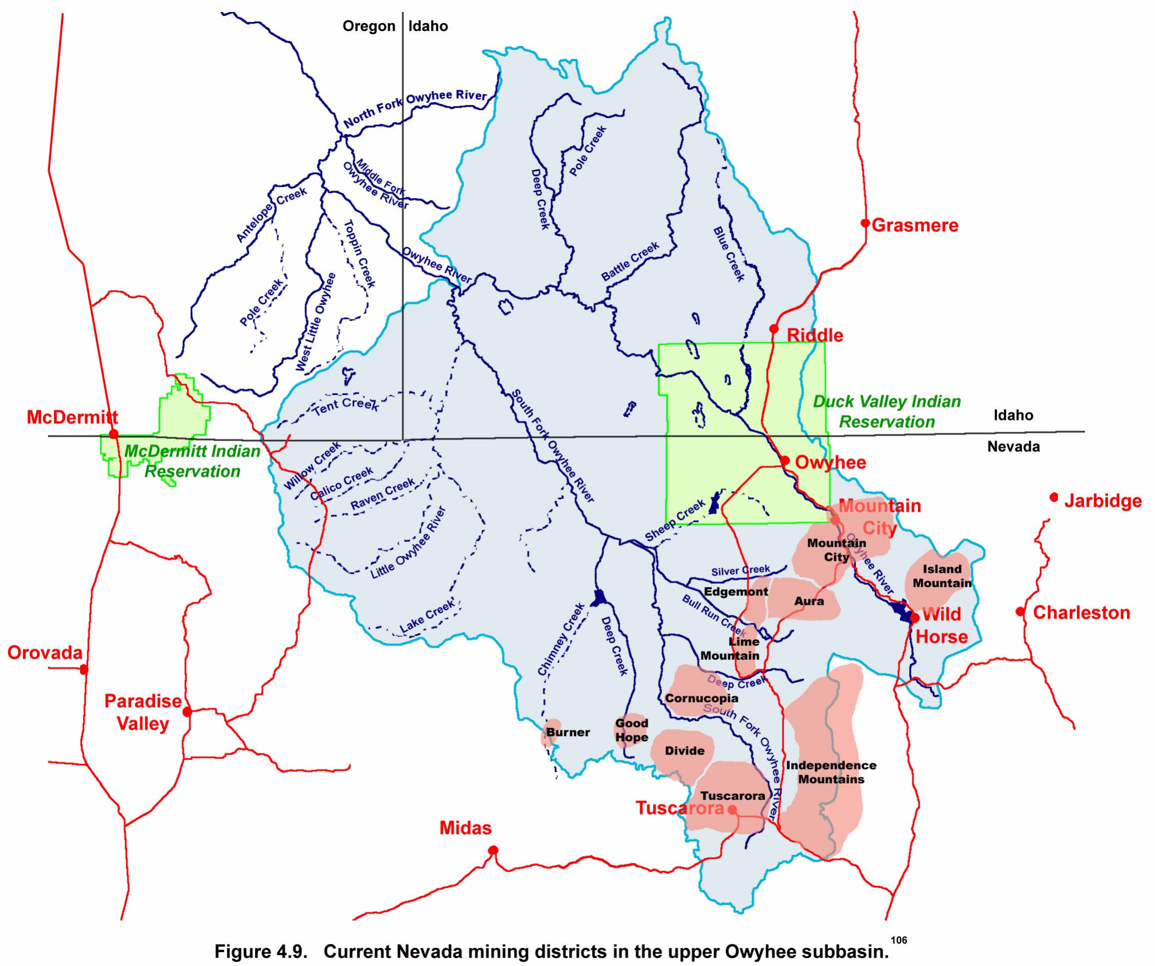

Figure 4.9. Current Nevada mining districts in the upper Owyhee subbasin.[106]

District boundaries were fluid, and both the names of districts and the boundaries varied over time. The names currently used may have been applied to a different district in the past.[Appendix B] Figure 4.9 shows the current Nevada mining districts.

b. Mining techniques[53,80,94]

In the Tuscarora District, by 1871 placer ores were being mined extensively in a square-mile area, principally by companies of Chinese miners who ran dirt, sand, gravel, and water through sluices.

The water which was needed for mining operations had to be diverted. Usually a rock dam was built across the stream at the point of diversion. Frequently the first spring flood would wash out the dam and it would need to be rebuilt.[104] Both Tuscarora and Gold Creek miners built several-mile long ditches to bring water from more distant sources.[26]

High grade lode ore is relatively uncomplicated to mine, whereas processing gold and silver placers require special techniques. The best, and earliest known solution to this problem was the use of mercury. When gold and silver particulates (and those of any other metal but platinum or iron) are brought into contact with mercury, they amalgamate or clump. Amalgamation was used by placer miners to recover fine particles. Mercury was placed behind the riffles of their sluices, and the amalgam that was heavier than regular gravel and sand particles was collected at intervals.

Sluices were effective methods for collecting ore occurring in small particles, however the mercury they used was not all recaptured. In California, where placers were mined extensively, sluice losses of mercury have been estimated at a minimum of 10% per year, and more typically 25% of the total used. An individual sluice would have an operating requirement of at least 0.1 pound of mercury per square foot.

Amalgamation was also used extensively in the processing of lower-grade hard-rock ores. Stamp mills would crush the ore to a sand-like particle size. Using the Washoe process developed in Nevada's Comstock Lode, the crushed ore was placed in shallow iron tanks, combined with mercury and salts of sodium chloride and copper sulfate, heated and agitated. In the late 1800s and early 1900s, gold and silver miners in the upper Owyhee subbasin used mercury to process much of the ore.

Once amalgamated, gold, silver, and other metals would be separated from the mercury by retorting (heating to distill mercury vapors). 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 captured, condensed and reused. This was an important step, since mercury itself was an expensive metal. Regardless, mercury losses on the Comstock Lode using these methods were approximately 1:1, with an ounce of mercury lost for each ounce of silver or gold produced. A similar loss could be expected in the processing of ore in the upper Owyhee subbasin.

Mercury amalgamation was the only known way to process low-grade ore until the arrival of cyanide. Nevada's first cyaniding plant was built in Tuscarora District in 1892 with additional plants built to rework tailings in 1898 (at the Independence Mine)

Photo 4.10. An abandoned structure in the canyon below Blue Jacket mine.

and 1911. Cyanide was also used in the Bull Run District beginning in 1899. It is unclear to what extent the cyanide process supplanted amalgamation or if it merely supplemented the mercury process by allowing the processing of tailings from earlier operations.

c. Boom-bust cycles

Sometimes ore reserves played out quickly and a town lasted only a short period of time (Figure 4.7). A national depression or drop in ore prices might lead to the closure of nearby mines. In some cases a small number of prospectors remained, processing placer gold or working small veins. A new discovery or reopening of a mine would result in another influx of miners, sometimes reviving the town.

Until the 20th century, Tuscarora's mining never completely stopped and it repeatedly picked up following a downturn.[31] Bull Run exemplifies the more precipitous ups and downs of some of the other towns. Although gold was discovered in 1869, little was produced before new discoveries were made in 1896. All activity ceased in 1910 and the residents left. The mine was reactivated in 1936 with a 25 ton mill. Although a 100 ton mill was built in 1939, all work ceased in 1940.[26]

d. Natural resource consumption

Prior to 1903, there were no complete records of precious metal production. The upper Owyhee subbasin probably produced in excess of $10,000,000 of gold and silver.[56,84] The lode gold came primarily from Tuscarora and Edgemont. Gold prices varied little, $18.94 per ounce,[56] so around 53,700 ounces of lode gold were mined before 1900.[42] Placer gold was produced primarily at Island Mountain and Tuscarora. Placer gold production prior to 1899 has been estimated at 77,800 ounces.[39] Silver varied considerably in price, from $.59 to $1.75,[23] averaging $1.08 an ounce so based of the profits about 6,950,000 ounces on silver were also produced.

Wood was needed both for mine timber and as an energy source. During the 1870s and 1880s woodlands were severely depleted as energy sources for the mining industry.[104] The development of lode deposits at Cornucopia was slowed by a lack of wood for mine timber. Wood timbers from abandoned mines might be salvaged for reuse. The mine timbers at Lime Mountain came from old mines at Kennedy.[26]

A huge demand for fuel was created by the mills. By 1877 in Tuscarora "the lack of wood necessitated the use of sagebrush."[26] During the fall and winter, Chinese made up a large portion of crews hired to cut sagebrush to fuel the steam boilers in the silver mills and mines of Tuscarora. Sagebrush was harvested up to 25 miles from town.[31] The mills at both Cornucopia and Good Hope also ran on sagebrush.[26] Obtaining fuel for all uses was a problem. The Tuscarora Times-Review "called attention to a message from telegraph company headquarters in San Francisco. The message warned that the telegraph lines to Tuscarora would be taken away if Tuscarora-Elko teamsters didn't quit chopping down the poles to use as fuel."[74]

Photo 4.11. Ruins of the mill at Tuscarora

4. Timber industry

Jack Creek was a major source of the wood used in Tuscarora. Both mine timbers and firewood were brought from there. An 1881 description identifies both the general scarcity of trees and the forested hills around Jack Creek. "Wood is found in the gulches in limited quantities, but in the Jack Creek range, on the east, there is plenty of timber, and a sawmill is established on the creek by that name, whence come the mining timbers for the Tuscarora silver mines. About forty men are constantly employed in the lumbering business at this mill."[93] Between 1877 and 1892, 200,000 linear feet of mine timber and 12,000 cords of firewood were harvested around Jack Creek.[26]

On the other side of the mountains, Reuben Riddle started a lumber and saw mill in Mountain City in 1870.[62]

5. Livestock industry

Miners and the other people in the developing towns required food. Cattle were introduced to the region to feed the miners. Sheepmen also realized that "gold-seekers would pay high prices for mutton, especially when beef was scarce."[27] Jack Harrington was possibly the first rancher near the Nevada mines. He homesteaded on Jack Creek in 1868 and was a rancher all of his life.[26] Other entrepreneurs had already recognized the grazing potential of the land just north of the subbasin. In 1867 Con Shea brought in a herd of long horns from Texas for the start of the cattle business in the Owyhee region.[6] Pick Anderson, who settled at Golconda in Nevada sometime before 1874, utilized the range on Juniper Mountain in the upper Owyhee watershed (Figure 4.10) Cattlemen frequently also ran sheep. At one time Pick was grazing twenty thousand head of cattle and fifteen to twenty bands of sheep.[27]

Near Tuscarora, the South Fork Owyhee River flows through Independence Valley.[58] This crescent shaped valley is about twenty five miles long and eight miles wide. By 1871 there were five ranches in the valley and the number continued to increase over the years. [65] One of these original ranches as owned by two Basque brothers, the Altubes. They drove 3,000 cattle from "Old Mexico" to Independence Valley. Their ranch, near Tuscarora was roughly 20 miles long by 10 miles wide and they also ranged their cattle on thousands of acres of public land.[43] In 1881 Independence Valley was described as having "an abundance of water, many small creeks rising in the mountains and swelling the main stream. . . . Along the river are

Photo 4.12. Looking out over Tuscarora towards the upper end of Independence Valley

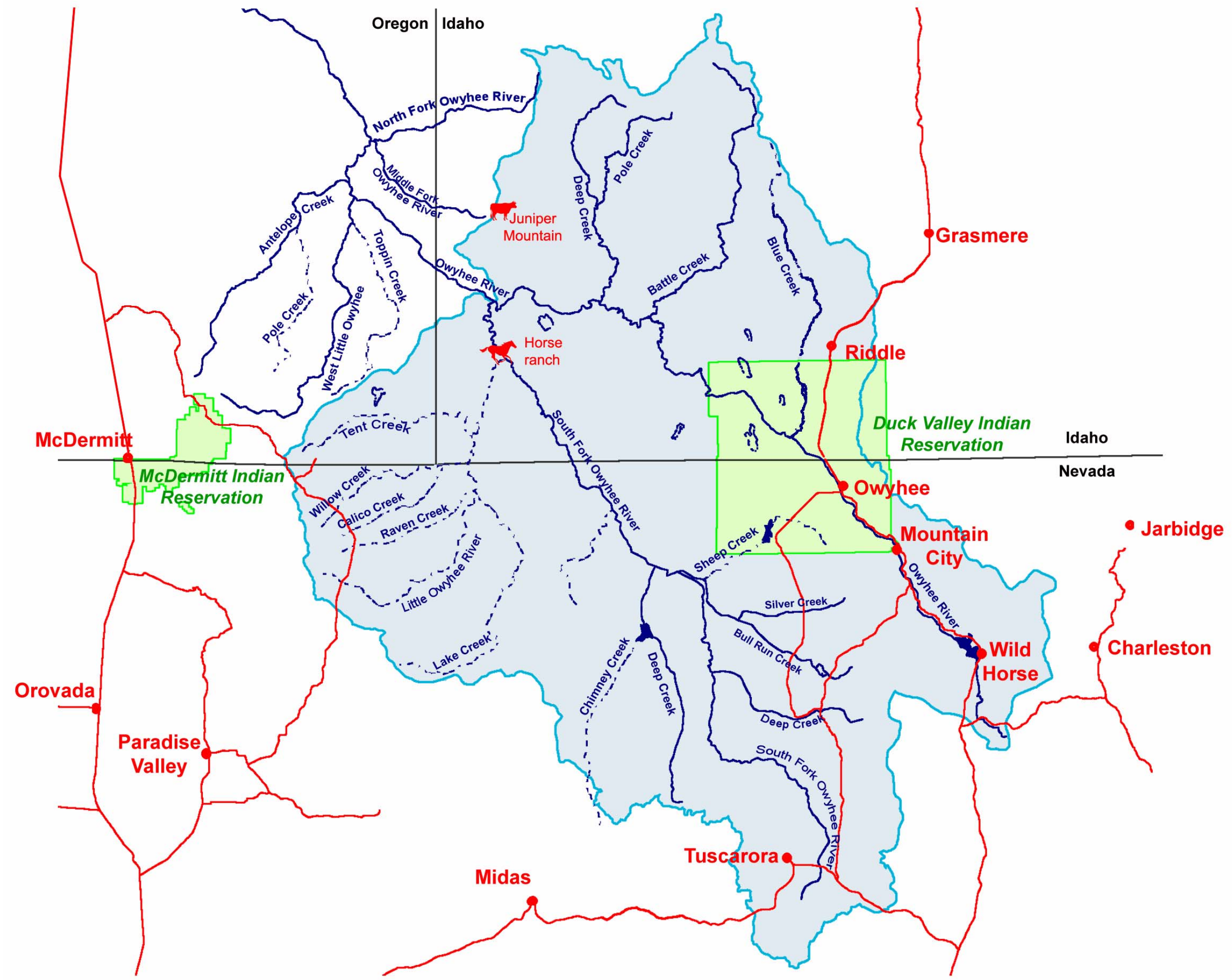

Figure 4.10. Early use of the Idaho section of the upper Owyhee subbasin.

beautiful meadows that widen out in some places to three miles, which produce thousands of tons of hay. Lying at an altitude of 7,000 feet above the level of the sea, grain does not grow as well as could be wished, though it is raised to some extent. . . The land is used principally for grazing purposes, only about 300 acres being devoted to agriculture, most of which lies in the eastern portion of the valley."[93]

Grazing on the range followed the Spanish system of open-range livestock.[104] However, the large operations tacitly utilized different areas. Cattle were generally moved with the seasons. Sagebrush ranges were used in the spring and fall while mountain ranges were summer pastures. During the winter, cattle were moved to areas where they wintered on bunch grass and winterfat (white sage), frequently at the margins of playas (salt deserts).[104] In 1870, David Shirk, who was supplying cattle to the mining towns just north of the subbasin, drove cattle up from their winter range to Duck Valley. He identified it as an ideal summer range, with miles and miles of waving bunch grass covering the hills and mountain slopes.[81] Few ranchers thought about putting up hay for cattle although from the earliest days most ranches put up some hay for stock horses.[104] Homesteaders with just a few cattle supplemented their income by making and selling butter and cheese. As their herds grew, they also turned their animals out on the Owyhee desert.[62]

With the completion of the transcontinental railroad, shipping cattle by rail cars changed the economics of ranching. Some ranchers expanded their operations and ranchers with bases outside the upper Owyhee subbasin used the upper Owyhee subbasin as part of their range. Humboldt Valley ranchers used the Owyhee Desert to winter cattle.[104] One outfit, Jarvis and Brass purchased steers to winter them on the Owyhee desert and canyons. Other cattlemen like David Shirk only used the upper Owyhee subbasin for summer range.[81] In the Idaho section of the subbasin, cattle of the Horn outfit had ranged into the lower country, including Duck Valley, starting around 1880.[77]

Horse ranching was also profitable in the sagebrush/grasslands. "Southeastern Oregon and northern Nevada were well known by 1880 for producing fine cow horses"[104] In 1880 a horse ranch was established just downstream of the confluence of the South Fork Owyhee River and Little Owyhee River in the upper Owyhee subbasin (Figure 4.10).[8]

During the 1879-80 winter, there was little snow on the ground in the Owyhee Desert. Many intermittent and ephemeral streams lacked water. Since the cattle stayed close to existing water supplies, the forage, mainly winterfat and Indian ricegrass, was entirely consumed near water sources. Cattle starved, but few ranchers started putting up hay. Sheep, which could obtain water from skiffs of snow and were less selective browsers, were less impacted.[104]

From 1886 to 1889, precipitation throughout the region was reported to be below normal. There was a terrible drought in the spring and summer of 1889. Waterholes dried up and feed was scarce. Streams that had been perennial for as long as the oldest settlers could remember shrank to interrupted pools, then dried up completely. Cattle were already in poor condition when an early December snowstorm brought seven consecutive days of blizzard conditions. Snow storm followed snow storm and temperatures through February reached record lows. Elko newspapers estimated that 95% of livestock was lost.[102,104]

"The transplanted Spanish system of open-range livestock was dead."[104] One immediate effect of the harsh winter was an increase in the sheep on the range. Previously the range sheep industry had competition from established cattle ranches. However, there were fewer sheep losses over the extreme winter; the sheep industry was smaller and sheep were better adapted to the environment and forages of the desert ranges.[104]

F. End of the nineteenth century, early twentieth century

By the end of the 1800s, changes in the upper Owyhee subbasin included the introduction of cattle, sheep, and horses on the range. Towns had appeared and disappeared.

The changes in the subbasin during the 19th century following Euro-American settlement set the stage for activities in the succeeding decades. The routes of principal roads evolved near where they are today. By 1927, the highways on the Rand McNalley road map are shown in their current locations.[75]

The principal enterprises in the subbasin during the 1800s were engaged in mining or ranching. Mining and the associated towns relied on the geology of the region and the location of gold and silver deposits. Ranching relied on utilization of public lands for grazing on the extensive, unpopulated Owyhee uplands. The amount of land which could be homesteaded was quite restricted so some control over use of the rangelands was exerted by ownership of the lands with water.

Many of the records consulted for the following section of the history do not have exact dating, especially those recollections written long after the fact. There has been an attempt here to develop an accurate sequence for the changes recorded below, however many of the topics cover several decades and there may be some unintentional errors.

1. Effects of the white winter, 1889-1890

a. On vegetation

Two decades of unlimited livestock grazing had severely reduced the pristine plant communities of the sagebrush grasslands. Cattle and sheep had selectively eaten the perennial grasses. The perennial grasses were largely bunchgrasses which reproduce by seed. The two decades of excessive grazing had virtually eliminated seed production in many areas. Low reserves of grass seed in the soil meant that perennial bunchgrasses couldn't respond to improved growing conditions like shrubs and juniper.[104]

The water provided by the snows of the white winter promoted excellent plant growth. In the spring of 1890, the ranges had virtually no cattle on them. Shrubs took advantage of the lack of perennial grasses to expand their dominance. Shrub establishment included stands of the desirable browse species bitterbrush, but also included an abundance of toxic big sagebrush. There was a basic change in forage resources of sagebrush grasslands. The juniper woodlands also greatly expanded.[104]

b. On ranching

i. Expansion of sheep

The first Basques in the upper Owyhee subbasin had arrived in the Nevada portion in the early 1870s.[16] These original settlers like the Altube brothers on Spanish Ranch and the Garats on the YP Ranch were cattlemen. Sheep and cattle were frequently run on the same ranch, although the range sheep industry didn't really take off until the beginning of the 1900s. Young men from the Basque Country were willing to take the lonesome job of sheep herder even though the job was different from what they had done in the old country.[43] Their dependability and hard work led sheep owners and ranchers to hire workers from this immigrant group. By the late 1880s, Basques were also working in eastern Oregon and southwestern Idaho.[16]

The diet of sheep and cattle overlaps. However, sheep are browsers, eating forbs and brush. Cattle are grazers, preferring grass. Following the white winter, the

Altube brothers on the Spanish ranch greatly increased the numbers of sheep they were raising. To herd them they hired Basques. At one time the Spanish Ranch ran about 18,000 cattle and 12,000 sheep on the same ranch.[43]

As the sheep industry expanded, more labor was required. Some Basque sheepherders took sheep instead of wages. As these new outfits grew, they tended to hire newly arrived Basques, frequently family members.[43,12] Many of these sheep bands were grazed on public lands. When a sheep herder had no home base, his herd was considered a tramp sheep outfit.[43]

ii. Cattle outfits

Some small outfits like the Horn outfit were forced out by the winter of 1889-1890.[77] Surviving ranchers realized the need to put up hay for the winter to feed cattle that grazed on the sagebrush ranges.[104] The Riddle brothers had built up a cow herd with a home base at Whiterock. Following the winter of 1889-1890 when the need for winter feeding became apparent, they felt the Duck Valley wild hay meadows could provide a good source of hay. Owyhee County, Idaho could be homesteaded since surveys to establish townships had been completed. The Riddle brothers were among the earliest Euro-Americans who settled in that part of the Idaho section of the subbasin.[30,62,77,85,104]

Photo 4.13. Irrigated hay fields in the upper Owyhee subbasin being used for fall pasture after harvest.

The number of settlers who followed the Riddle brothers and their families into the Duck Valley region was limited.[77] In 1898, the Wickahony directory, which included not only Duck Valley but families living in other nearby drainages listed, 18 ranchers.[1] The 1919 Idaho Farm directory listed people by their home town and then the township and range of land which they owned. It listed 22 land owners as living in Riddle. Of these 22, only 16 owned land in the Idaho section of the upper Owyhee subbasin. Eight of these were Riddles, three were Yates and two were Stones.[22]

2. Water

The need for a reliable source of winter feed led to an increase in the need for water. Hay required water. Existing natural hay meadows could be enlarged by flooding adjacent areas. However, irrigation was necessary to economically grow larger amounts of forage in the semiarid environment.[104]

In the Nevada section of the upper Owyhee subbasin, the mining companies were already utilizing water, the twelve-mile-long ditch at Gold Creek being the greatest redirection of water by miners.[26] The ranchers on the western side of the Bull Run and Independence Mountains were utilizing the water from the creeks flowing out of the mountains. Water was a finite resource and increased demands on this resource highlighted the need for laws governing water rights. In general, water laws in the West evolved from mining laws. Western semiarid states were granted authority to regulate waters for irrigation whereas the federal government controlled stock water.[104]

As state laws evolved, the upper Owyhee subbasin occupied areas where the appropriation doctrine for water rights was used. Water rights were based upon the beneficial use of the water rather than upon the ownership of land. The priority for the rights was based upon when the user first began to utilize the water for the stated purpose or when the construction of diversion works began. The owners of the earliest water rights could use the water even if it meant that the owners of later rights were deprived of water.[104] Ranchers were frequently the first settlers to make beneficial use of the water, so their water rights were established under the "prior appropriation" doctrine. Idaho, Oregon, and Nevada all recognized and protected such rights.[86]

Although Reuben Riddle had filed a number of water right claims in the upper Owyhee subbasin by 1874,[62] many early water users did not file claims until a much later date. Then people encountered problems in remembering the dates, locations, and amounts of water utilized as long as fifty years previously.[104]

Where placer miners wanted to divert water from a stream, they had been piling rocks across the stream to create a primitive rock dam. The first spring flood would wash out the dam. When ranchers began irrigating with diverted water, they built similar rock dams. In the spring, before they could start irrigating, they needed to repair the dam.[104]

Irrigation greatly increased the available forage base in the subbasin. This forage could be converted to hay for winter feeding and irrigated farming became integrated into range livestock operations.[104] To provide enough water and irrigable land to grow hay to feed their herd through the winter, ranchers acquired tracts of private property. During the summer the herds drank from streams and springs on the public lands where they were grazing, but established water rights were crucial for the success of a ranch. When land was sold, it was understood that the water rights on both the land and on the public portion of the ranch's grazing allotment were included.[86]

3. Settlement in Idaho

a. Land ownership

The number of land patents issued is some indication of the number of ranchers or farmers in an area. A land patent documents the transfer of land ownership from the federal government to an individual.[9] Most of these transfers were based on one of the homesteading acts. Sometimes each member of a family filed a claim but the claims were managed as a single ranch. A rancher might file claims for different sections of land at different times. There was a steady increase in the number of patents issued in the Idaho section of the upper Owyhee subbasin. Prior to 1900 there had been only three patents issued. Other than land deeded to the state of Idaho or to railways, between 1900 and 1909, 17 patents were issued. Between 1910 and 1919, 88 were issued. And, 165 patents were issued between 1920 and 1929(Table 4.1).[9]

Figure 4.11 is a generalization of the pattern of settlement in the basin based on the land patents.[Note A] By 1909 individuals had settled in the Riddle area and along the headwaters of Pole Creek and along Battle Creek. The following decade patents were also issued along Deep Creek and Blue Creek. A common element of all these lands was their placement along water courses, underscoring the integration of water for irrigating hay with ranching. Both the Riddle and Stone families constructed reservoirs to hold water from melting snow.[30,85] Henry Rhubelt built a reservoir on Shoefly Creek.[77] Many of the later claims were adjacent to land directly north of the upper Owyhee subbasin and may have been parts of larger operations.

Table 4.1. Number of patents issued in the Idaho section of the upper Owyhee subbasin through 1929. Townships listed are only those where patents were issued.[9]

Township	Range	Before 1900	1900-1909	1910-1919	1920-1929
14S	2E	3		5	10
14S	3E		11	17	14
13S	3E		1	14	13
13S	2E		2	2	7
10S	1E		1	4	7
10S	1W		2	13	8
16S	5W			1	
15S	1W			2	2
14S	5W			1	1
14S	2W			2	1
13S	4E			1	
12S	3W			4	6
12S	1E			1	5
12S	2E			1	5
11S	1E			1	1
11S	2E			1	2
10S	3W			2	9
9S	3W			2	8
9S	1W			2	2
9S	1E			9	5
8S	1W			1	
8S	1E			2	3
16S	1W				1
15S	4W				1
14S	1W				1
14S	1E				2
13S	1E				3
12S	5W				1
12S	1W				2
11S	4W				8
11S	3W				6
10S	4W				10
10S	2W				6
9S	2W				14
8S	3W				1
	Total	3	17	88	165

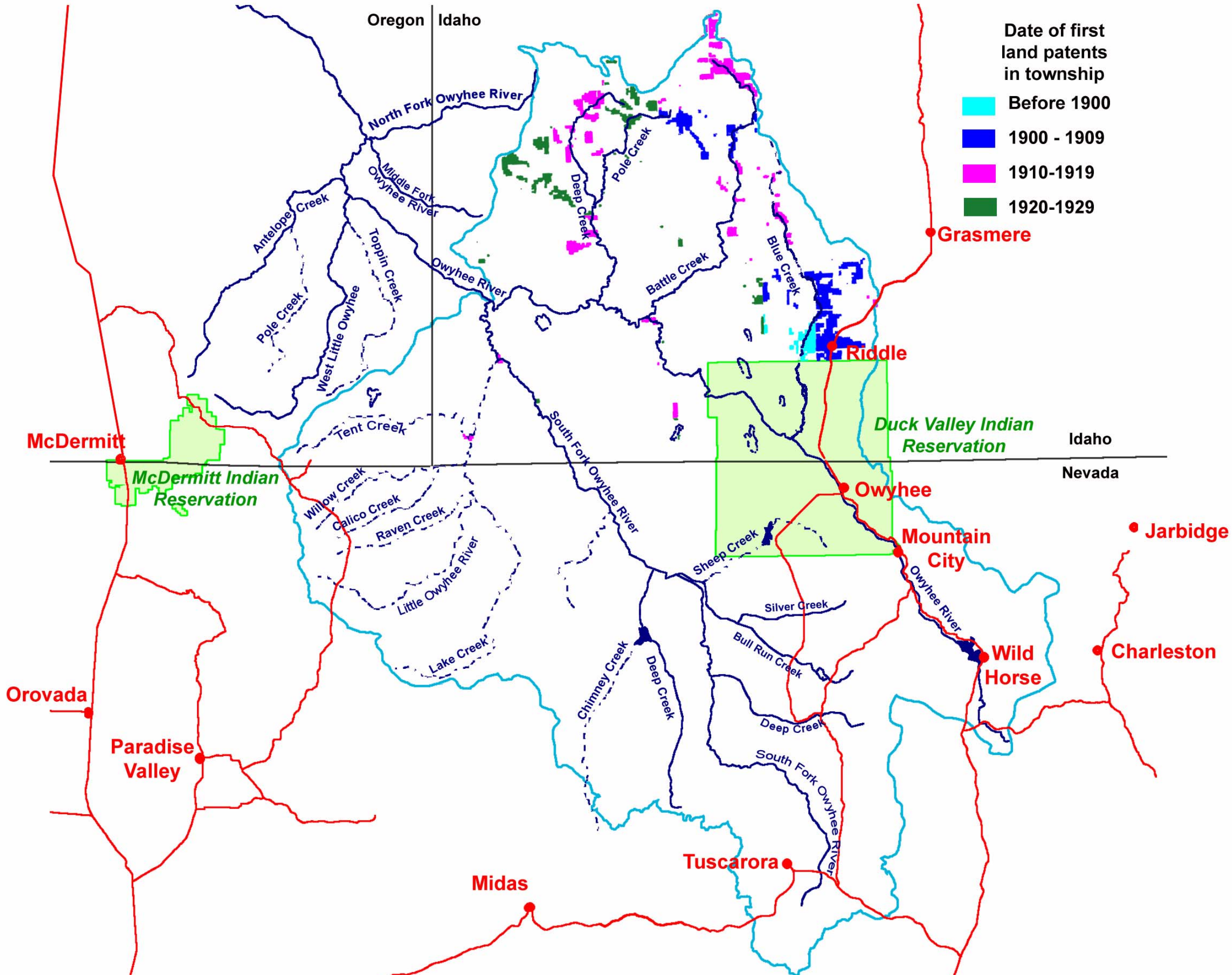

Figure 4.11. Progressive land settlement in the Idaho section of the upper Owyhee subbasin by date of entry in the township. Cumulative land ownership over the decades.

Not all of the settlers were successful. Even the Riddle's small apple orchard across from a stream flowing out of a spring never produced. However, the Riddle families successfully grew wild varieties of hay for winter feed. Horse drawn sleighs crossed the snow covered fields of winter to deliver loads of hay to the cattle.[30]

Three German emigrants who settled on Harris Creek and at Dad Springs "couldn't develop sufficient water for farming so they only stayed a few years, selling out to Mr. Sewell."[77] Joseph Sewell, the owner of a general store and trading post in Owyhee, waited, and "when all the available land with water was located and proved upon he bought each settler out, finally owning all the land on Blue and Little Blue Creeks all the way to the head of each creek."[77] He built reservoirs on both creeks. He ran both cattle and sheep.

Since homesteaded land could be sold once it was "proved up", the number of original patents might not represent people living on the land. The 1919 Idaho Farm directory not only lists thirteen upper Owyhee subbasin land owners living outside the subbasin, but also includes one livestock company based in Grandview.[22]

There were no claims made on a huge section of the upper Owyhee subbasin. These areas might have enough water for cattle to graze on them, but there was not adequate water for producing hay to winter the cattle (Figure 4.11).

b. Snippets of life

The density of settlers in the Idaho section of the upper Owyhee subbasin during the first two decades of the 1900s was low. Marjorie Hawes remembers that they considered people living 45 to 50 miles away as neighbors. Before the advent of motorized travel, families would make about two trips per year to get supplies.[10,30] The ranchers would cure hams and bacon when fat hogs were killed in the fall, but they had to purchase flour, sugar, bayo [sic] beans, dried fruits, coffee beans, coal oil, and Chinese block matches.[30]

Marjorie had her first automobile ride in Mountain City about 1906.[30] By 1915, her family had a car. The roads were dusty and full of both ruts and chuck holes. Since tires blew out frequently and had to be fixed on the road, they could make Bruneau in a day or all the way to Mountain Home if they had few blow-outs.[30]

Many of the original homes were rock houses.[10] The earthquake of October 3, 1915, in Pleasant Valley, Nevada resulted in considerable damage in southwest Idaho a hundred miles from epicenter.[108,109] After the earthquake, the Hawes wood frame house listed and had to come down. Marjorie wrote, “Everyone was building rock houses around the area so we joined the club” and built a new two story house of stone.[30] A scarcity of local wood meant that sagebrush was used as fuel both in the kitchen stove and the fireplace.[10] A huge sagebrush was even turned into a Christmas tree.[30] There were flocks of ducks and geese which fed on the wild meadows. These not only made good eating, but their feathers were made into feather beds and pillows.[10,77]

In 1926, thirteen year Oliver Tremewan’s jobs on the ranch outside Mountain City included irrigating, haying, building fence, gathering cattle, fixing machinery and breaking horses. In the winter he also sawed blocks of ice from the frozen pond and stored them in a hole.[50]

Some areas retained more of their pioneer aspect for longer. Nancy Fretwell’s parents purchased the 45 Ranch at the confluence of the Little Owyhee River and South Fork Owyhee River in 1937. Nancy remembers a one room main house built into the hillside. There was no ceiling but a sheet tacked across the room. When the Mormon crickets were bad, they would build up on the sheeting until it wouldn’t hold, then they dumped out. In addition to the main house, there was a sod roofed bunkhouse, a rock and willow barn, a rock chicken house, and a rock ice house to store blocks of ice. During World War II, they would make one trip per year out to Mountain Home to purchase a year’s supply of goods.[21]

4. Grazing Pressure

When livestock were first introduced, the grass on public lands was "free" and lured livestock growers to turn out herds of sheep, cattle, and, sometimes, horses to roam freely. There was a "winner take all" attitude that encouraged grazing.[40,28] To protect their interests to the free grazing range, livestock owners acquired lands with water resources. "Owning the sources of water was a means of controlling the surrounding grazing lands."[40]

The established sheep and cattle operators had a base property. Many of these were developed to raise hay for wintering the stock.[55] "Several large local cattle operations branched into the sheep business with scarcely a comment from their neighbors."[104] "It was the tramp cowman and tramp sheepman who caused the friction. They had no base property, so mooched off those who had put together an outfit. Cattlemen and sheepmen alike fought these itinerant individuals,"[27] frequently completely migratory Basque herders who owned no base property at all.[104]

There is evidence that during the late 1880s Sparks and Tinnin, large ranchers in the Nevada section, recognized that the rangelands were nearing grazing capacity.[104] However, in 1914 Owyhee County was being touted as having grazing lands which "were almost limitless in extent."[20] As the number of cattle in Owyhee County declined from a high of 100,000 head before the white winter, the sheep industry increased to 200,000 sheep in 1914. Sheepmen had holdings ranging from 3,000 to 50,000 head which grazed in bands of from one to three thousand. Owyhee County was described as providing " the most ideal conditions for stockmen that are to be found within the state [Idaho]."[20]

G. End of an era

1. Taylor Grazing Act

Years of unbridled use of western range lands eventually resulted in the passage of the Taylor Grazing Act of 1934. To undo the over-grazing of the open range by sheepmen herding sheep wherever there was grass and water and by cattlemen and horse owners who turned their herds out onto the public domain, the Taylor Grazing Act required livestock owners to show proof of a base of operations. This requirement would eliminate "tramp" operators. The BLM began to adjudicate the range based on the productive capability of the base properties, prior use of the federal land, and a system of seniority that gave old time operators preference over late comers.[27]

The Taylor Grazing Act also ended the policy of the previous 150 years of transferring public lands into private ownership. It withdrew public lands from homesteading. Now to file a desert claim, a man had to prove that his quarter section was more valuable for agriculture than for grazing. "The only way he [could] prove that [was] to get water enough to irrigate it."[37]

2. Dam construction

Downstream from the upper Owyhee subbasin, near the mouth of the Owyhee River, the Owyhee Dam was constructed during the 1930s. A dam was also constructed in the subbasin on the Owyhee River upstream of the Duck Valley Indian Reservation. Wild Horse Dam was authorized by congress in 1931 to provide water storage for the reservation. Construction was begun in 1934 and completed in 1938. Wild Horse Dam is owned by the US Department of the Interior Bureau of Indian Affairs.[18,60,73,91]

On the South Fork Owyhee drainage the Willow Creek Dam was constructed in 1931. It was a WPA project for flood control and irrigation.[100] This dam is currently owned by the Petan Company. There are another five dams on their holdings, including the Bull Run Dam on the Bull Run Creek. (At the time of writing this assessment the author did not have information on when the other five dams were constructed.)

Although small dams had previously been built, the larger dams had a much greater impact on the hydrology of the subbasin.

3. Mining

Mining in the upper Owyhee subbasin has never completely stopped. There was a resurgence around Mountain City in the 1930s with the opening of the Rio Tinto copper mine. The buildings constructed at the mine and in the supporting town of Patsville have become ghostly structures since the mine closed in the 1940s.

Photo 4.13. An abandoned store in Patsville south of Mountain City

4. Conclusion

As the geography and natural resources of the upper Owyhee subbasin are complex, so its history varies. The passage of the Taylor Grazing Act and the increased water available for irrigation behind dams introduced a new era. Technology in mining and ranching was evolving along with a greater awareness of how to protect natural resources. Along with the rest of the nation, the upper Owyhee subbasin slowly slipped into the modern age.

Note A. The Idaho land records database viewer was used to identify the current boundaries of private land in Owyhee County Idaho.[35] A land patent search was conducted for every township and range in the Idaho section of the upper Owyhee subbasin. All Idaho private land within the subbasin was identified by the first patent issued within the township.[9] This gives a rough idea of the settlement pattern of the area, but individual properties settled later than the initial patent are not identified separately.

Bibliography

1. *A Historical Descriptive and Commercial Directory of Owyhee County, Idaho*. 1898. Press of the Owyhee Avalanche, Silver City, Idaho. Retrieved 10/28/2008. http://ia341037.us.archive.org/0/items/historicaldescri00silv/historicaldescri00silv.pdf
2. Aikens, C. M. 1986. *Archaeology of Oregon*. US Department of Interior Bureau of Land Management, Oregon State Office.
3. Baker, Bruce W. and Edward P. Hill. 2003. Beaver. In *Wild Mammals of North America: Biology, Management, and Conservation*, edited by George A. Feldhamer,, Bruce Carlyle Thompson, Joseph A. Chapman. 2003. JHU Press
4. Ball, John. 1925. *Autobiography of John Ball*. The Dean-Hicks company, Grand Rapids.
5. Bartleson-Bidwell Party. 2008. *Wikipedia, The Free Encyclopedia*. Retrieved 10/6/2008. http://en.wikipedia.org/wiki/Bartleson
6. Beach, Joe. 1980. In Alice Bronsdon, ed. *Owyhee River Oral History Narratives.* Vale District Bureau of Land Management, Vale, OR. 1999.
7. Beaver. *Wikipedia, the free encyclopedia*. Retrieved 10/1/2008. http://en.wikipedia.org/wiki/Beaver
8. Bureau of Land Management. 45 Ranch # 373. Retrieved 12/30/2008. http://www.blm.gov/pgdata/etc/medialib/blm/id/publications/technical_bulletins/tb_98-5.Par.32631.File.dat/part13.pdf
9. Bureau of Land Management. 2008. Land patent search. *General Land Office Records*. Retrieved 1/10/2009. http://www.glorecords.blm.gov/PatentSearch/
10. Cahalan, Dorothy Tindall. History and memories of being an early pioneer's daughter on the Tindall Ranch. In archives at the Owyhee County Historical Museum.
11. California Trail. 2008. *Wikipedia, The Free Encyclopedia*. Retrieved 10/6/2008. http://en.wikipedia.org/wiki/California_trail
12. Center for Basque Studies. 2001. Lenore Holbert. *Oroitzapenak Voices from Basque America*. Retrieved 1/6/2009. http://basque.unr.edu/oralhistory/holbert_lenore/LenoreHolbert.html
13. Coyote Willow. Range Plants of Utah. Utah State University extension. Retrieved 4/27/06. http://extension.usu.edu/rangeplants/Woody/coyotewillow.htm
14. Coyote Willow · Salix exigua. Retrieved 4/27/06. http://www.boskydellnatives.com/description_page%5CSalix_exigua.htm
15. Eddins, O. Ned. John Jacob Astor - Pacific Fur Company Astorians - Tonquin - Fort Astoria. Retrieved 4/11/08. http://www.mountainsofstone.com/astorians.htm
16. Edlefsen, John. 1950. Enclavement among Southwest Idaho Basques. *Social Forces*, Vol. 29, No. 2 , Published by University of North Carolina Press.
17. Elko Chamber of Commerce. 2007. Elko Area History. http://www.elkonevada.com/history.shtml 2/28/08
18. Elko County History. *Online with Elko County*. Retrieved 1/11/2009. http://www.elkocountynv.net/history.htm
19. Fowler, Catherine S. and Sven Liljeblad. 1986. Northern Paiute. In *Handbook of North American Indians, volume 11: Great Basin*, edited by W. L. D'Azevedo, pp. 435-465. Smithsonian Institution, Washington.
20. French, Hiram T. 1914. *History of Idaho: A Narrative Account of Its Historical Progress, Its People and Its Principal Interests. Volume 1.* The Lewis Publishing Company, Chicago and New York.
21. Fretwell, Nancy and Mary O'Malley. 2007. The 45 Ranch on the Owyhee River. *Owyhee Outpost: A Journal of the History of the Owyhee Country*, 38.
22. Gem State Rural's 1918-19 Farm Directory of Owyhee County Idaho and Malheur County, Oregon. Retrieved 12/30/2008. http://distantcousin.com/Directories/OR/Owyhee_Malheur_Counties/1918_19/

23. Goldmasters USA. 2009. Silver Prices - Historical. Retrieved 1/2/2009. http://www.goldmastersusa.com/silver_historical_prices.asp

24. Greenfield, Geo. H. 1912. Elko County. In *The History of Nevada* (Vol 2, chap. 47), edited by Sam P. Davis. Reprinted in *the nevada observer, Nevada's Online State News Journal*, Nov. 3, 2005. Retrieved 1/1/2009. http://www.nevadaobserver.com/History%20Of%20Elko%20County%20(1912).htm

25. Hafen, LeRoy R. and Ann W. Hafen, eds. 1955. The Peoria Party - Sidney Smith Diary. In *To the Rockies and Oregon 1839-1842*. The Arthur H. Clark Company, Glendale, California.

26. Hall, Shawn. 1998. *Old Heart of Nevada: Ghosts Towns and Mining Camps of Elko County*. University of Nevada Press, Reno/Las Vegas, Nevada.

27. Hanley, Mike with Ellis Lucia. 1988. *Owyhee Trails, The West's Forgotten Corner*. The Caxton Printers, Ltd., Caldwell, Idaho.

28. Hanley, Mike. 1988. *Tales of the I.O.N. Country*. Jordan Valley, Oregon.

29. Harris, Jack S. 1940. The White Knife Shoshoni of Nevada. In *Acculturation in seven American Indian Tribes*, edited by Ralph Linton, pp 39-116. D. Appleton-Century Company, New York.

30. Hawes, Marjories A. My pioneer family in Duck Valley with ancestral background. Presented to the Owyhee County Historical Museum.

31. Hickson, Howard and Tony Primeaux. 2002. Tuscarora never died. *Northeastern Nevada Historical Society Quarterly, 83-1*. Retrieved 4/20/2008. http://www.outbacknevada.us/hickson/Tuscarora.html

32. Hickson, Howard. 2004. Chinese voting in Tuscarora: Tuscarora, Nevada c.1890. *Howard Hickson's Histories.* Retrieved 3/3/2008. http://www.outbacknevada.us/hickson/LeeAhLake.html

33. Hiler, John. 2005. Mountain men. In *Early Owyhee County*. *Owyhee Outpost: A Journal of the History of the Owyhee Country*, 36.

34. Hunt, Wilson Price. Wilson Price Hunt's diary of his overland trip westward to Astoria in 1811-1812. In *The discovery of the Oregon trail: Robert Stuart's narratives of his overland trip eastward from Astoria in 1812-1813,* Philip Ashton Rollins. 1935. University of Nebraska Press.

35. Idaho Department of Lands. 2008. Land records database viewer. Retrieved 1/8/2009. http://gis1.idl.idaho.gov/website/pdlr/

36. Jackman, S.W., Ed. 1978. Journal of William Sturgis. Retrieved 2/22/06. http://www.hallman.org/indian/sturgis.html *1799*

37. Jackman, E.R. and R.A. Long. 1964. *The Oregon Desert.* The Caxton Printers, Ltd., Caldwell, Idaho.

38. Joe Meek's Years in the Rocky Mountains. Originally published as *The River of the West*, edited by Frances A. Fuller. R. W. Bliss and Co, Hartford, Connecticut and Toledo, Ohio. 1870. Retrieved 2/22/06. http://www.xmission.com/~drudy/mtman/html/jmeek/ *1832*

39. Johnson, Maureen G. 2001. Placer Gold Deposits of Nevada. USGS Bulletin 1356.

40. Jones, Ilea and Eunice Guerrant eds. 1988. *Malheur County History*. Taylor Publishing Company, Dallas, Texas.

41. KNPB Public Broadcasting. Elko to Mountain CIty. *Wild Nevada*. Retrieved 4/21/2008. http://www.knpb.org/WildNevada/Trip212.asp

42. Koschmann, A.H. and M.H. Bergendahl. 1968. Elko County Nevada Gold Production. *Western Mining History*. Retrieved 1/2/2009. http://www.westernmininghistory.com/articles/121/page1/

43. Laughlin, Mike. 2008. Basque Ranching Culture in the Great Basin. Retrieved. 1/6/2008. http://www.cowboyshowcase.com/basque.htm

44. Leonard, Zenas. 1839. Narrative of the Adventures of Zenas Leonard. Retrieved 9/27/08. http://www.xmission.com/~drudy/mtman/html/leonintr.html

45. Lieuallen, William. The Journal of William Lieuallen, emigrant of 1864. Retrieved 3/10/06. http://www.endoftheoregontrail.org/piofam/famlieu.html

46. Lyman, Lee R. and Steve Wolverton. 2002. The late prehistoric-early historic game sink in the Northwestern United States. *Conservation Biology*, 16(1), pp. 73-85.

47. MacNeil/Lehrer Productions. 2000. Empire of the Bay: A company for the future. Retrieved 2/21/06. http://www.pbs.org/empireofthebay/broadcast4.html

48. MacNeil/Lehrer Productions. 2000. Empire of the Bay: Crossing the continent. Retrieved 2/17/06. http://www.pbs.org/empireofthebay/broadcast3.html

49. MacNeil/Lehrer Productions. 2000. Empire of the Bay: Setting sail for the North. Retrieved 2/17/06. http://www.pbs.org/empireofthebay/broadcast1.html

50. Martin, Gregory. 2000. *Mountain City*. North Point Press, New York.

51. Meatte, Daniel S. 1990. *Prehistory of the western Snake River Basin*. Occasional paper of the Idaho Museum of Natural History, 35. Pocatello, Idaho.

52. Miller, Wick R. 1986. Numic languages. In *Handbook of North American Indians, volume 11: Great Basin*, edited by W. L. D'Azevedo, pp. 98-106. Smithsonian Institution, Washington.

53. Moore, Randall l. 2002. Mercury contamination associated with abandoned mines. *Oregon Geology*, 64(1). Oregon Department of Geology and Mineral Industries. Retrieved 2/1/07. http://www.oregongeology.com/sub/publications/OG/OGv64n01.pdf

54. Murphy, Robert F. and Yolanda Murphy. 1986. Northern Shoshone and Bannock. In *Handbook of North American Indians, volume 11: Great Basin*, edited by W. L. D'Azevedo, pp. 284-307. Smithsonian Institution, Washington.

55. Murphy, William. 1999. *Taming the High Desert.*

56. National Mining Association. 2007. Historical Gold Prices 1833 to present. Retrieved 1/2/2009. http://www.nma.org/pdf/gold/his_gold_prices.pdf

57. National Park Service. 2004. Fur Trappers and Traders. *Whitman Mission National Historic Site*. http://www.nps.gov/archive/whmi/educate/ortrtg/6or3.htm

58. Nevada Adventures. Independence Valley:Jack Creek. Retrieved 4/20/2008. http://www.nevadadventures.com/communities/elko/indep/main.html

59. Nevada Adventures. Welcome to Tuscarora, Nevada. Retrieved 4/20/2008. http://www.nevadadventures.com/communities/elko/tuscarora/tuscaroramain.html

60. Nevada heritage. 1994. Retrieved 1/11/2009. http://www.nevadaheritage.com/timeline/timelinemainpage.htm

61. Nevada place names populations 1860-2000 by decade. Retrieved 1/12/2009. http://nevadaculture.org/nsla/dmdocuments/nv_place_names1860-2000_decade.pdf

62. Notes in a file on the Riddle Family at the Owyhee County Historical Museum.

63. Ogden, Peter Skeen. 1950. *Peter Skene Ogden's Snake Country Journals 1824-25 and 1825-26,* edited by Rich, E.E. The Hudson's Bay Record Society, London.

64. Ogden, Peter Skeen. 1971. *Peter Skene Ogden's Snake Country Journals 1827-28 and 1828-29*, edited by Glyndwr Williams. The Hudson's Bay Record Society, London.

65. Old heart of Nevada: ghost towns and mining camps of Elko County, Nevada. Retrieved 4/22/08. http://nvghosttowns.topcities.com/elko/elkolst.htm

66. Oldham, Kit. 2003. John Jacob Astor's Pacific Fur Company establishes Fort Spokane in 1812. *HistoryLink.Org: The Online Encyclopedia of Washington State University*. Retrieved 4/11/08. http://www.historylink.org/essays/output.cfm?file_id=5101

67. Oregon Trail. 2008. *Wikipedia, The Free Encyclopedia*. Retrieved 10/6/2008 http://en.wikipedia.org/wiki/Oregon_trail

68. Oregon and California Trail Map. Exploring the far west. *World Book Encyclopedia and learning resources.* http://www.worldbook.com/wb/Students?content_spotlight/lewis_and_clark/settling_exploring

69. PBS. 2001. New perspectives on the west. Retrieved 2/17/06. http://www.pbs.org/weta/thewest/events/1800_1820.htm

70. Plew, Mark G. 1986. The archaeology of Nahas cave: material culture and chronology. *Archaeological Reports*, 13. Boise State University, Boise.

71. Plew, Mark G. 1985. A prehistoric settlement pattern for the southcentral Owyhee uplands, Idaho. Unpublished PhD thesis, Indiana University.

72. Plew, Mark G. 1980 Fish remains from Nahas Cave: archaeological evidence of anadromous fishes in southwestern Idaho. *Journal of California and Great Basin Anthropology*, 2:129-132.

73. Prior, Kyle. Testimony of Chairman Kyle Prior on behalf of the Shoshone-Paiute Tribes of the Duck Valley Reservation. Retrieved 1/11/2009. http://indian.senate.gov/public/_files/Prior042607.pdf

74. Pryor, Alton. 2003. *Little Known Tales in Nevada History*. Stagecoach Publishing, Roseville CA.

75. Rand McNally and Company. 1927. Rand McNally junior auto road map California, Nevada. In *Rand McNally auto road atlas of the United States and Ontario, Quebec, and the Maritime Provinces of Canada, with a brief description of the national parks and monuments*. Rand McNally & Co., Chicago, Ill. Retrieved 1/4/2009. http://www.davidrumsey.com/luna/servlet/detail/RUMSEY~8~1~33770~1171486:Rand-McNally-junior-auto-road-map-C

76. Ricketts, A.H. 1931. American mining law. California State Division of Mines Bulletin 98, 811 p.

77. Riddle, George. 1981. A history of Duck Valley and Riddle, Idaho. *Owyhee Chronicle/Canyon Herald*, December 16.

78. Scrugham, James. The Bartleson-Bidwell Party, 1841. In James G. Scrugham, *Nevada: The Narrative of the Conquest of a Frontier Land* (1935), vol. I, pp. 59-68. Reprinted in *the nevada observer, Nevada's Online State News Journal*, Dec 9, 2006. Retrieved 2/28/08. http://www.nevadaobserver.com/Reading%20Room%20Documents/Early%20Nevada%20The%20Bidwell-Bartleson%20Party%201841.htm

79. Scrugham, James G. 1935. The Bonneville-Walker Expedition, 1833-1834. In *Nevada: The Narrative of the Conquest of a Frontier Land vol. I,* Retrieved 9/27/08. http://www.nevadaobserver.com/Reading%20Room%20Documents/Early%20Nevada%20The%20Bonneville-Walker%20Expedition%201833-1834%20(1935).htm#_ftn2

80. Shinn, Charles H. 1896. Nevada silver. *Appleton's Popular Science Monthly,* 49. Retrieved 2/28/2008. http://www.archive.org/details/californianevada00ksrich

81. Shirk, David L. 1956. *The Cattle Drives of David Shirk from Texas to the Idaho Mines, 1871 and 1873*. Martin F. Schmitt, ed. Champoeg Press.

82. Shock, Candace, Myrtle Shock, and Clinton Shock. 2007. *Lower Owyhee Watershed Assessment*. Prepared for the Owyhee Watershed Council, prepared by Scientific Ecological Services. Accessible online, http://shockfamily.net/Owyhees/Index.htm.

83. Shock, Myrtle. 2002. Rock art and settlement in the Owyhee uplands of southeastern Oregon. Bachelor of Philosophy in Anthropology thesis, University of Pittsburgh, University Honors College.

84. Smythe, William E. 1900. The Conquest of Arid America. Harper & Brothers Publishers, New York and London. Retrieved 1/7/2009. http://www.archive.org/details/conquestofaridam00smytrich

85. Stephens, Carol A. The Stone family history. Presented to the Owyhee County Historical Museum.

86. Steward of the Range. Briefing paper on the LU Ranching water rights case: Historical Background. Retrieved 1/08/2009. http://www.stewards.us/lu-ranching/luranch-bkgd.htm

87. Steward, Julian H. 1941. Cultural Element Distributions: XIII Northern Shoshone. *Anthropological Records* 4(2). University of California Press, Berkeley

88. Steward, Julian H. 1943. Cultural Element Distributions: XXIII Northern and Gosiute Shoshoni. *Anthropological Records* 8(3). University of California Press, Berkeley.

89. Stewart, Omar C. 1941. Cultural Element Distributions: XIV Northern Paiute. *Anthropological Records* 4(3). University of California Press, Berkeley.

90. Stuart, Robert. *The discovery of the Oregon trail: Robert Stuart's narratives of his overland trip eastward from Astoria in 1812-1813*, edited by Philip Ashton Rollins. 1935. University of Nebraska Press.

91. Taylor, Tracy. 2009. State of Nevada division of water resources. Retrieved 1/11/2009. http://water.nv.gov/Engineering/Dams/Dam_results.cfm

92. Thomas, David Hurst, Lorann S.A. Pendleton, and Stephen C. Cappannari. 1986. Western Shoshone. In *Handbook of North American Indians, volume 11: Great Basin*, edited by W. L. D'Azevedo, pp. 262-283. Smithsonian Institution, Washington.

93. Thompson and West. 1881. History of Elko County. In *History of Nevada 1881, With Illustrations And Biographical Sketches Of Its Prominent Men And Pioneers* (chap. 43). Reprinted in *the nevada observer, Nevada's Online State News Journal*, Feb. 5, 2006. Retrieved 1/1/2009 http://www.nevadaobserver.com/History%20of%20Elko%20County%20(1881).htm

94. Thureau, G. 1879. *Synopsis of a Report on Mining in California and Nevada, USA*. Government Printer, Melbourne. Retrieved 2/28/2008. http://www.archive.org/details/synopsisofreport00thurrich

95. Timbisha Shoshone Tribe. 2003. History. Retrieved 11/12/2008. http://timbisha.org/history.htm http://timbisha.org/WSTreaty_1863_Map.jpg

96. Tingley, Joseph V. 1998. Mining districts of Nevada. Nevada Bureau of Mines and Geology Report 47. Retrieved 10/13/2008. http://www.nbmg.unr.edu/dox/r47/r47.pdf

97. Torrence, C.W. 1944. *History of Masonry in Nevada*. Retrieved 10/28/2008. http://www.nvmasons.org/history/torrence/torr21.html

98. Welcome to Jordan Valley. Retrieved 2/25/06. http://www.cityofjordanvalley.com/

99. Whitman, Narcissa. 1836. Journal of Narcissa Whitman: July 18, 1836 – Oct. 18, 1836. Retrieved 3/8/06. http://www.xmission.com/~drudy/mtman/html/NWhitmanJournal.html

100. Willow Creek Reservoir, Elko County, Nevada. *Elko County Rose Garden*. Retrieved 4/21/08. http://www.elkorose.com/willowcrk.html

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

102. Wren, Thomas. 1904. *A History of the State of Nevada: Its Resources and People*. The Lewis Publishing Company, New York, Chicago.

103. Wyeth, Nathaniel. The Journals of Captain Nathaniel J. Wyeth's Expeditions to the Oregon Country: First Expedition - 1832. Retrieved 2/7/06 http://www.xmission.com/~drudy/mtman/html/wyeth1.html

104. Young, James A. and B. Abbott Sparks. 2002. *Cattle in the Cold Desert*. University of Nevada Press, Reno & Las Vegas.

105. Smucker, Samuel M. 1856. *The life of Col. John Charles Fremont, and his narrative of explorations and adventures, in Kansas, Nebraska, Oregon and California: The memoir by Samuel M. Smucker*. Miller, Orton & Mulligan, New York & Auburn

106. Tingley, Joseph. 1998. Mining Districts of Nevada, second edition: modified from NBMG Map 43, 1995. Nevada Bureau of Mines and Geology. Retrieved 2/28/09. ftp://comstock.nbmg.unr.edu/pub/MD/Report47/plate.pdf

107. Daubenmire, Rexford. 1985. The western limits of the range of the American Bison. *Ecology* 66(2).

108. Idaho Bureau of Homeland Security. Putting down roots in earthquake country: Your handbook to earthquakes in Idaho. Accessed 5/14/2011. http://www.bhs.idaho.gov/Pages/PressRoom/Releases/Putting%20Down%20Roots%20in%20EQ%20Country.pdf

109. USGS. Historic earthquakes: Pleasant Valley, Nevada. Accessed 5/14/2011. http://earthquake.usgs.gov/earthquakes/states/events/1915_10_03.php

Upper Owyhee Watershed Assessment

V. Hydrology

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.

V. Hydrology

Hydrology is the study of how water moves within a system. Hydrology incorporates factors other than just precipitation, runoff into streams, and flows to the ocean. In addition to describing how water travels across the landscape, hydrology takes into account the source of the water and the fate of the water. The processes involved are described as the water cycle.

A. The water cycle

1. Description of parts of the water cycle

Precipitation is the water that falls out of the atmosphere and reaches the ground. The water can arrive at the earth's surface as rain, snow, hail, or a mixture of these. There are several things that can happen to precipitation.[25,45]

Interception occurs whenever anything interrupts the flow of precipitation into the soil or runoff to streams. This can happen when water flows into puddles or lands on vegetation or organic material. During freezing conditions, the precipitation may be "intercepted" on the surface of the ground; most of it doesn't go anywhere until it melts.[25,46]

Infiltration is the movement of water from the surface of the ground into the soil. The infiltration rate (how much water is absorbed into the soil) depends both on the composition, structure, and compaction of the soil and on the amount of moisture already in the soil.[25,45] Wet, frozen soil conditions greatly interfere with infiltration.

Percolation is the movement of water through the soil. Once underground, gravity is the primary force moving water. Impermeable layers of rock and the water table are the locations where the groundwater stops moving downward. If there are large natural underground reservoirs which can store the water, they are called aquifers.[25]

Runoff is the water that travels downslope on the soil surface towards streams. Runoff is made up of water that has fallen on the ground and has flowed across the surface and of water that has infiltrated or percolated into the soil and has moved horizontally to reappear on the surface. All the sources of water flowing in a stream channel form the total runoff which is called the streamflow.[25,45,50]

Transpiration is a plant's "sweating". Plants remove water from the soil. Water inside the plants exits the plants through pores in the leaves called "stomata". How much water is transpired depends on the species of plant, water in the soil, temperature, relative humidity, wind, and the amount of light it receives.[25,39,45]

Evaporation is a change in the physical state of water from a liquid to a gas. The gaseous water in the air is called water vapor. The amount of evaporation from the soil depends on soil moisture, wind, relative humidity, temperature, atmospheric pressure, and the amount of direct light (solar radiation).[25,46]

Condensation is the change in the physical state of water from a gaseous state to a liquid state. Condensation forms liquid water droplets on plant leaves and in the air when the air cools or the amount of vapor in the air increases to saturation point.[25,46]

Water is stored in three basic locations: in the atmosphere, on the surface of the earth, and in the ground. Storage on the surface is in lakes, reservoirs, glaciers, and the oceans. Underground storage is in the soil, in aquifers, and in small cracks in rock formations.[25,45]

2. Discussion

In general, the water cycle is described as evaporation off oceans, off other water bodies, and off soil and plants, adding moisture to the atmosphere. Atmospheric conditions cause the moisture to condense and fall as precipitation. Some of that precipitation is returned to the atmosphere by evaporation from water on vegetation, soil, rocks, roads, and buildings. Some of the precipitation is intercepted by plants, some is absorbed into the soil, and some of it flows into streams and rivers. The water in the soil can be returned to the atmosphere by evaporation, transpiration of plants, or it can percolate down to the groundwater. Also, some of the water in the streams and rivers can infiltrate into the soil and recharge the groundwater. In turn, the groundwater can resurface (springs) and contribute to the streamflow.[25,45]

There is no real beginning or end to the water cycle and no definite path that water follows. Water in the water cycle moves between the atmosphere, surface bodies of water, and the soil and rock underground.[25,46]

The different aspects of the water "cycle" affect the fate of water differently in different environments.

B. The water cycle in the upper Owyhee subbasin

The upper Owyhee subbasin is part of a semiarid desert created by the rainshadow of mountain ranges. To the west, the Cascade Mountains and the Sierra Nevada both receive much more rain and snow on their western sides. The prevailing wind direction moves air from the west to the east. Air cools as it rises to cross the mountains. As air cools, the water vapor in it condenses and falls as precipitation on the western side of the mountains. The water has been "wrung out" so little rain falls to the east.[25,26,45,49] Other mountains can also capture moisture if the air flow across them still contains sufficient moisture. The Calico, the Owyhee, the Independence, and the Bull Run Mountains around the boundaries of the basin all collect precipitation as the air crosses them. Some of the water captured by these surrounding mountains supplies flow into the rivers and streams of the upper Owyhee subbasin.

The majority of the upper Owyhee subbasin to the west of the Bull Run and Independence mountains can be classified as semiarid desert, specifically cold winter desert (background section). The winter temperatures in this semiarid desert section drop significantly so that most of the winter precipitation falls as snow.

1. Sources of primary precipitation data.

There are two primary sources of precipitation data for the upper Owyhee subbasin: weather stations and snow surveys. Traditional meteorological stations have measured temperature and precipitation. Snow surveys have been used to forecast annual streamflow volume. Beginning in the 1930s, snow surveys were conducted manually.

In the upper Owyhee subbasin, automated SNOpack TELemetry (SNOTEL) stations which record both temperature and precipitation were installed at seven sites and have continual records since 1980: Mud Flat, Fawn Creek, Laurel Draw, Jack Creek Upper, Jacks Peak, Big Bend, and Taylor Canyon (Figure 5.1).[20,21] The SNOTEL stations measure precipitation year-round, not only during the period of winter snow. Since these records cover the same years, they are comparable. The standard measurements at the SNOTEL stations are the snow depth, the snow water equivalent, air temperature, and precipitation from rain.

There are four meteorological stations within the upper Owyhee subbasin with more than 25 years of data: Tuscarora, Tuscarora Andrae Ranch, Mountain City, and Wild Horse Reservoir (Table 2.7). ***These stations have recorded data over different years and are not directly comparable either to each other or to the SNOTEL***

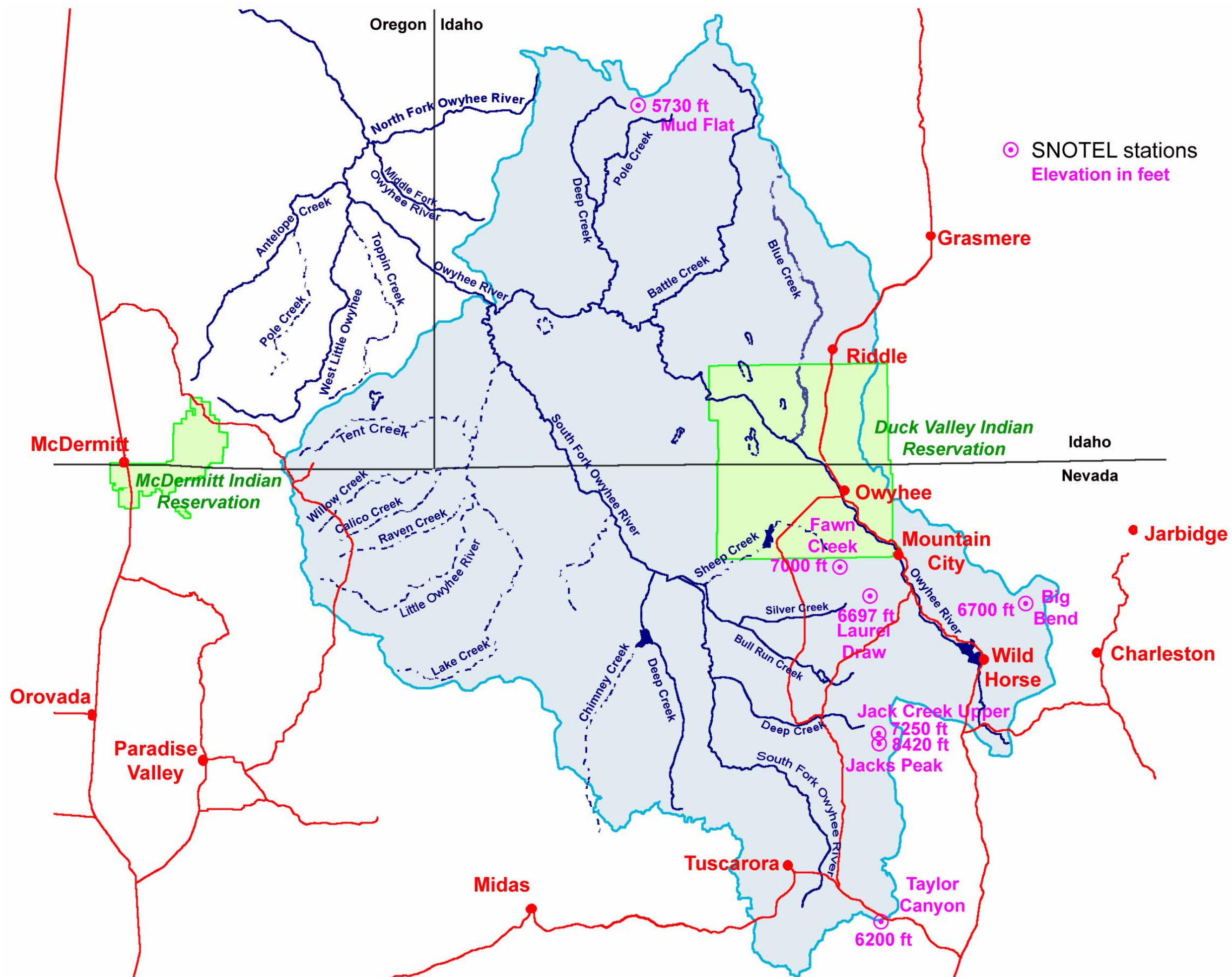

Figure 5.1. SNOTEL stations in the upper Owyhee subbasin.

records. However, the data from these stations give ideas of general conditions. In addition, the Owyhee station was included in some of the analyses of precipitation since it is within the geographical boundaries of the subbasin although it is located within the Duck Valley Indian Reservation (Figure 5.2). The temperatures recorded at these stations are discussed in the background section of this assessment.

2. Water cycle interactions

How does the water cycle operate within the upper Owyhee subbasin? The subbasin is at the headwaters of the Owyhee River, so the primary source of water in the subbasin is precipitation. Precipitation includes both the rainfall and the amount of water in snow.

a. Precipitation

To calculate the mean monthly precipitation, the daily precipitation readings are totaled for each month. Totals for a given month of the year (e.g. March) are averaged across the multiple years of readings to obtain the mean monthly precipitation for that month. This is done for each weather station and SNOTEL station. The water year is considered to start October 1 and end September 30.

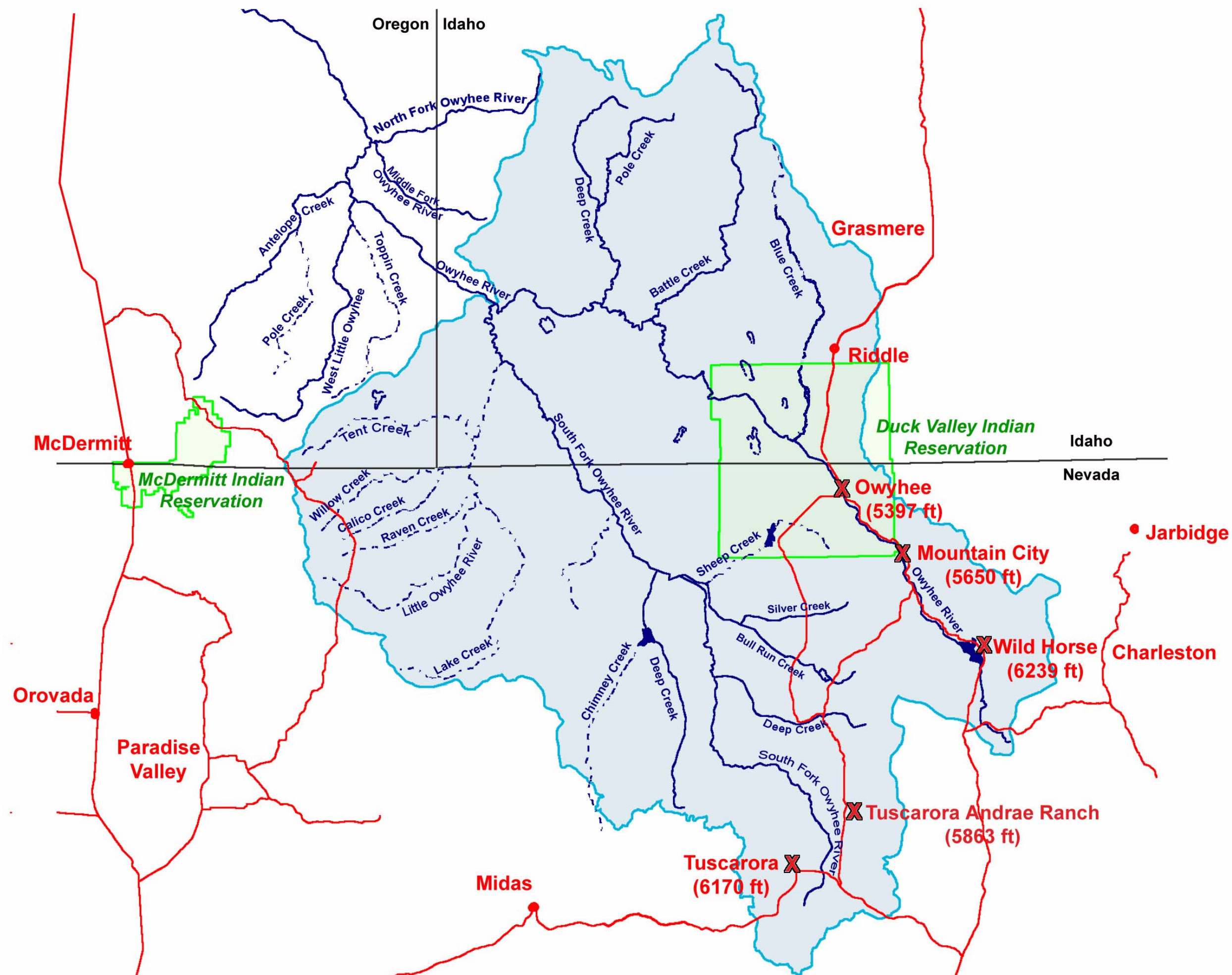

Figure 5.2. Locations and elevations of meteorological stations within the upper Owyhee subbasin.

The pattern of precipitation over the year has been similar between the five meteorological stations (Figure 5.3). July and August were the driest months, rainfall increased through December, dropped some in February (fewer days in the month) and peaked again in May. A similar pattern of precipitation is observed at the SNOTEL stations (Figure 5.4). However, these higher elevation stations receive greater precipitation. At the Jacks Peak station, the month with the greatest mean precipitation, January, averages close to five inches. Only the Taylor Canyon station has a mean precipitation in January less than two inches. The meteorological stations are at lower elevations. In no month did any meteorological station have a mean precipitation that reached two inches.

The total amount of precipitation which falls in a year varies significantly from year to year. These totals are based on the calendar year and span water years. On Figure 5.5, the total precipitation for a year is represented by a cross. The greatest yearly precipitation recorded and the least annual precipitation recorded are the highest and lowest marks for each station. Both the amount of precipitation and the year in which it fell are shown for the greatest and least precipitation at each station. Across all the SNOTEL stations, 1984 was the wettest year. The mean annual precipitation for each station is shown in the red box. This mean may not coincide with the amount of

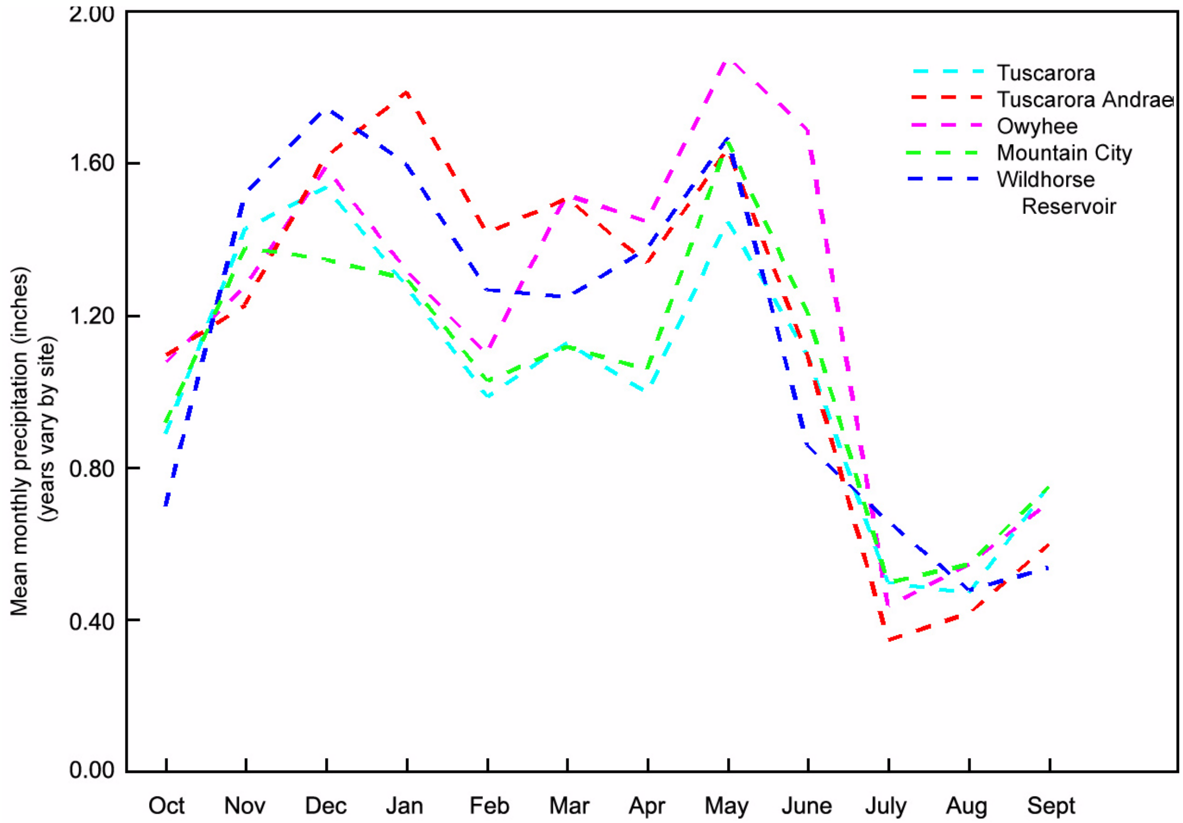

Figure 5.3. Mean monthly precipitation at five meteorological stations in the upper Owyhee subbasin.

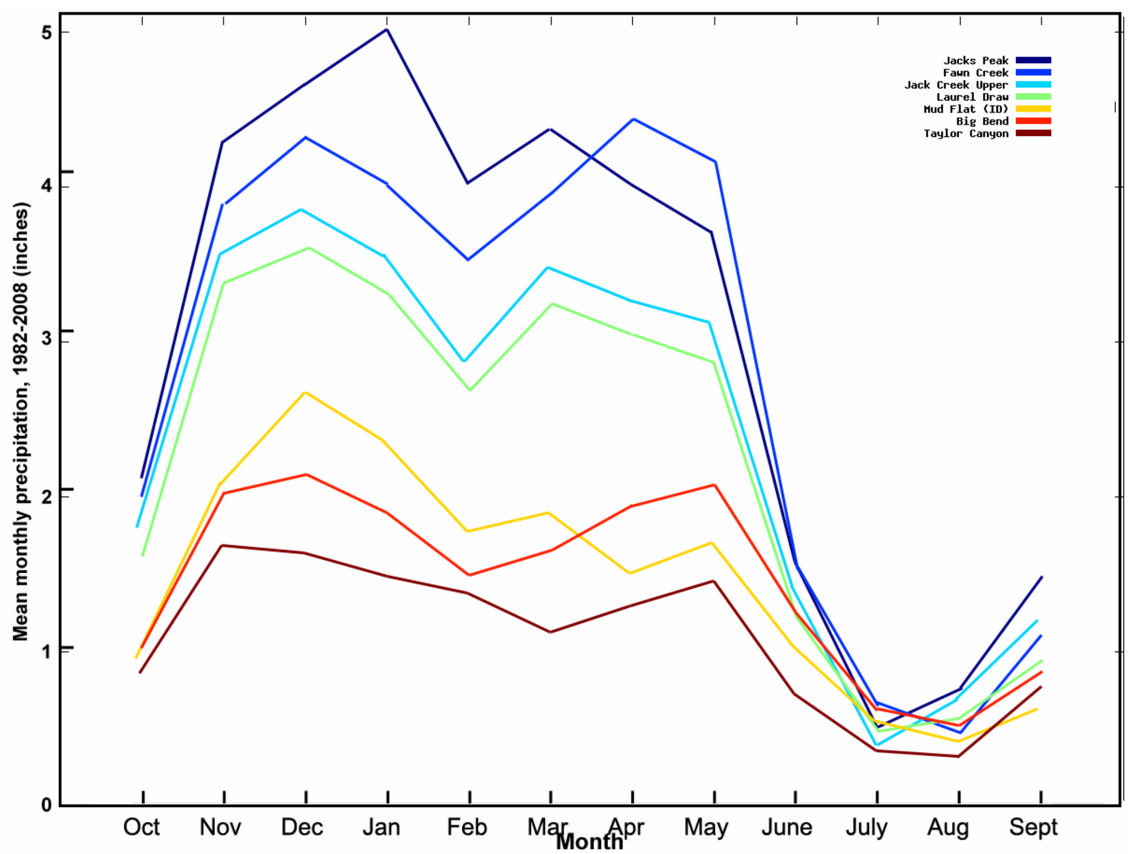

Figure 5.4. Mean monthly precipitation at 7 SNOTEL stations in the upper Owyhee subbasin.

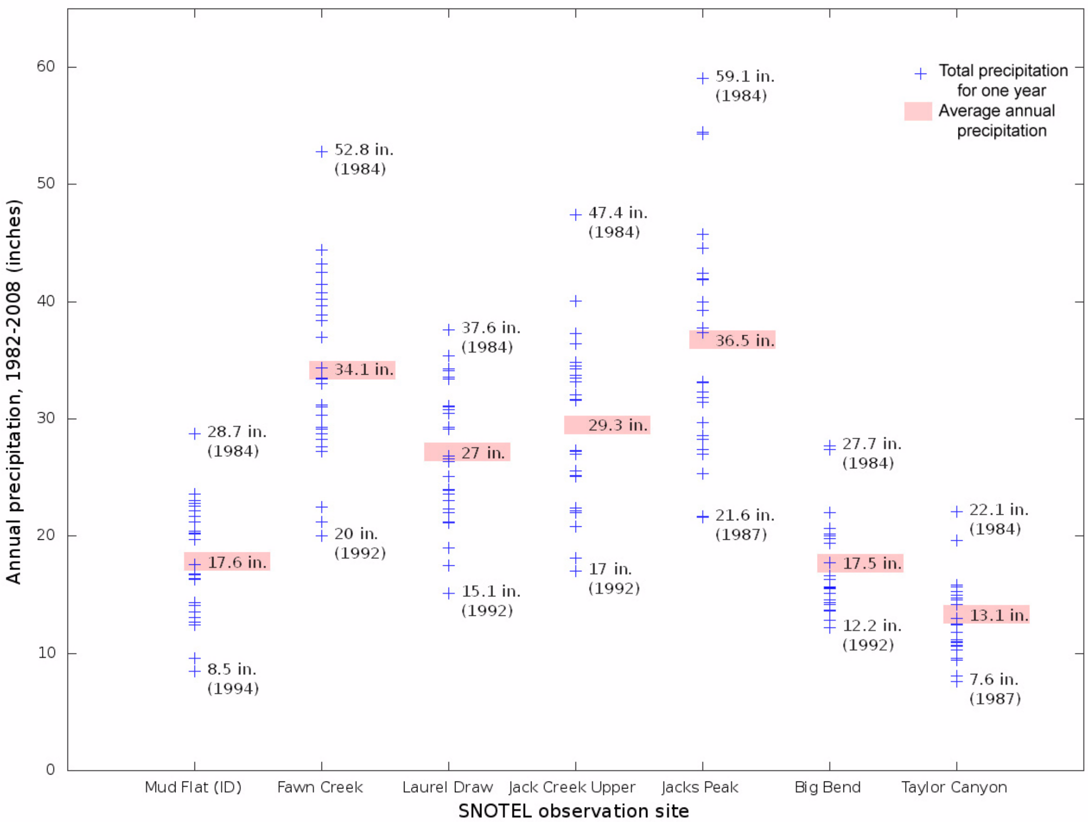

Figure 5.5. Total annual precipitation at 7 SNOTEL sites in the upper Owyhee subbasin

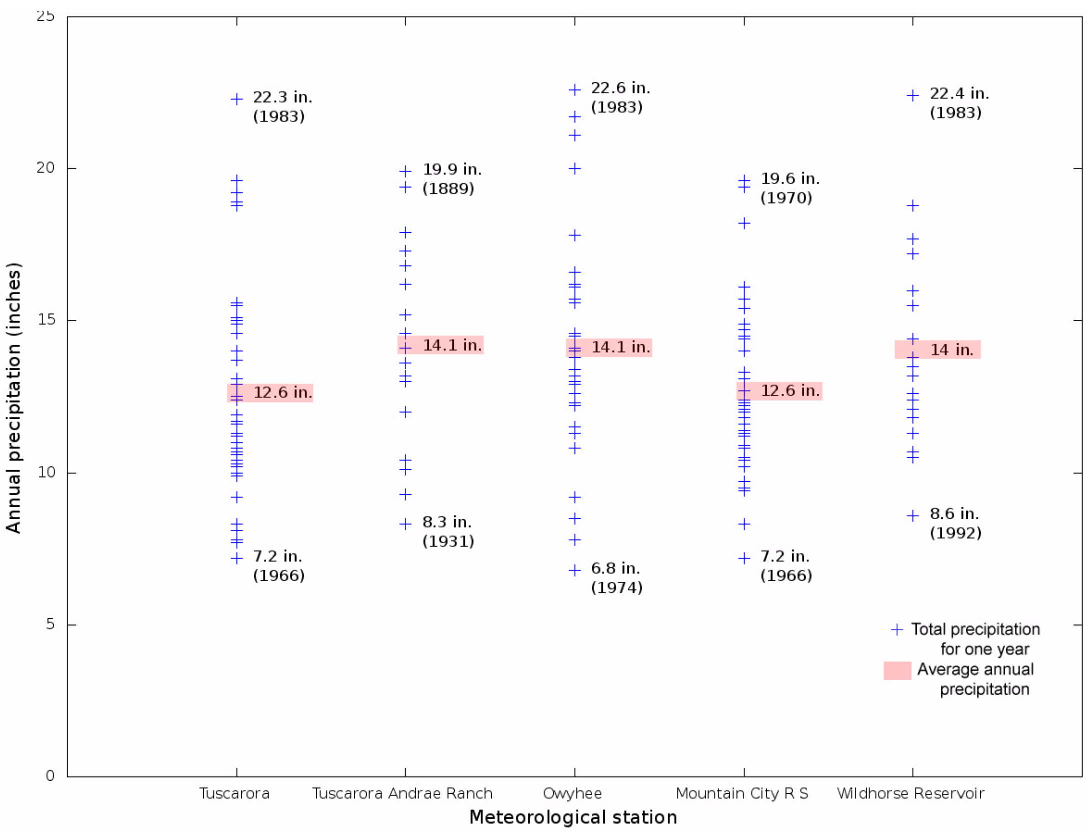

Figure 5.6. Total annual precipitation at 5 meteorological sites in the upper Owyhee subbasin.

precipitation in any one specific year, as is obvious for the Jack Creek Upper station. A similar graph for the five meteorological stations indicates that the mean annual precipitation was not directly related to elevation since the Owyhee station, at the lowest elevation, received the most precipitation (Figure 5.6). This information can only be taken as an indication since the five stations have data from different years.

The amount and the timing of precipitation affect what happens to the precipitation. As mentioned above, the rainfall at the stations within the upper Owyhee subbasin is not evenly distributed over the year (Figures 5.3 and 5.4). Although just two months apart, average precipitation in May is significantly more than in July, varying from 2.5 times as much at Wild Horse Reservoir to 7.7 times as much at Jack Creek Upper station (Figure 5.7).

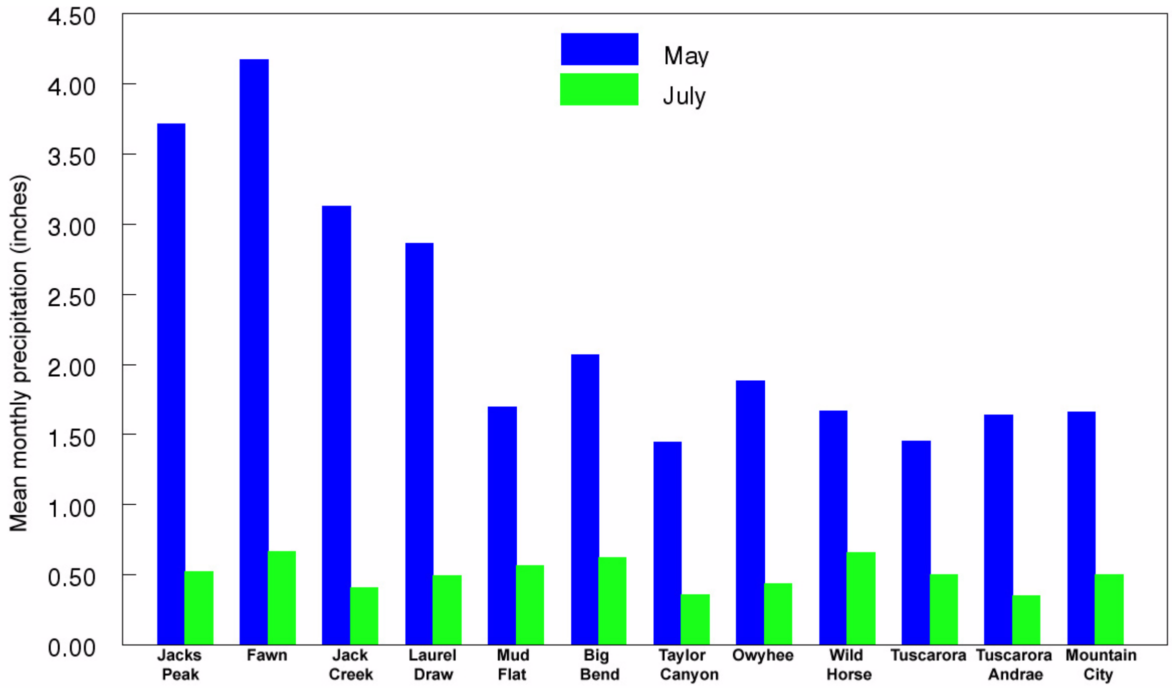

Figure 5.7. Rapid decline of precipitation from May, a wet month, to July, a dry month, at seven SNOTEL and five meteorological stations in the upper Owyhee subbasin.

b. Water budget

What happens to precipitation after it arrives on the land surface? After falling, precipitation is partitioned into four principal components: evapotranspiration, runoff, groundwater recharge, and the change in soil water. This "water budget" can be expressed as an equation where P = precipitation, ET = evapotranspiration, R = runoff, G = groundwater recharge, and ΔS = change in soil water.[50] Some rainfall is directly intercepted by plants and not included in the water budget.

$$P = ET + R + G + \Delta S$$

The specific figures for the percentages that each of these components contribute to the fate of precipitation in the upper Owyhee subbasin are not available, but there are some general principles for arid rangelands which apply to the unirrigated section of the upper Owyhee subbasin.

c. Runoff

Runoff is the water that flows toward stream channels. Some of the runoff may be evaporated en route or soak into the soils, but the runoff that reaches channels becomes the streamflow.[50] Although worldwide about a third of precipitation which falls on land runs off into streams and rivers,[44] runoff from rangelands is much lower. Rangeland "runoff generally accounts for less than 10%, and most often below 5%, of the annual water budget, and most of this occurs as flood flow."[50] Flood flow can result from snowmelt in the spring or large rain events at other times. Small runoff amounts are alsoimportant as they redistribute and concentrate the limited water resource.

There are a number of factors that help determine the proportion of a rainfall event that is lost to runoff. Some of the physical characteristics that affect runoff include soil permeability, soil moisture resulting from prior precipitation, soil cover, and topography. Some of the meteorological factors affecting runoff are the intensity, duration and amount of rainfall, and climatic conditions that affect evapotranspiration including temperature, wind, and relative humidity.[44] Possibly the intensity of the rainfall and the soil permeability and cover are the most important factors in determining runoff from a specific event. If soil is wet and frozen it has low permeability.

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

In the upper Owyhee subbasin, a large percentage of the runoff that does occur comes from snowmelt. Snow fields “act as natural reservoirs for many western United States water-supply systems, storing precipitation from the cool season, when most precipitation falls and forms snowpacks, until the warm season when most or all snowpacks melt and release water into rivers. . . water supplies in the western states are [largely] derived from snowmelt.”[42]

d. Evapotranspiration

Evapotranspiration is the sum of all the different processes by which water is changed from a liquid state to a gas. These include evaporation from the soil, evaporation of water that lands on plant or littered organic material surfaces (called interception loss), transpiration from plants, and sublimation.[39,50] Each of these processes is discussed separately below. Sublimation is the direct change of the state of matter from a solid to a gas (e.g. snow to water vapor) with no intermediate liquid stage.[43,46] Almost all the water from small, infrequent precipitation may be evaporated back into the atmosphere. With wind or heat, greater amounts of precipitation evaporate.[25,44]

i. Evaporation

Evaporation is a process by which liquid water is transformed back into water vapor. Evaporation can be from the soil surface or from precipitation that was intercepted. The rate of evaporation depends on a number of factors. Warmer water evaporates more quickly. Higher air temperatures increase the rate of evaporation. Drier air (lower relative humidity) above the soil surface has a greater "thirst" for water and more water evaporates into it. Wind across the soil surface increases the rate of evaporation. Sunlight directly hitting a surface increases the rate of evaporation.[5,8,11,25,48] A shaded stock trough may have 36% less evaporation than an unshaded trough.[48]

The amount of water evaporated depends on the amount of water present and on the rate of evaporation. In the upper Owyhee subbasin there are no measurements of the rate of evaporation. The closest evaporation pan is at a weather station in Elko Nevada. There is also an evaporation pan at the NOAA and AgriMet station at the Malheur Experiment station in Ontario, Oregon.[52,55] Evaporation pans measure how much evaporation occurs from a standing body of water and is indicative of the rate of evaporation. The total amount of water that can evaporate from the soil also depends on the amount of available moisture in the top layers of the soil.

Based on the climatic data from the two meteorological stations in the drier section of the upper Owyhee subbasin on the west side of the Independence Mountains, the temperatures for part of the year are relatively high. From May through September the average maximum temperatures at Tuscarora Andrae are, respectively, 63, 75, 86, 84, and 73 degrees Fahrenheit. At Tuscarora the average maximum temperatures for the same months are 63, 74, 85, 83, and 73 degrees Fahrenheit. By comparison, the maximum temperatures at the Elko airport are 70, 80, 91, 89, and 79, respectively from May through September. The five- to six-degree difference between Elko and the meteorological stations in the subbasin indicates that there would be some difference between the amount of evaporation expected due to the heat.

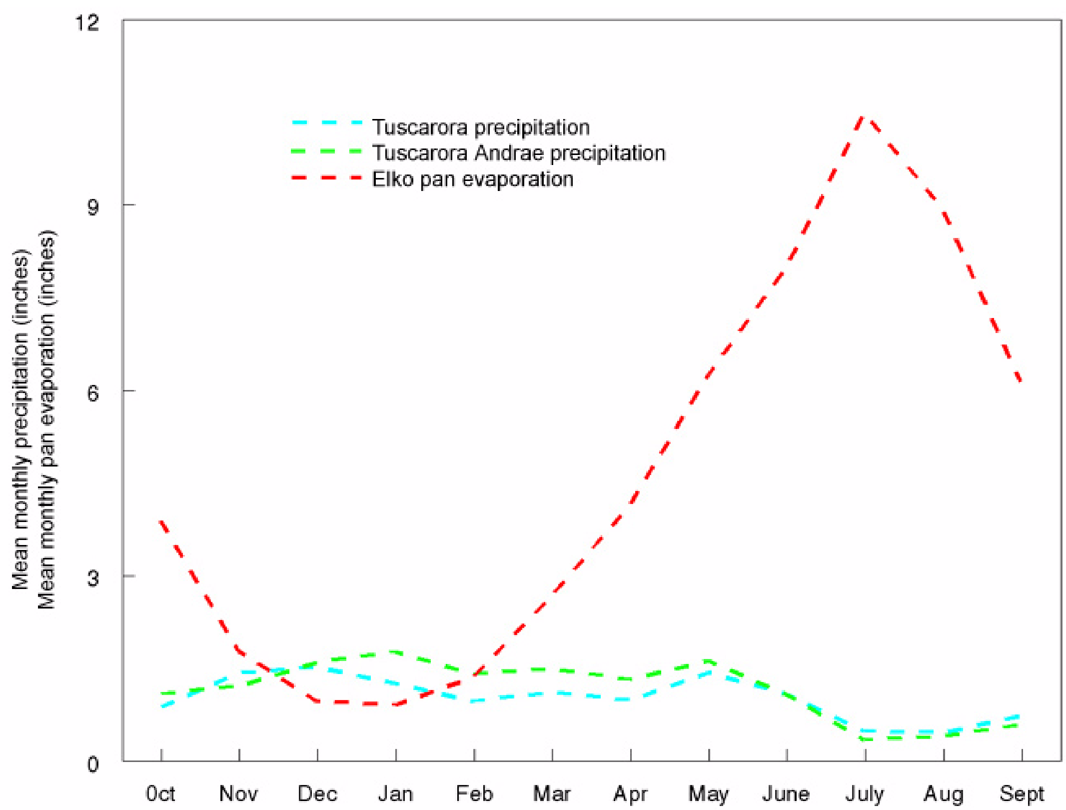

Figure 5.8. Mean monthly precipitation at Tuscarora and Tuscarora Andrae meteorological stations in the upper Owyhee subbasin compared to pan evaporation at Elko Nevada.

When the average monthly rainfall at Tuscarora over a 52-year period and at Tuscarora Andrae over a 68-year period are compared to the average amount of water which evaporated from a flat evaporation pan at Elko over a 108-year period, the rainfall is only a small portion of the water which could evaporate (Figure 5.8). Even assuming that the evaporation at Tuscarora and Tuscarora Andrae were less than at Elko, it would appear that the evaporative potential from April through October would be great enough to return most of the rainfall to the atmosphere. A larger rainfall event during these months might lead to some water infiltrating into the soil or running off, but a large portion of precipitation during these months could be expected to evaporate. These patterns are similar to the rainfall and evaporation patterns in the lower Owyhee subbasin.[56]

In rangelands, soil water evaporation generally accounts for 30 to 80 percent of the water budget. Soil water evaporation is often limited to the uppermost layers of the soil.[50] General estimates of soil water evaporation from mountainous areas of the western United States vary significantly. A seven year study in a semiarid region of New Mexico showed that evaporation from unvegetated ground ranged from 88 to 95%. The greater the slope of the ground, the higher the percentage of evaporation.[22]

ii. Interception loss

Precipitation which has been intercepted by leaves or other organic matter has a larger exposure to environmental conditions that might cause it to evaporate. Interception loss results when precipitation landing on organic matter evaporates and thus never reaches the soil surface. Drylands lose considerably more water, on a percentage basis, via interception than do more humid environments. Interception loss on rangelands may be substantial.[25,50]

The vegetative cover affects interception. In general arid shrublands have a smaller interception than a similar area with juniper cover. Juniper leaves and stems intercept a higher percentage of precipitation since they have a large leaf area all year long. They also create an organic carpet that intercepts considerable water. Measured interception, expressed as a percentage of precipitation, may be as high as 46% for juniper. For sagebrush the value ranges from 4 to 30%. The vegetative canopy in each area can only intercept so much water. For any specific storm, the percentage of precipitation intercepted varies greatly. Larger storm events have a smaller percentage of the water from that storm intercepted.[50]

Although figures for the percentage of precipitation intercepted by different types of canopy covers are available for other areas, interception data has not been collected in the upper Owyhee subbasin.

Not all precipitation that is intercepted is evaporated back into the atmosphere. Water on plants can be absorbed by plant tissues and can also drip off onto the surface beneath the plant or it can run down the leaf to the stem and from the stem to the ground.[28] The amount of precipitation that reaches the soil surface often depends on the total precipitation of a storm event as a strong rain will provide more opportunity for water to drip onto the soil surface than a light shower.

iii. Transpiration

In a desert environment transpiration contributes a smaller percentage to the total evapotranspiration than in less arid environments. Many arid region plants have developed adaptations that conserve water, allowing them to transpire at a slow rate when there is little available soil moisture.[25,39] Transpiration rates also vary depending on the temperature, humidity, and wind as mentioned above. The transpiration rate both goes up as the temperature increases and as the relative humidity falls. Both of these conditions are met during the upper Owyhee subbasin summer. However, as plants start to senesce (die), they transpire less.[39]

Vegetation not only transpires, it also shades the soil and reduces the wind speed. Both shade and lower wind speed slow down the evaporation from the soil surface. However, the water absorbed from the soil by the plant roots offsets any effects that the vegetation has in slowing evaporation from the soil. Transpiration not only contributes to the loss of soil moisture in the upper soil layers, but also from substantially greater depths if water is available since moisture from uptake by plant roots can reach the leaves and be transpired.[25,39,50]

iv. Sublimation

Since much of the precipitation in the upper Owyhee subbasin falls during the colder winter months, it may fall as snow. Even with freezing temperatures, the snow cover on the ground will gradually be reduced over time. This is sublimation. Ice (or snow) will go straight from a solid state to a vapor. Low relative humidity, dry winds, lower air pressure, and a higher sun angle increase the rate of sublimation. Sublimation is greater at higher altitudes since the air pressure is lower. The effect of the sun angle is only relevant on sunny days. At the start of winter, the sun angle is a minimum (the sun is lowest in the sky) and the angle is much higher in late winter so the rate of sublimation is apt to be much higher in late winter than in early winter.[9,43,46]

Many winter days in the upper Owyhee subbasin have low relative humidity and dry winds, favoring sublimation. The effect of sublimation may not be obvious if additional snow accumulates on the ground.

A common way for snow to disappear in the arid west is a "Chinook wind." If a warm wind (60-70^{0}F) with relative humidity less than 10% hits the snowpack, ice evaporates directly to vapor.[43] David Shirk recalls a Chinook wind in the region in about 1868. "When we retired the previous evening, there was fully twenty-four inches of snow covering the ground. At about eight o'clock, the Chinook wind began blowing, and in eight hours, not a particle of snow remained anywhere in the valley."[29]

Since the upper Owyhee subbasin snowpack supplies part of the spring runoff needed to fill Lake Owyhee, a Chinook wind could decrease the supply of water to the reservoir.

e. Infiltration

There are a number of factors that can affect water infiltration into the soil including precipitation, soil characteristics, soil saturation, land cover, slope of the land and evapotranspiration. The amount, intensity, duration, and form (rain, snow, etc.) of precipitation varies between precipitation events. There is variability across the landscape. More water will run off of sloped land, and more water infiltrates if the land is flat. No water infiltrates where there are impervious surfaces such as rocks or bentonite clay. Vegetation slows the movements of runoff and allows more time for water to seep into the soil.[15,28,41]

Soils with different soil textures and structures have differing infiltration rates and absorb more or less water. Some soils have greater degrees of water repellency. Fractures in the soil surface also affect the amount of water infiltrated. Infiltration slows as soil becomes wet; fully saturated soils can hold no more water.[15,28,41]

f. Groundwater recharge

The high evaporative demand in an arid climate means that eventually most water that has infiltrated and is stored in the soil will evaporate or be transpired. If there is further precipitation, it can cause the water to percolate down. Percolation also occurs due to the pull of gravity over time if the soil moisture is not lost to evapotranspiration. Groundwater recharge in rangelands is generally only a fraction of an inch per year. Soils with high permeability because they are sandy or fractured will have higher percolation and higher groundwater recharge.[25,50]

The movement of groundwater is controlled by gravity and geologic formations below the surface soil. Not only is groundwater replenished slowly, it tends to move very slowly. The water tables are generally formed above impermeable layers of rock or salt accumulations within the soil. Like all water, if it moves, it moves downhill. Water returns to the surface at a lower elevation than where it infiltrated. Some of the infiltrated water may travel close to the surface and soon emerge as discharge into streambeds. This water tends to move over duripans, layers of soil cemented by silica, iron oxides or calcium carbonate. Most of the discharges of groundwater into a stream occur where the water table intersects the ground surface. There may be a spring or slow seepage of the water into the stream. Seepage of groundwater into a stream forms the base flow for perennial streams.[25,27,40,45,46]

There has been no mapping of groundwater reserves or calculation of groundwater recharge for the upper Owyhee subbasin.[37,38]

The type and stability of water flow from a spring or seep is dependent upon the size and nature of the groundwater reservoir that feeds the spring. A spring fed by a deep aquifer will be more reliable and uniform. The water being produced by the spring can be from precipitation which fell hundreds or thousands of years ago. However, a spring which is dependent upon a local shallow water

Photo 5.1. Wilson Reservoir dam, Nevada

table for its recharge will have a more variable flow based upon precipitation, infiltration, and water use within the last few years. The predominance of water use by deep-rooted vegetation, such as big sage or juniper, will reduce flows to riparian areas and streams from shallow aquifers.[2,13,32]

g. Storage in dams

There are a number of impoundments in both Owyhee County, Idaho and Elko County, Nevada (Figure 5.9). In Idaho there are six larger reservoirs: Big Blue Reservoir on Blue Creek, Little Blue Reservoir on Little Blue Creek, Paine Creek Reservoir on Paine Creek, Juniper Basin Reservoir on Juniper Creek, Squaw Creek Reservoir on Squaw Creek, and Bybee Reservoir on Shoo-fly Creek.[24] In Nevada there are seven larger reservoirs: Wild Horse Reservoir on Owyhee River, Wilson Reservoir on Wilson Creek, Bull Run Reservoir and Rawhide Reservoir on Bull Run Creek, Desert Ranch Reservoir on Chimney Creek, Deep Creek Reservoir on Deep Creek, and Dry Creek Reservoir on Dry Creek (Appendix D).

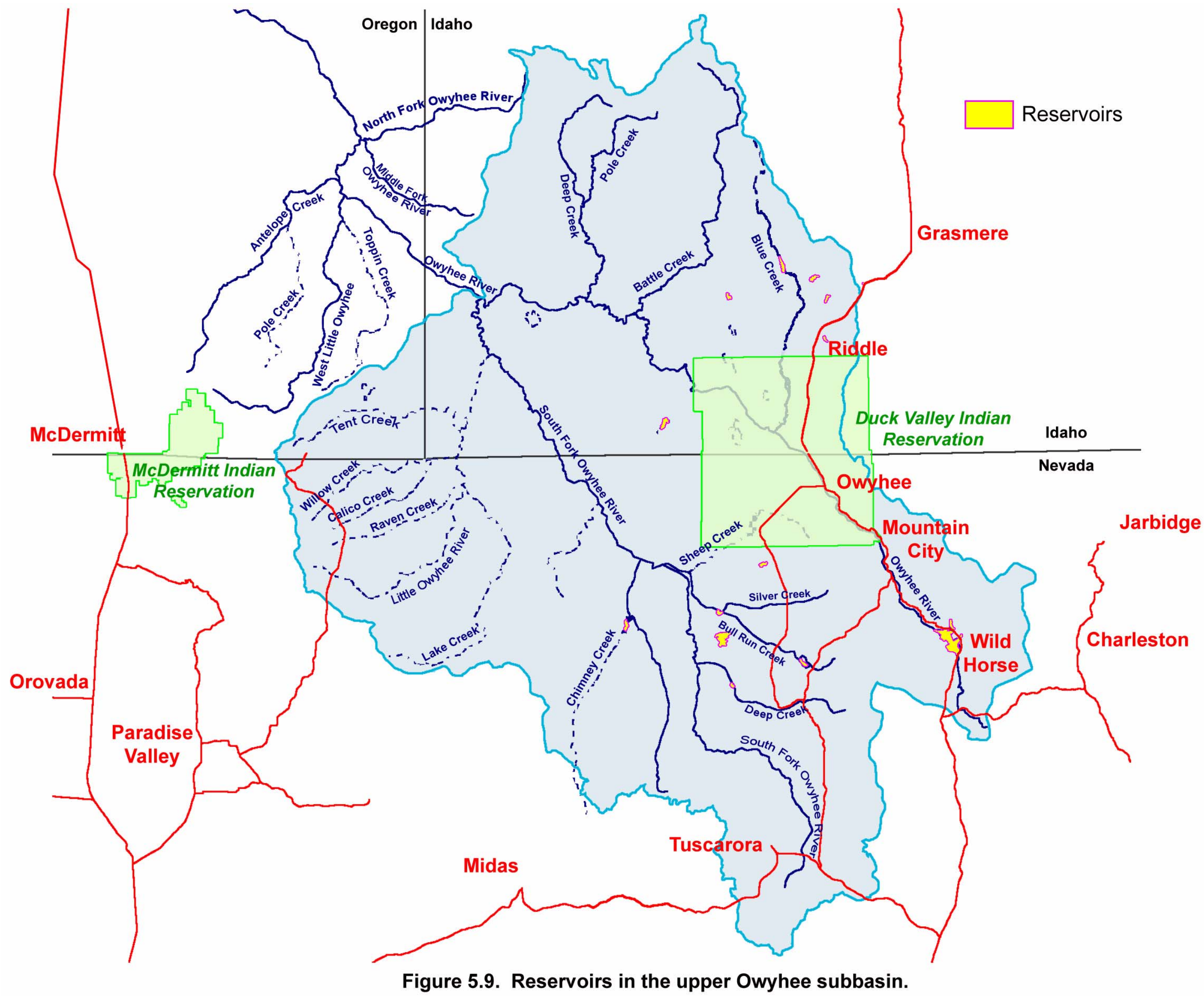

Figure 5.9. Reservoirs in the upper Owyhee subbasin.

Photo 5.2. Wild Horse (above) and Wilson (left) Reservoirs are the reservoirs that cover the largest surface areas in the upper Owyhee subbasin in Nevada.

There are several small dams as well as those mentioned above that have been built in the upper Owyhee subbasin to impound stream flows in small reservoirs or stock ponds. Dams create a different distribution of surface storage.[25] Dams on intermittent streams will increase the infiltration of water into the ground and reduce or eliminate the flow of water in the streambed. However, these ponds do not have the potential to impound much water. The guide for estimating the acres of drainage area required to average an acre-foot of pond storage shows that away from the base of the mountains, more than 80 acres are required on the plateau in the upper Owyhee subbasin.[33]

Beaver are also building dams on some of the small streams, generally streams less than 10 feet wide. Like dams created by people, beaver dams can provide a more stable water supply for wildlife. Water retention behind the dam can also increase infiltration into local water tables stabilizing the water supply for vegetation. By reducing the flow velocity following heavy rainfall, dams mitigate flow fluctuations in the stream bed below the dam. This reduces channel scouring, stream bank erosion, and

Photo 5.3. Beaver dams on Trail Creek in the Bull Run Mountains, Nevada.

downstream flooding. Dams also can form considerable sediment traps, reducing sediment loads in downstream water.[57,58,59]

h. Subbasin water balance

Within the relatively arid upper Owyhee subbasin, the water balance is determined by the fact that potential evapotranspiration is much greater than precipitation, creating a large soil water deficit. As a rule, evapotranspiration is the largest component of the loss side of the water balance equation, in comparison other components are generally quite small.[50]

C. Data for flow estimates

One of the primary concerns of the assessment of the hydrology of an area is identifying potential peak flows and low flows. Using data from the past, we can try to anticipate what might happen in the future.

Photo 5.4. Beaver dam on Current Creek along Mud Flat Road, Idaho

1. Precipitation

The precipitation that provides stream flow in the upper Owyhee subbasin comes from two principal sources. Snowfall, particularly in the higher elevations of the upper Owyhee subbasin, melts in the late winter and in the spring. This is supplemented by runoff from the rainfall events in winter and spring.

There is a very great variation in both the amount of precipitation and when it occurs. In one day, more rain can fall than would be expected for total rainfall for the whole month. Figure 5.10 compares the average total monthly rainfall to the recorded maximum one day rainfall at Tuscarora. Almost every station has had at least one single event where in one day more precipitation has fallen than the average amount for the month. A single large event, if the precipitation falls as rain, will result in runoff. Smaller back-to-back significant events will also result in runoff.

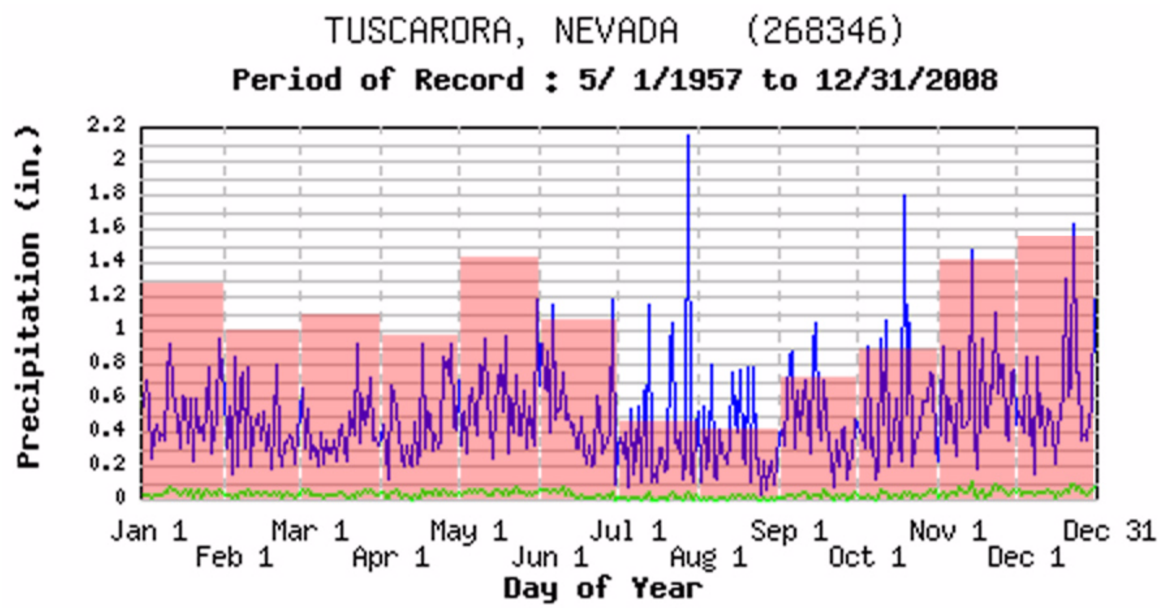

Figure 5.10. A comparison of the extreme precipitation on one day of the year (blue line) with the average for that date (green line) with the mean monthly precipitation (background shading).

When television weather forecasters predict rain for the following week, they give a probability of rain each day. "We can only make probabilistic statements because even if we have perfect knowledge of weather variables at some point in time, we cannot predict their values for some future time with certainty."[51] Figure 5.11 shows that there is a small probability of half an inch of rain (green line) falling at Tuscarora around

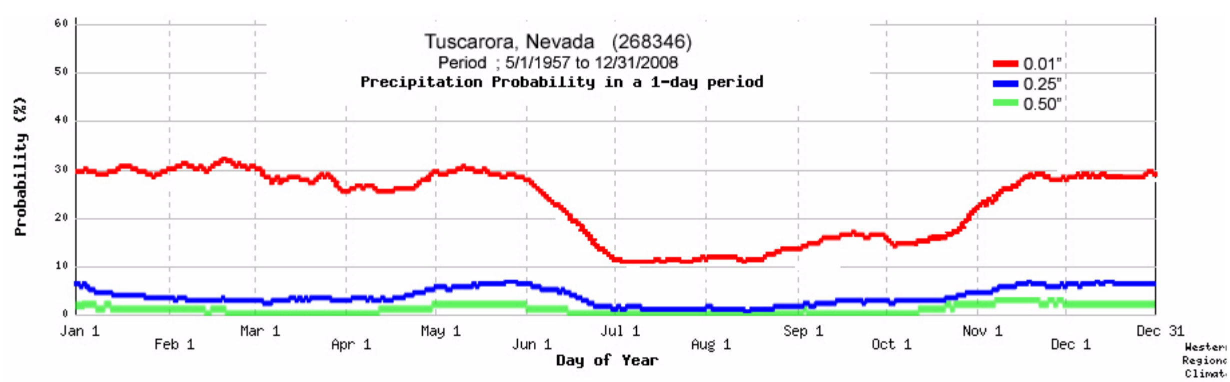

Figure 5.11. The probability of specific amounts of precipitation on a specific day of the year.

the first of June. However, there is the same small probability of half and inch of rain the next day and then the next day. The probability of it raining half an inch three days in a row is VERY small, but the possibility exists.

2. Streams with water

Although only a small percentage of the precipitation becomes runoff, the less probable large events are the ones which account for most of the runoff. During a large precipitation event or snow melt, there are many drainages in the upper Owyhee subbasin which can carry water (Figure 5.12). These drainage flow lines are ***not*** streams but the courses along which water would flow if there were water to flow in that region.

The previous condition of a stream can also affect the rate of runoff from that stream. The flatter the land, the more slowly water moves across it. Broad, flat valleys often have curving, sinuous stream channels in them. Over time the meandering

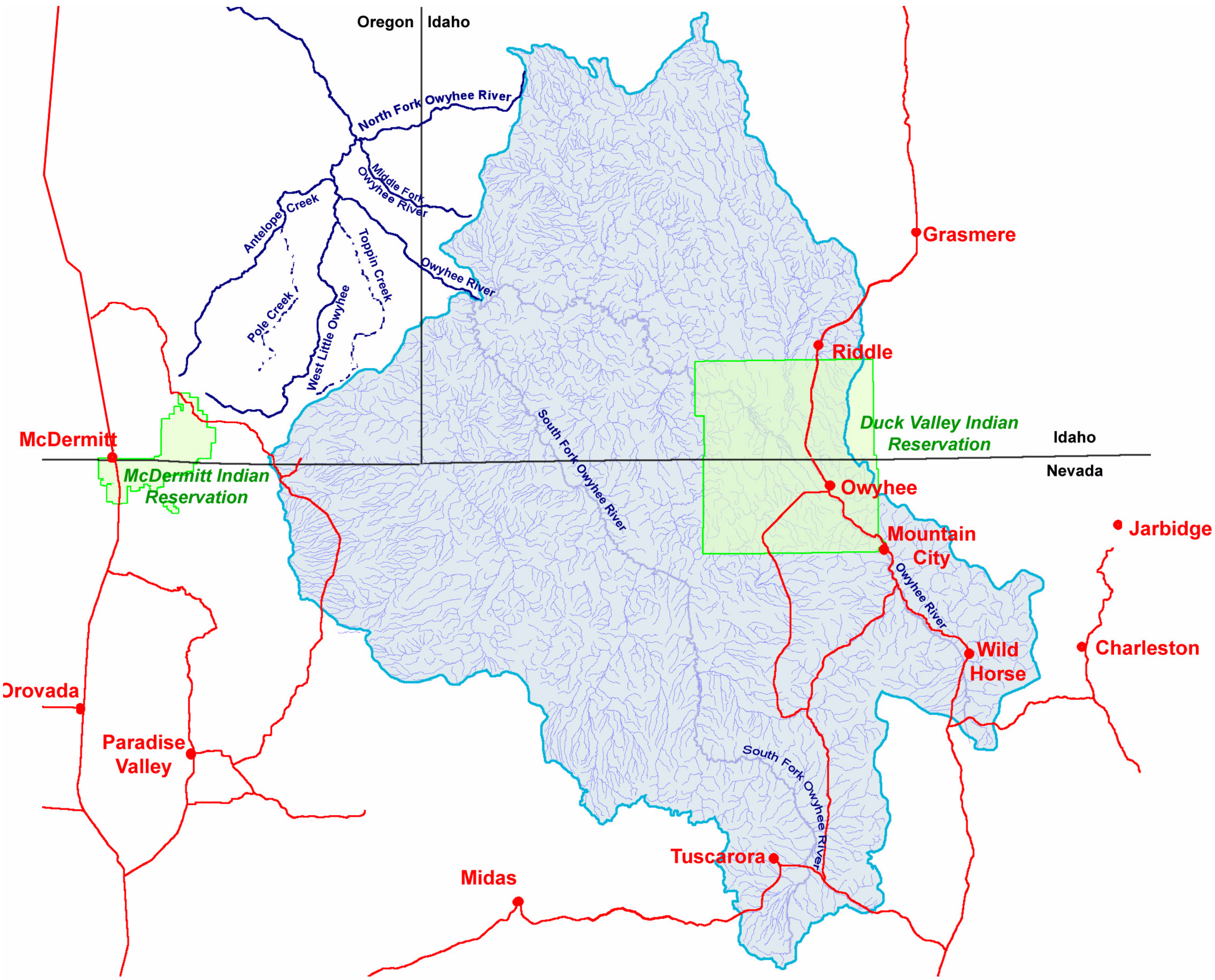

Figure 5.12. Water flow lines in the upper Owyhee subbasin.

stream reworks the entire valley floor. Sediment dropped by the stream continues to build a large flat valley. Large amounts of water entering a stretch of stream like this will spread out across the land and lose velocity. By contrast, once a stream has eroded down into the surrounding landscape, large flows will largely be contained within the stream course. Not losing velocity, they will continue to scour the channel and deliver more water downstream.[60]

Photo 5.5. Penrod Creek, a meandering stream east of Wild Horse Reservoir, Nevada

a. Perennial streams

In an arid region, there are very few streams that carry water all year, every year. USGS topographic maps distinguish between perennial streams, those that essentially flow year-round, and intermittent or ephemeral streams which flow for only part of the year.[23] These designations are not changed in map revisions unless the information has been verified on the ground.[35]

Photo 5.6. A stream which has started to cut down into the landscape, Nevada

The stream reaches in the upper Owyhee subbasin identified as perennial in the National Hydrography Dataset GIS coverage of the area are not numerous (Figure 5.13). A careful comparison with a selection of the USGS topographic maps that cover the upper Owyhee subbasin indicates only minor differences between the GIS coverage and the stretches which are identified as perennial on the USGS maps.[AppendixA]

Both the South Fork Owyhee River and the Owyhee River are perennial throughout their reaches in the upper Owyhee subbasin except near their upper reaches where they become intermittent (authors' observations). A number of the creeks draining into the South Fork Owyhee River from the Independence and Bull Run Mountains, such as Bull Run Creek, Deep Creek, and Jack Creek, are also perennial throughout their reaches. Blue Creek, Deep Creek, and Battle Creek draining into the Owyhee River from the north are also perennial.

The short distances of perennial tributaries which do not continue as perennial are typical of desert landscapes where runoff decreases over distance because of transmission losses in the alluvial stream channels.[50] There are no tributaries of the Little Owyhee River that are perennial for more than a short distance. The huge expanse of the upper Owyhee subbasin south of the South Fork Owyhee River and between the Owyhee River and the South Fork contains no perennial streams.

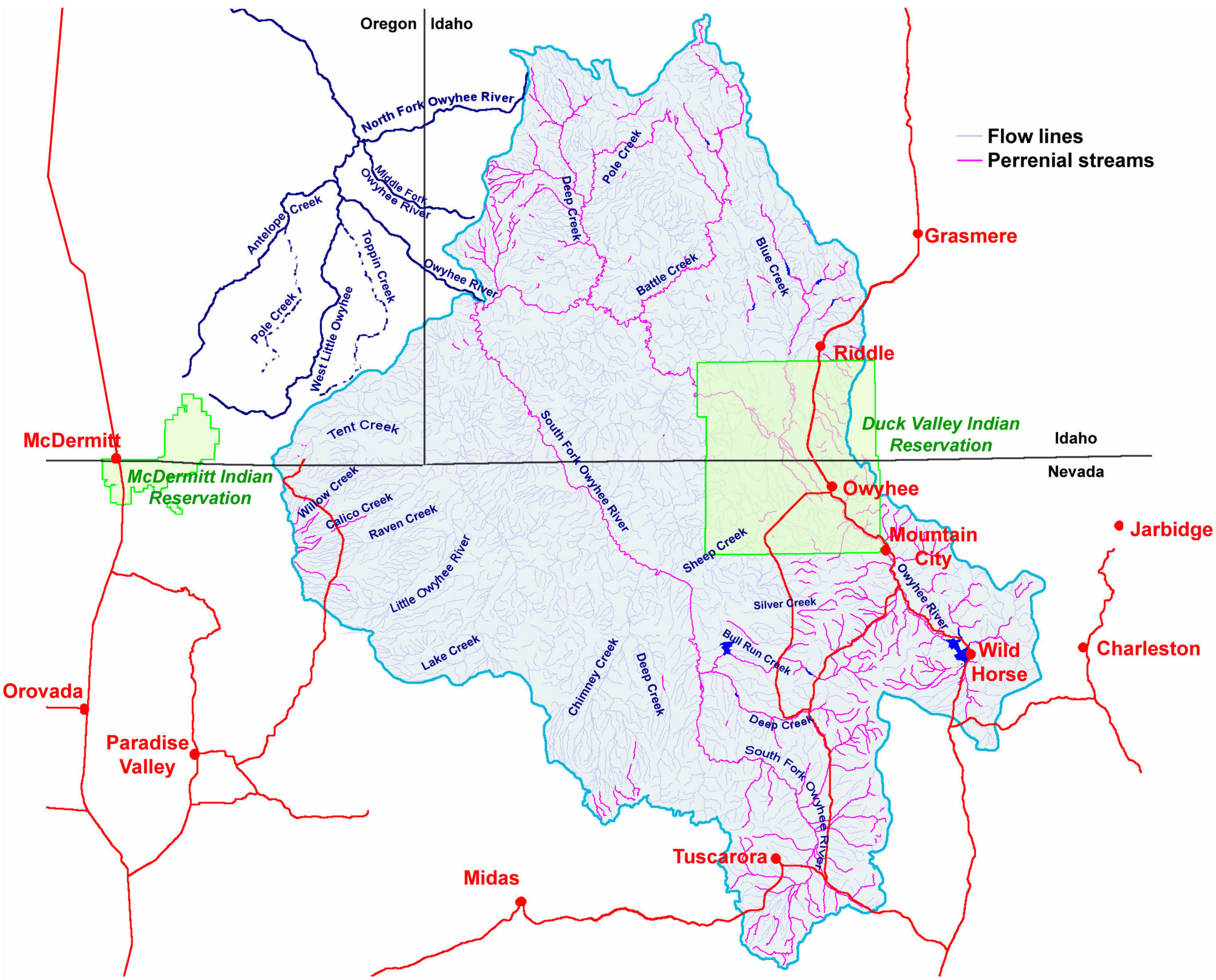

Figure 5.13. Perrenial streams only occur along a small proportion of the water flow lines in the upper Owyhee subbasin.

Photo 5.7. Near the upper end of the Owyhee River, Nevada

b. Intermittent and ephemeral streams

In the USGS guidelines for creating their topographic maps, intermittent streams were not distinguished from ephemeral streams. The guidelines say "Do not distinguish between Streams that contain water for only part of the year and Streams that contain water just after rainstorms and at snowmelt in arid or semiarid regions."[36] They further define a drainage as a stream if it flows out of a lake or pond, if it is 2,500 ft in length, or if it "contains water throughout the year, except for infrequent periods of severe drought and is in an arid region."[36]

For purposes of a watershed assessment it is very important to know which streams are intermittent and which streams are ephemeral. "Intermittent streams are those which flow for only certain times of the year, when they receive water from springs or runoff. . . . During dry years they may cease to flow entirely or they may be reduced to a series of separate pools."[7] Ephemeral streams have channels which are always above the water table. They only carry water during and immediately after rain, particularly storm events.[7,31] "Most of the streams in desert regions are intermittent or ephemeral"[7] as we observe in the upper Owyhee subbasin.

c. Classification of streams as ephemeral

Since the USGS maps do not distinguish between intermittent and ephemeral streams, ground survey is necessary to make a determination. This information is not available for most drainages in the upper Owyhee subbasin. How could the determination be made in the future? There are at least several lines of reasoning that could be used to classify streams as ephemeral.

Observation of streams for several years may show some streams to have water in them for many weeks each year independent of snow melt and runoff; they are probably connected to the groundwater and are intermittent. If streambeds are dry most years, they have no connection with groundwater and are ephemeral by definition. If water runs in streams only briefly in response to snow melt and very large precipitation events they are ephemeral.

Sagebrush dies when flooded. Stream channels that have sagebrush growing directly in the bottom of the wash are most likely ephemeral (Photo 5.9). Sagebrush does not tolerate saturated soil, and if the soil stays saturated for two weeks, sagebrush dies. Spreading water for two weeks on sagebrush land is a well known method of sagebrush control, since the root systems die from lack of aeration, but the method is little utilized in arid lands due to scarcity of water.[23]

Sampling of stream bed soils can show whether the soils have been subject to persistent water logging during at least part of the year. Soils subjected to water logging should develop some of the chemical and physical characteristics of hydric soils. Such a soil would indicate an intermittent stream.

Photo 5.8. Water course of an intermittent stream draining west from the Independence Mountains, Nevada.

3. Runoff

Because the other parts of the water balance equation account for the destination of much of the precipitation, it isn't possible to use the average amounts of precipitation to determine flood risk.

In streams, increased flows can be associated with winter rainstorms, winter rain-on-snow, snowmelt, spring rain-on-snow, and spring or summer cloudbursts or thunderstorms.[47] Snowmelt, the runoff produced by melting snow[14], will generally be more gradual if it isn't accompanied by rain-on-snow. When the ground is frozen, rain can cause snow to melt and run off without soaking into the ground. Rain hitting saturated ground will also flow overland.[44]

Each of the factors associated with increased flows can also increase the danger of "flash flooding" or other huge runoff events in intermittent streams. Ephemeral drainages which don't normally have flow are more apt to have runoff associated with unusual precipitation in a short amount of time. There has been no distinction made in the upper Owyhee subbasin between intermittent streams and ephemeral streams on maps or by ground truth.

During heavy rain events, water will tend to run in the established stream courses. As a liquid, water runs downhill. The path of least resistance is also the steepest gradient.[45] The steepest gradient funnels water into the established water courses of intermittent and ephemeral streams. In the beds of intermittent streams and

Photo 5.9. Sagebrush growing in the bottom of an ephemeral stream

in dry washes where the streambed flows only after significant rainfall, the sudden torrent of water from rains upstream may cause a flash flood.[31]

The typical condition for this ecoregion is that the maximum peak flow in each drainage is vastly greater than the average flows and average flows are much larger than the minimum flows, although data to support this fact have not been collected.

a. Snowmelt

i. Models

Models that predict water runoff from snow melt on a daily time scale are important in water resource management and flood hazard assessment. Different models such as HBV and Snowmelt Runoff Model (SRM) handle meltwater modeling differently. Decisions in the modeling include problems of complexity or simplicity, the inclusion of different types of measurements, and the way spatial variability of snow cover is incorporated.[1,6,18]

Forecasting the future of any system relying on weather is difficult. The SRM model is used for areas such as the upper Owyhee subbasin where snow melt makes a significant contribution to runoff into streams. The model requires both the daily mean air temperature and the extent of the snow. The daily mean air temperature is extrapolated for each elevation zone from one or more meteorological stations so the fewer the meteorological stations the less accurate the forecast. The extent of the snow depends on the area covered, the depth of the snow, and the water content of the snow. These data for the upper Owyhee subbasin are taken from the SNOTEL stations.[18] In evaluating the SRM model in one basin, Thomas et al[101] found that the main source of error of the runoff forecasts was the limited quality of the meteorological forecasts.

ii. Contribution of snowpack melt to spring runoff

A good way to visualize the contribution of snowmelt to streamflow in rivers is to look at the hydrograph (Figure 5.14), which shows daily mean streamflow (average streamflow for each day) for nine years for the South Fork Owyhee River at Spanish Ranch near Tuscarora, Nevada (USGS real-time streamflow data). The light pink bars highlight the readings in April, May, and June of each year. The large peaks in the chart are mainly the result of melting snow, although storms can contribute runoff also.

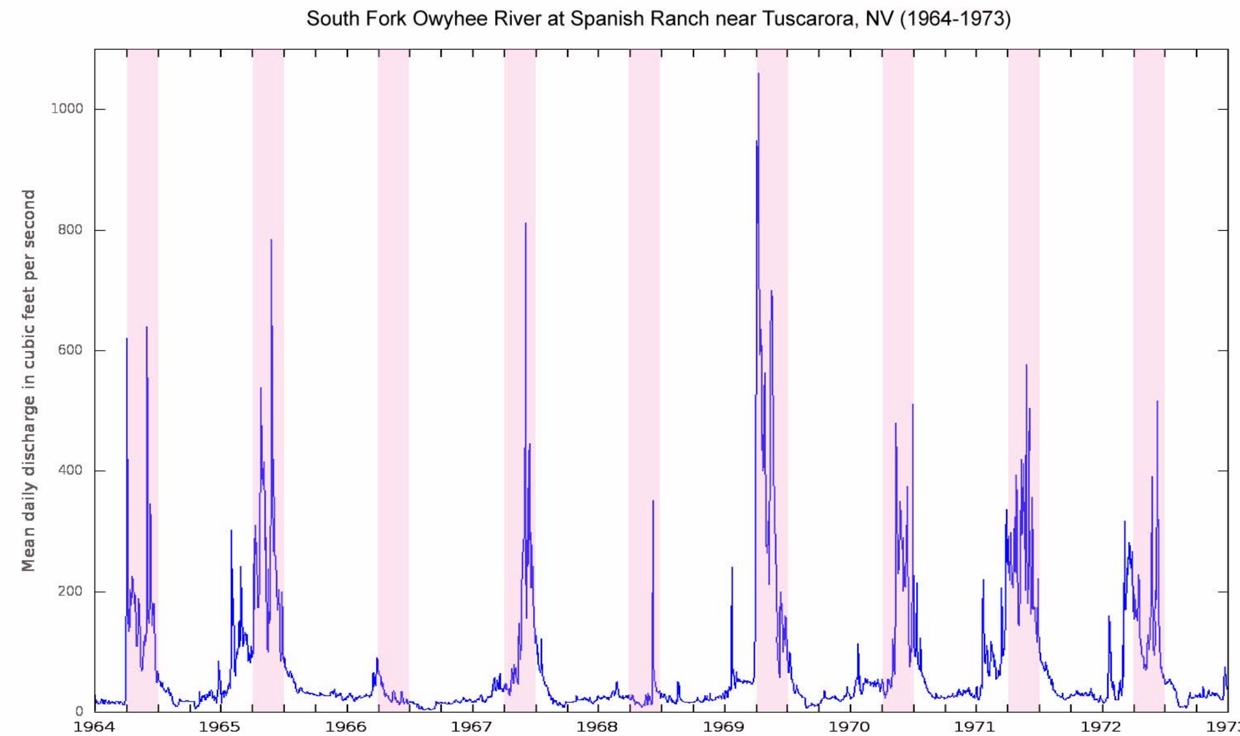

Figure 5.14. Daily mean streamflow from 1964 to 1973 at gage 13177200 on the South Fork in the upper Owyhee subbasin. The pink blocks are the months of April, May and June each year.

Note that runoff from snowmelt varies not only by season but also by year. Compare the high peaks of streamflows for the year 1969 with the much smaller streamflows for 1966. The lack of water stored as snowpack in the winter can affect the availability of water for the rest of the year. This can have an effect on the amount of water in reservoirs located downstream, which in turn can affect water available for irrigation or other downstream uses.[42]

Table 5.1. Sites of historic and current stream flow gages in the upper Owyhee subbasin.

Site Number	USGS Site Name	Years of data	
South Fork Owyhee			
13176600	TAYLOR CYN TRIB NR TUSCARORA, NV	1967-1979	Peak flow only
13176900	JACK CK BLW SCHOONOVER CK NR TUSCARORA, NV	1962 -1969	Peak flow to 1978
13177000	JACK CK NR TUSCARORA, NV	1913 -1925	
13177200	S FK OWYHEE RV AT SPANISH RANCH NR TUSCARORA, NV	1959 -1975	
13177800	S FK OWYHEE RV NR WHITEROCK, NV	1955 -1981	
Upper Owyhee			
13174500	OWYHEE RV NR GOLD CK, NV	1916 - 2009	
13174900	OWYHEE RV AT PATSVILLE, NV	1971 - 1975	
13175000	OWYHEE RV AT MOUNTAIN CITY, NV	1913 -1948	

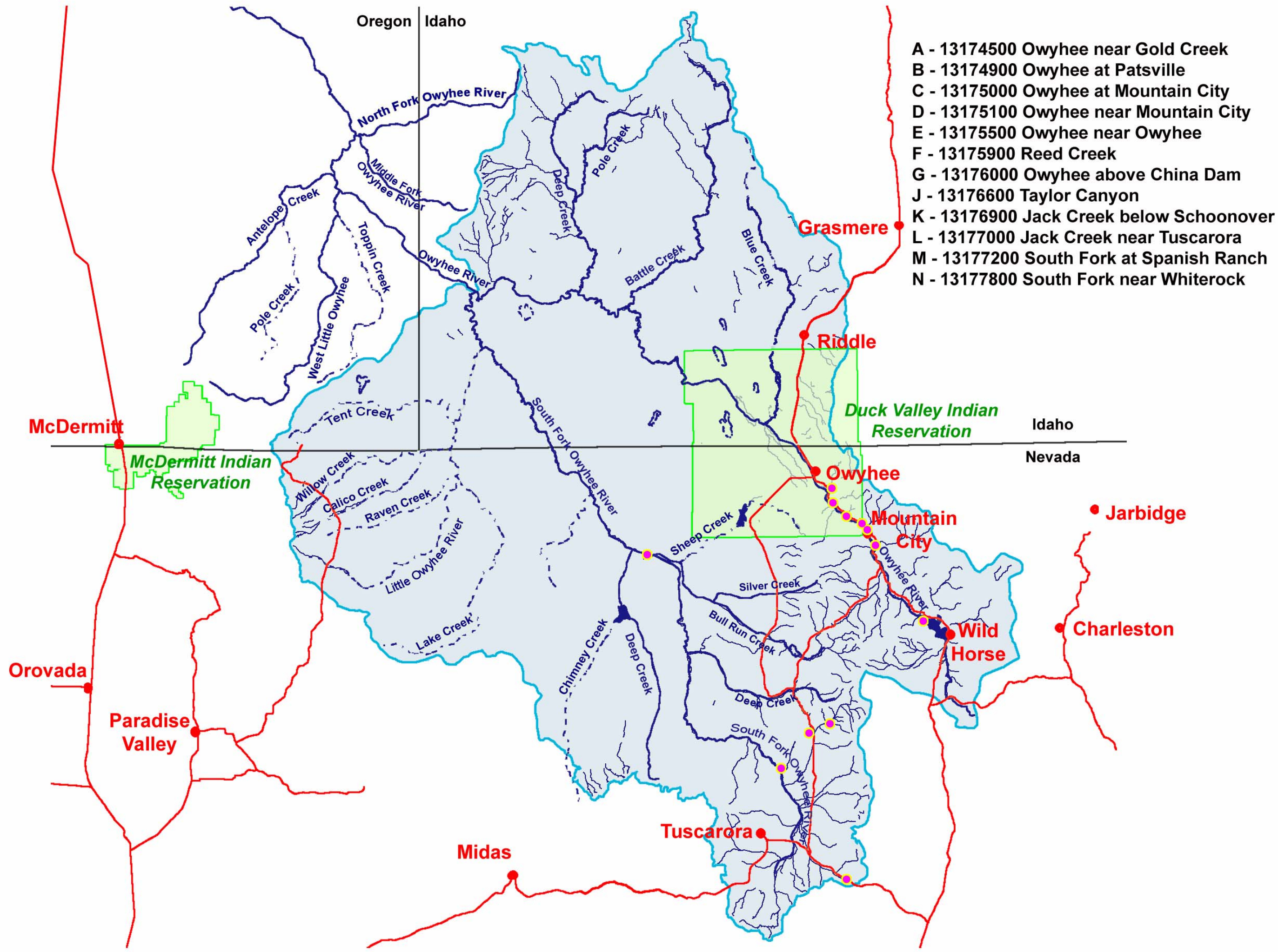

Figure 5.15. Location of historic and current stream gages in the upper Owyhee subbasin.

4. River flows

Due to the erratic nature of storm events, it is difficult to make any estimation of the flood danger in a particular intermittent or ephemeral stream bed. However, past records of flows in the Owyhee River can help estimate the probability of flood events along the river.

a. Sources of river flow data

Within the upper Owyhee subbasin the number of locations with stream gages is extremely limited. Information from seven USGS gages in the Upper Owyhee HUC and from five gages in the South Fork Owyhee HUC is accessible. Three of the gages in the South Fork Owyhee HUC and five of the gages in the Upper Owyhee HUC have at least ten years of data (Table 5.1, Figure 5.15).

The South Fork Owyhee River and the Owyhee River remain separate rivers until close to the Idaho-Oregon border, so flow in the two systems can be considered separately. The earliest of the gages in the South Fork Owyhee drainage began recording in 1913 on Jack Creek near Tuscarora. However, after it was abandoned in

1925 no other gages were installed until 1955. Currently there is no gage on the South Fork Owyhee. On the Owyhee River, gages began recording data in 1913 near Mountain City and Owyhee. The Mountain City gage continued recording until 1948 and overlapped with gages installed later at other points along the river.

In considering stream flows, a word of caution is needed. The data for each river is very limited both in the number of years data has been collected and the number of locations. There have never been gages downstream from the one abandoned in 1981 on the South Fork Owyhee near Whiterock. There are no gages in the upper Owyhee subbasin on the Owyhee River beyond the Duck Valley Indian Reservation. The first gage on the Owyhee River after it leaves the upper Owyhee subbasin is at Rome, Oregon, after the confluences with Middle Fork Owyhee River, North Fork Owyhee River, and Jordan Creek.

An assertion made in the *Digital Atlas of Idaho* that "the Owyhee River has an annual average discharge of 661,500 acre-feet of water at the Oregon/Idaho border"[12] has no source given and can not be substantiated from any of the USGS gage data. What can be substantiated is that the mean daily flow from 1950 to 2008 at Rome, Oregon, much farther downstream, is 932 cubic feet/second or 675,000 acre-feet per year. The flow at Rome includes substantial contributions from Jordan Creek, the Middle Fork Owyhee River and the North Fork Owyhee River.

It is possible, however, to look at probable general trends in the data.

b. Data

Figure 5.16 shows information from the gage at Jack Creek near Tuscarora. The central double line between the yellow and green colors shows the median daily discharge in cubic feet per second (ft^3/sec). Each day of the year the total flow for the day in cubic feet is averaged by the number of seconds in a day (86,400). This gives the mean daily flow (or discharge) per second. The median shows the daily discharge rate at which the mean daily discharge rate is exceeded for half of the years graphed and not exceeded for the other half. It indicates what the flow rate is on a given day in an "average" year.

The information is graphed on a logarithmic scale so that the information about the low flows is not lost due to a few extreme high flows. On a logarithmic scale the distance on the y axis from 0.1 to 1 is the same as from 1 to 10, which in turn is the same as from 10 to 100 and from 100 to 1000. Figure 5.17 shows a logarithmic scale with the multiples of 10 below. Each of these is split into the nine major intervening intervals with some of the interpretations of these intervals labeled above.

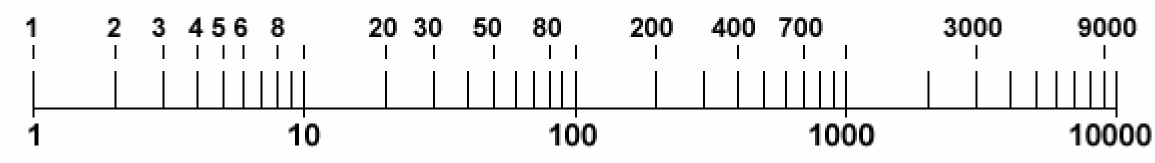

Figure 5.17. A logarithmic scale

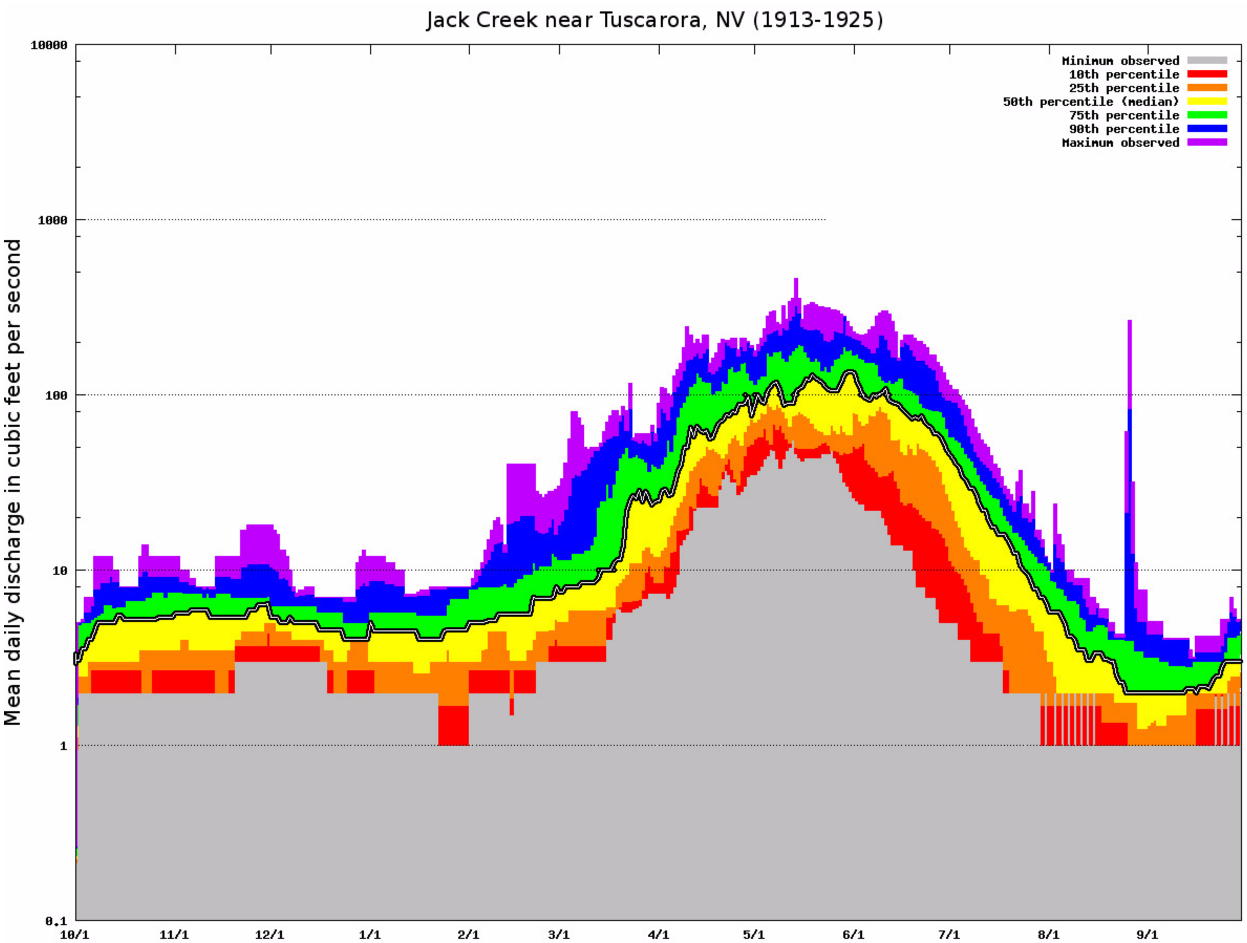

Figure 5.16. Observed distribution of the mean daily stream flow at USGS gage 13177000 in the upper Owyhee subbasin.

In addition to the median daily discharge shown by the border between the yellow and green sections, the distribution of daily means over the different years is shown by the differently colored sections. The top of the gray section is the minimum daily discharge on that date. At Jack Creek near Tuscarora (Figure 5.16), there were no years in which the flow was less than 1 ft^3/sec. The top of the purple section is the maximum daily discharge for that date. The median flows between the first of October and the first of March varied between 3 and 8 ft^3/sec. During March the median flows rose to 30 ft^3/sec. The greatest median flows, about 100 to 125 ft^3/sec occurred between the first of May and the middle of June. The flows dropped steadily so at the beginning of September the mean flow was close to 2 ft^3/sec. The unpredictability of flows is evidenced by one maximum flow near the end of August that is greater than the maximum mean flows for the year.

i. South Fork drainage

Gages shown on Figure 5.15 as K, Jack Creek below Schoonover Creek; L, Jack Creek near Tuscarora; M, South Fork Owyhee River at Spanish Ranch; and N, South Fork Owyhee River near Whiterock, are downstream from each other. Although the dates of record are not comparable, the change in flows may be indicative of general trends. On Figure 5.18 the flows at the gage farthest up the mountain on Jack Creek

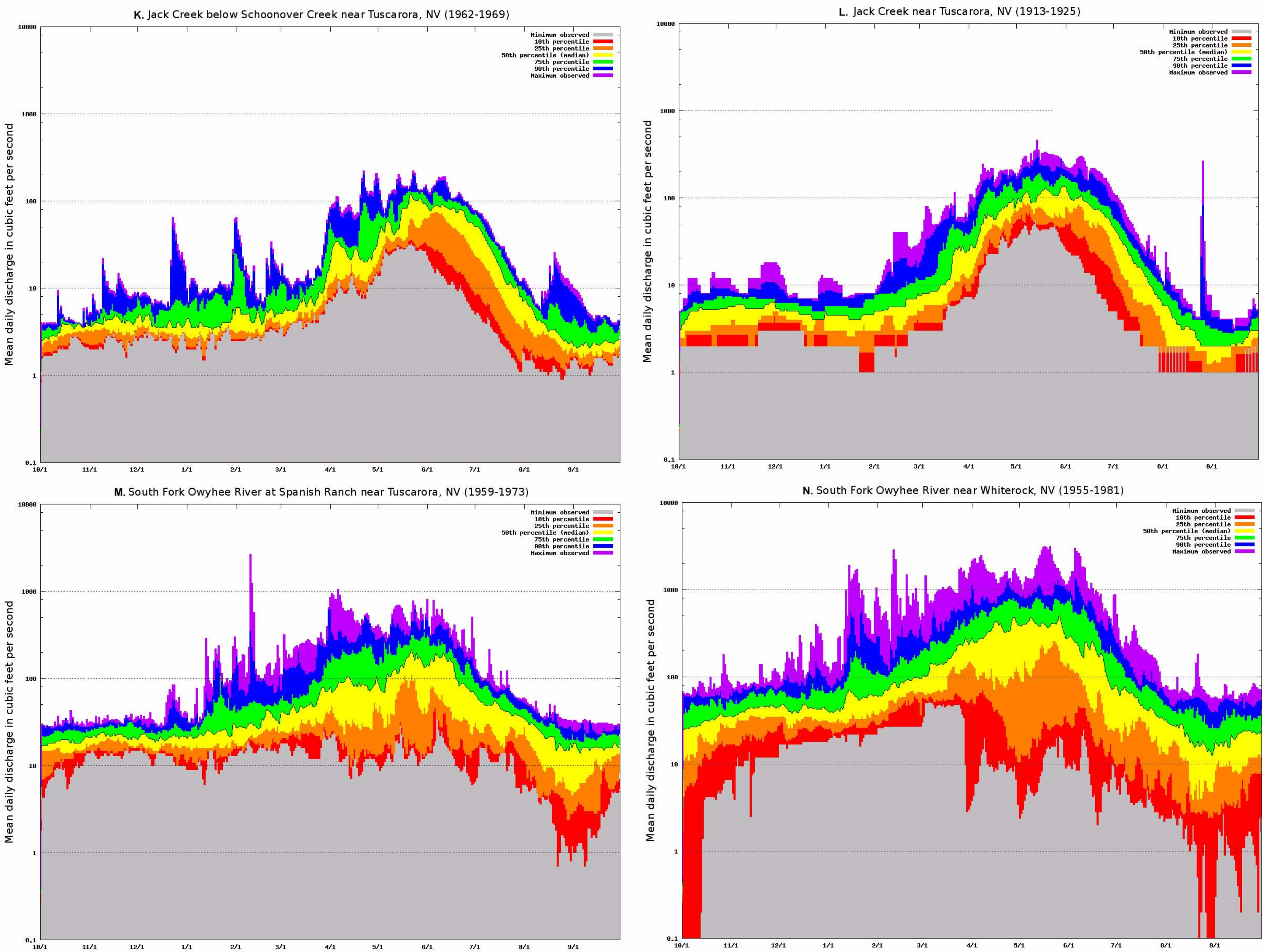

Figure 5.18. Observed distribution of the mean daily stream flows at sequential downstream gages in the South Fork drainage in the upper Owyhee subbasin.

tend to have the least fluctuation on any one date between the minimum flow observed and the maximum flow observed. The fluctuation between the minimum and maximum flows increases moving farther downstream. The median daily flow increases moving downstream past the gages, particularly during snowmelt during May and June from around 95 ft^3/sec at Jack Creek to close to 500 ft^3/sec near Whiterock.

The effect of the evaporative potential is shown by the gage near Whiterock. It is farther from the mountains out in the Owyhee uplands (on the Owyhee plateau). Where the bottom of the red band touches the x axis on the graph, the amount of flow in at least one year was less than 0.1 ft^3/sec. Since the next gage downstream is at Rome, there has been no data generated for the flows on the South Fork Owyhee River as it crosses the plateau. Between July and October, it is possible that there are years when even the South Fork Owyhee River has been at most a trickle.

ii. Owyhee River in Nevada

The gages on the Owyhee River in Nevada are even less comparable than those on the South Fork Owyhee River. The original Wild Horse Dam was completed in 1937[10] and changed the flows in the river. Only gage 1317550 near Owyhee recorded exclusively prior to the construction of the dam. Gages 13174500 near Gold Creek and 1317500 at Mountain City also began recording before the construction of the dam, but also continued recording after the construction. Gages 13175100 near Mountain City and 13176000 above China Diversion Dam both began recording after the construction of the dam.

Photo 5.10. Wild Horse Reservoir is impounded behind a double-curvature arch dam completed in 1969 to replace the original dam, Nevada

The gage on the Owyhee River near Gold Creek is currently just beyond Wild Horse Dam. The data from this gage show the radical change in the hydrology just below the dam (Figure 5.19). Before the river was impounded, the flows in late July and August were the lowest, but never fell below 1 ft^3/sec. As flows out of the dam were controlled following the construction of the dam, the river below the dam frequently fell below 0.1 ft^3/sec, including more than half the time between early February and early

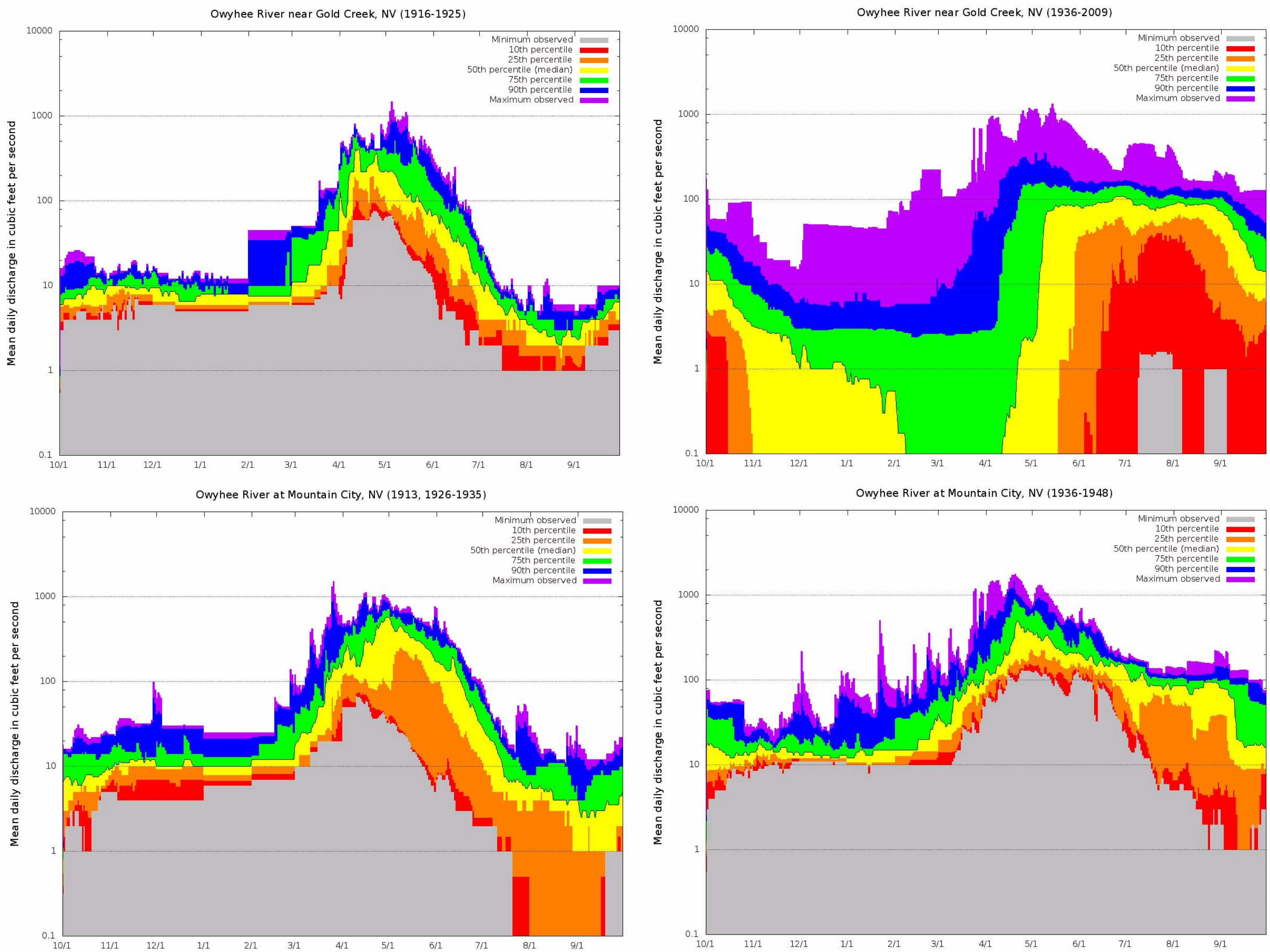

Figure 5.19. Observed distribution of the mean daily stream flow at two stream gages on the Owyhee River before (on left) and after (on right) the construction of Wildhorse Reservoir.

April. The fluctuations in the flow between years were also much greater than before the construction of the dam.

Farther downstream at Mountain City, the flows after the dam construction fluctuated less between years than before the construction. Following impoundment, the flows did not decrease as much between May and September as prior to impoundment. The supply of water from the dam during the growing season has been more constant, mostly in excess of 10 ft^3/sec.

iii. Snowmelt

Although the gages on the South Fork Owyhee River and Owyhee River have measured the flow generated by snowmelt in the Bull Run and Independence Mountains, Jay Chamberlin of the Owyhee Irrigation District estimates that the snow that accumulates on Mud Flat provides, on average, 35 to 40 percent of the water that eventually flows into the Owyhee Reservoir. Only one of the SNOTEL stations, Mud Flat, is in this area (Figure 5.1).

Photo 5.11. Water being released from Wild Horse Reservoir into the Owyhee River, Nevada

When the irrigation district flies the snow fields to look at their extent, the plane roughly circles from the Mud Flat SNOTEL station along Blue Creek to Riddle, back along the Owyhee River to the Idaho-Oregon border, and north along the western edge of the upper Owyhee subbasin.[54]

Semiarid mountain watersheds have both complex topography and vegetation that is not all of the same kind or nature. These cause the distribution and melting of seasonal snow cover to vary greatly in both space and time. The effect of topography, wind, and vegetative cover on climate conditions, snow deposition, and snow melt for these regions is not well understood.[16] Even though an estimate of the amount of snow and possible snow melt is made, the amount of water delivered to the river is also dependent on when and how quickly the snow melts. If the ground is frozen, melting snow will not soak into the ground but will flow into the Owyhee River. However, if the surface of the ground is no longer frozen when the snow melts, the soil usually absorbs a large portion of the water.

c. Flood risk

The information needed to accurately assess flood risk in any year in the upper Owyhee subbasin is not being collected. Flooding in the upper Owyhee subbasin on the Nevada side has not been a priority in the state's hazard mitigation plan,[30,34] possibly due to the sparse population in the subbasin. However, the National Weather Service does keep track of the gage height and flood stage at Wild Horse Reservoir and at Mountain City.[19]

On the Idaho side, the state's hazard mitigation plan identifies the Owyhee River as one of those "presenting the most significant flood risks."[14]

> "Flooding has produced the worst disasters in Idaho . . . The three types of flooding experienced in Idaho are riverine flooding, flash floods, and ice/debris jam flooding. Riverine flooding is generally associated with winter storms and spring runoff and produces the largest scale events. Flash flooding is associated with extreme precipitation and runoff events, insufficient infrastructure, and dam failures. Although typically limited in extent, flash floods are considered the most dangerous to human lives. Ice jam floods are associated with extreme winter cold events while debris jams may result from landslides or human activities."[14]

Annually the potential for flash floods exists throughout the upper Owyhee subbasin. When the ground is saturated and cannot hold much more water, the conditions are ideal for flash floods with further rain.[4] In addition, thunderstorms that are "slow-moving and strong . . . can produce heavy rain conditions and possible flooding."[17] "Predicting where the flooding might occur is difficult" so a flash flood watch is issued. If the watch turns into a flood warning, flooding has already occurred.[4]

The potential contribution of the upper Owyhee subbasin to flooding downstream can be visualized by comparing the earlier graph of snowmelt contribution to river flows (Figure 5.14) to a graph which includes a few prior years (Figure 5.20). In 1962 the mean daily streamflow on February 10 was 2,680 ft^3/sec followed by a streamflow of 1,250 ft^3/sec on February 11. This was a rain event that caused historic flooding in southeastern Idaho when earthen impoundments broke. The peak flow was over two times as great as the maximum mean daily streamflow in 1969. These flows may eventually combine with other flows to present a greater flooding danger downstream. In the lower Owyhee subbasin the Owyhee Reservoir has 100,000 acre feet of capacity assigned to flood control, however flood control is informal and advisory only. A "minimum of 70,000 acre-feet of space is maintained in Owyhee Reservoir through February and more space is maintained beginning in January if the inflow forecast is large."[3]

Real-time data to reliably forecast the contribution of the upper Owyhee subbasin to the flow into Owyhee Reservoir does not exist.

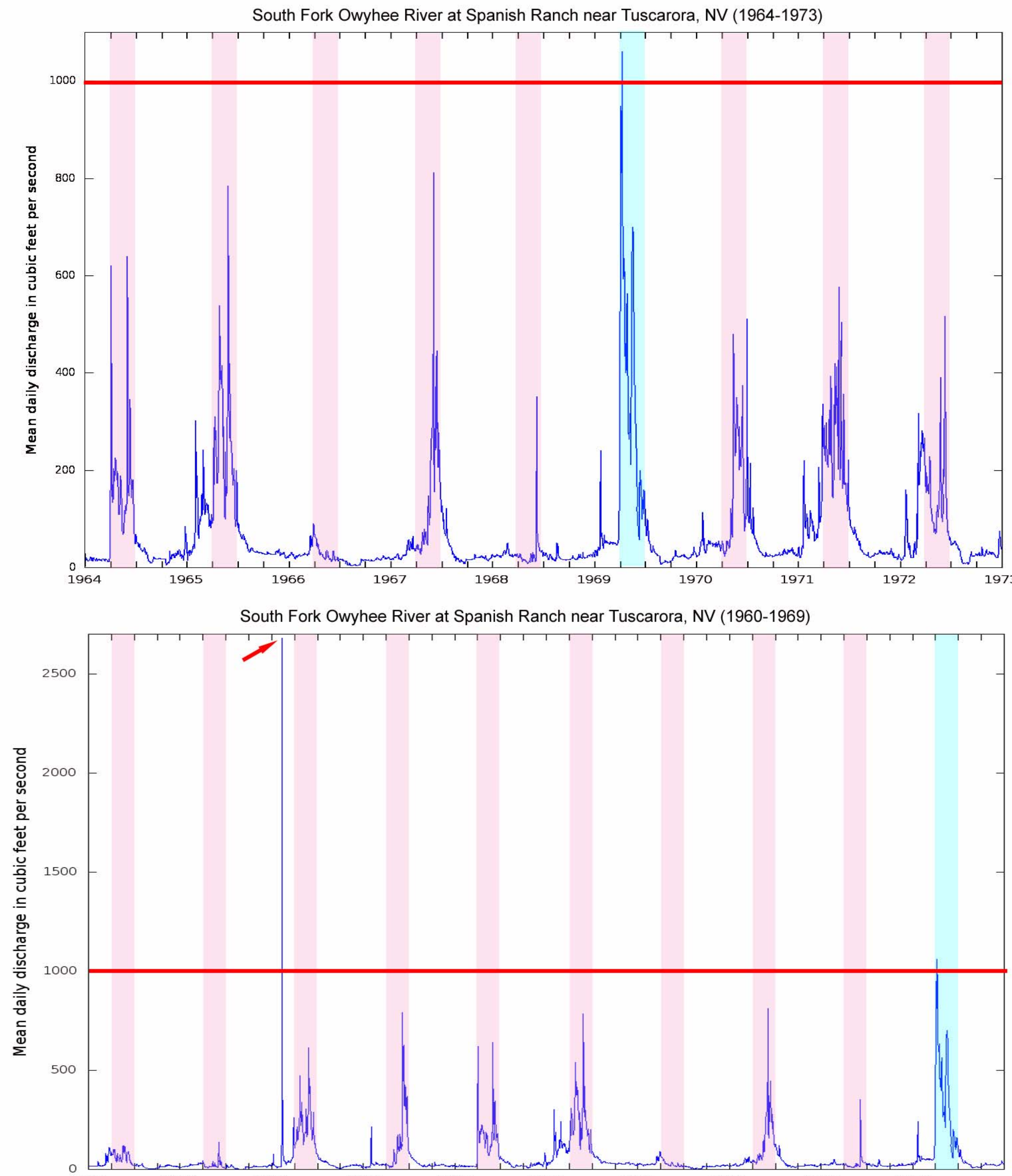

Figure 5.20. Daily mean streamflow from 1960 to 1969 at gage 13177200 on the South Fork in the upper Owyhee subbasin compared to streamflow from 1964 to 1973. The turquoise block highlights the identical information in 1969.

D. Land use effect on flows

Since most of the upper Owyhee subbasin is in rangeland, the management of the rangeland could have a significant effect on the flows, particularly on the flows of intermittent and ephemeral streams. Part of the impetus behind the passage of the Taylor Grazing Act was the condition of the rangelands in the western states. Overgrazing up to 1934 had led to areas where there were few plants left to stem the flow of water across the ground surface or secure the soil; rainfall events resulted in small eroded rivulets leading to the drainage channels. The continued erosive flow in these rivulets led to deeper scars in the landscape. Controlled grazing has eliminated most of this problem, as further discussed in the rangeland section of this assessment.

Many roads across the landscape consist of only two tire tracks. These tracks tend to interrupt the normal flow of water across the landscape; water that is running across the landscape concentrates in the tracks and is delivered downstream. In general no features are planned or built to remove water at relatively short intervals from the two-track roads. Consequently these two-track roads concentrate water and provide the volume and acceleration of runoff that subjects the land to soil loss.

All terrain vehicles can denude and compact the soil, leaving many paths for accelerated water runoff.

In the upper Owyhee subbasin, human activities are not responsible for the peak flows and their potential destructive force. The construction and management of dams, stock ponds, and small reservoirs tend to mitigate peak flows.

E. Data gaps

There are data missing for the upper Owyhee subbasin that are frequently available for other hydrologic basins. There are has been no mapping of groundwater aquifers, there are no data for water infiltration rates, and key variables for hydrology are generally unavailable. The mapping of vegetative coverage is basic.

There has been no ground verification of which streams are ephemeral, intermittent or perennial. The three types of streams can not be looked at in the same fashion when considering if any remediation is feasible. Rainfall estimates model rainfall between the sparse SNOTEL and meteorological stations in the subbasin and stations surrounding them. The sparsity of these stations means these precipitation models have limited accuracy and give little idea of any local conditions that differ. Models of snowmelt also rely on sketchy data.

Bibliography

1. Arheimer, Berit. 2006. The HBV model. Retrieved 7/9/2009. http://www.smhi.se/sgn0106/if/hydrologi/hbv.htm
2. Baker, Malchus. 1984. Changes in streamflow in a herbicide-treated pinyon-juniper watershed in Arizona. *Water Resources Research* 20:1639-1642.
3. Bureau of Reclamation, US Dept of the Interior. 2009. Owyhee project. Accessed 7/11/2009. http://www.usbr.gov/projects/Project.jsp?proj_Name=Owyhee%20Project
4. Evans, Scott. 2009. Creeks and rivers rise causing concern about flash flooding. Accessed 7/11/2009. *KTVB.com: Idaho News Now*. http://www.ktvb.com/news/localnews/stories/ktvbn-jun1309-flash_flood_concerns.79be85f3.html

5. Evaporation. 2000. *Encyclopedia of the Atmospheric Environment*. Accessed 7/4/2006. Http://www.ace.mmu.ac.uk/eae/Weather/Older/Evaporation.html.
6. Ferguson, R.I. 1999. Snowmelt runoff models. *Progress in Physical Geography* 23:2 pp. 205-227. Retrieved 6/21/2009. http://ppg.sagepub.com/cgi/content/abstract/23/2/205
7. Gordon, Nancy D., Thomas A. McMahon, and Brian L. Finlayson. 1992. *Stream Hydrology: An Introduction for Ecologists*. John Wiley & Sons, Chichester, New York, Brisbane, Toronto, Singapore.
8. Haby, Jeff. Rate of Evaporation. Accessed 7/4/2006. http://www.weatherprediction.com/habyhints2/470/.
9. Haby, Jeff. Solar intensity and snow sublimation. Accessed 7/4/2006. http://www.weatherprediction.com/habyhints2/369/.
10. Hall, Shawn. 1998. *Old Heart of Nevada: Ghosts Towns and Mining Camps of Elko County*. University of Nevada Press, Reno/Las Vegas, Nevada.
11. Hammond, Philo F. and Roy Goslin. 1933. The effect of humidity upon the rate of evaporation. *Ecology* 14:4. (Oct. 1933), pp.411-413
12. Harvey, Jacqueline. 1999. Owyhee River, Bruneau River Drainages, and Minor Tributaries - South Fork of Snake River. Retrieved 1/8/2009. http://imnh.isu.edu/digitalatlas/geog/fishery/drainage/drain21.htm
13. Hibbert, Alden. 1983. Water yield improvement potential by vegetation management on western rangelands. *Water Resources Bulletin* 19:375-381.
14. Idaho Bureau of Homeland Security. 2007. *Hazard Mitigation Program*. Retrieved 7/12/2009. http://bhs.idaho.gov/Resources/PDF/SHMPFinalw-signatures.pdf
15. Logsdon, Sally D. 2003. Soils, water infiltration and. In B.A. Stewart and Terry A. Howell, eds. *Encyclopedia of Water Science*. Marcel Dekker, Inc., New York and Basel. pp. 930-933.
16. Marks, Danny and Adam Winstral. 2001. Comparison of snow deposition, the snow cover energy balance, and snowmelt at two sites in a semiarid mountain basin. *Journal of Hydrometeorology* 2:3 pp 213-227.
17. Meyer, Jon. 2009. Rain prompts flood warning. *Idaho Press Tribune*, June 14, 2009.
18. Nagler, Thomas, Shaun Quegan, and Helmut Rott. 2000. Real time snowmelt runoff forecasting using ERS SAR PRI Data. Retrieved 6/21/2009. http://earth.esa.int/pub/ESA_DOC/gothenburg/247nagle.pdf
19. National Weather Service. 2009. Advanced hydrologic prediction service. Accessed 7/11/2009. http://ahps2.wrh.noaa.gov/ahps2/index.php?wfo=lkn
20. NRCS. Idaho SNOTEL sites. Accessed 3/16/2009. http://www.wcc.nrcs.usda.gov/snotel/Idaho/idaho.html
21. NRCS. Nevada SNOTEL sites. Accessed 3/16/2009. http://www.wcc.nrcs.usda.gov/snotel/Nevada/nevada.html
22. Nyhan, J.W. 2003. A seven-year water balance study of an evapotranspiration landfill cover varying in slope for semiarid regions. *Vadose Zone Journal*. Retrieved 6/21/2009. http://vzj.geoscienceworld.org/cgi/content/abstract/4/3/466
23. Pechanec, J.F., A.P. Plummer, J.H. Robertson, and A.C. Hull Jr.. Sagebrush control on rangelands. *United States Department of Agriculture, Agricultural Handbook No. 277*
24. Pollard II, Herbert. 1974. Owyhee County reservoir fishery survey: Job completion report, lake and reservoir investigations. F-53-R-8. Job VII-b. Retrieved 1/8/2009. https://research.idfg.idaho.gov/Fisheries%20Research%20Reports/Volume%20031_Article%2054.pdf
25. Portland District Corps of Engineers. The water cycle. Accessed 6/5/2006
26. Rain shadow. 2006. *Wikipedia, the free encyclopedia*. Accessed 2/26/2006. http://en.wikipedia.org/wiki/Rain_shadow.

27. Ritter, Michael E. 2006. Subsurface water. *The Physical Environment: an Introduction to Physical Geography*. Accessed 7/4/2006. http://www.uwsp.edu/geo/faculty/ritter/geog101/textbook/title_page.html.

28. Ritter, Michael E. 2006. The hydrologic cycle. *The Physical Environment: an Introduction to Physical Geography*. Accessed 7/4/2006. http://www.uwsp.edu/geo/faculty/ritter/geog101/textbook/title_page.html.

29. Shirk, David L. 1956. *The Cattle Drives of David Shirk from Texas to the Idaho Mines, 1871 and 1873*. Martin F. Schmitt, ed. Champoeg Press.

30. State of Nevada. 2004. Standard multi hazard mitigation plan. Accessed 7/11/2009. http://www.nbmg.unr.edu/nhmpc/nevadastandardplan.pdf

31. Stream: rain shadow. *Wikipedia, the free encyclopedia*. Accessed 2/26/2006. http://en.wikipedia.org/wiki/Stream.

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

33. Tuttle, Ronald W. 2003. Farm ponds. In B.A. Stewart and Terry A. Howell, eds. *Encyclopedia of Water Science*. Marcel Dekker, Inc., New York and Basel.

34. URS Corporation. 2008. Elko County multi-jurisdictional hazard mitigation plan. Accessed 7/11/2009. http://dem.state.nv.us/documents/OLD%20ITEMS/11508_Elko%20MJHMP%20Final%20_5Dec08_.pdf

35. USGS National Mapping Division. 2000. Revision of primary series maps fact sheet 047-00. 243. Accessed 7/13/2006. http://erg.usgs.gov/isb/pubs/factsheets/fs04700.html.

36. USGS National Mapping Division. Standards for 1:24,000-Scale digital line graphs-3 core: Part 2 hydrography. Accessed 7/13/2006. http://rockyweb.cr.usgs.gov/nmpstds/acrodocs/digqmap/Pdqm0401.pdf.

37. USGS. 2009. Nevada active water level network. *Active Groundwater Level Network*. Retrieved 6/21/2009. http://groundwaterwatch.usgs.gov/StateMaps/NV.html

38. USGS. 2009. Owyhee County, Idaho. *Active Groundwater Level Network*. Retrieved 6/21/2009. http://groundwaterwatch.usgs.gov/countymaps/ID_073.html

39. USGS. 2009. The water cycle: evapotranspiration. *USGS Water Science Basics*. Accessed 7/12/2009. http://ga.water.usgs.gov/edu/watercycleevapotranspiration.html.

40. USGS. 2009. The water cycle: ground-water discharge. *USGS Water Science Basics*. Accessed 7/12/2009. http://ga.water.usgs.gov/edu/watercyclegwdischarge.html.

41. USGS. 2009. The water cycle: infiltration. *USGS Water Science Basic*s. Accessed 2/26/2006. http://ga.water.usgs.gov/edu/watercycleevapoinfiltration.html.

42. USGS. 2009. The Water Cycle: Snowmelt runoff. *USGS Water Science Basics*. Retrieved 6/21/2009. http://ga.water.usgs.gov/edu/watercyclesnowmelt.html

43. USGS. 2009. The water cycle: sublimation. *USGS Water Science Basics*. Accessed 7/12/2009. http://ga.water.usgs.gov/edu/watercyclesublimation.html.

44. USGS. 2009. The water cycle: surface runoff. *USGS Water Science Basics*. Accessed 7/12/2009. http://ga.water.usgs.gov/edu/watercyclerunoff.html.

45. Van Brahana, John. 2003. Hydrologic cycle. In B.A. Stewart and Terry A. Howell, eds. *Encyclopedia of Water Science*. Marcel Dekker, Inc., New York and Basel. pp.412-414

46. Water cycle. *Wikipedia, the free encyclopedia*. Accessed 2/26/2006. http://en.wikipedia.org/wiki/Hydrologic_cycle.

47. Watershed Professionals Network. 2001. *Hydrologic Process Identification for Eastern Oregon*. Printed by Oregon Watershed Enhancement Board.

48. Webster, I.T. and C.R.B. Day. 1993. The impacts of shade on evaporation rates and temperatures in stock watering troughs. *Australian Journal of Agricultural Research* 44:2 pp.287-298.

49. Weisbrod, Noam. 2006. Desert hydrology. *Water Encyclopedia*. Accessed 6/26/2006. http://www.waterencyclopedia.com/Da-En/Desert-Hydrology.html.

50. Wilcox, Bradford P., David D. Breshears, and Mark S. Seyfried. 2003. Rangelands, water balance on. In B.A. Stewart and Terry A. Howell, eds. *Encyclopedia of Water Science*. Marcel Dekker, Inc., New York and Basel. pp. 791-794.

51. Woolhiser, David A. 2003. Precipitation, stochastic properties. In B.A. Stewart and Terry A. Howell, eds. *Encyclopedia of Water Science*. Marcel Dekker, Inc., New York and Basel. pp. 734-736.

52. Department of the Interior/Bureau of Reclamation. 2009. AgriMet network map. Accessed 7/14/2009. http://www.usbr.gov/pn/agrimet/agrimetmap/agrimap.html.

53. USGS. 2009. USGS 13181000 Owyhee River nr Rome OR. *National water information system: web interface*. Accessed 7/13/2009. http://waterdata.usgs.gov/or/nwis/inventory/?site_no=13181000&amp

54. Chamberlin, Jay. 2009. Personal communication.

55. Kowalewski, Peter E. 1999. Design and evaluation of engineered soil covers for infiltration control in heap leach closure. In Dorothy Kosich and Glenn Miller, eds. *Closure, Remediation & Management of Precious Metals Heap Leach Facilities*. Retrieved 7/19/2009. http://www.unr.edu/mines/mlc/conf_workshops/book1/chapter21.pdf

56. Shock, Candace, Myrtle Shock, and Clinton Shock. 2007. Lower Owyhee Watershed Assessment. Prepared for the Owyhee Watershed Council, prepared by Scientific Ecological Services. Accessible online: http://shockfamily.net/Owyhees/Index.htm

57. American Geophysical Union. 2006. Beaver dams create healthy downstream ecosystems. *ScienceDaily* June 6. Retrieved 10/15/2009. http://www.sciencedaily.com/releases/2006/06/060605120417.htm

58. Beaver Information Exchange for Wales. Beaver impact: hydrology. Retrieved 10/15/2009. http://www.beaverinfo.org/impact/hydrology.htm

59. Grannes, Steven G. 2008. Beaver dam information site. Retrieved 10/15/2009. http://www.beaverdam.info/