A Review of the History of Water Use throughout the Klamath River Basin

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INTRODUCTION

For the purpose of simplicity and ease of analysis, it is easiest to divide the Klamath River Basin in to two parts. There is the lower basin, which extends downstream from Iron Gate Dam on the mainstem Klamath river to the Pacific Ocean, and the upper basin which extends upstream from the dam. Although the basins lie on the same river that flows directly to the Pacific, they are quite different in terms of hydrology and management. The upper basin has six mainstem dams which are used for hydropower, supply of irrigation water, and to control and regulate the levels of flow in the river as well as lake levels in Upper Klamath Lake. Flows below Iron Gate dam to the lower part of the basin are reduced and altered seasonally due to water management along the upper reaches. Along this lower part of the mainstem is the pathway of migration and important spawning and rearing habitat for several anadromous fishes (Mount and Moyle 2003).

Hydrologic processes and water levels in the Klamath main stem and tributaries are dominated by the amount of snowpack accumulated each year. Even though there is a great deal of management along the river, the influence of snowmelt, resulting in large spring discharges, is clear. Inputs from groundwater and summer precipitation are small in comparison to the annual snowmelt pulse (Mount and Moyle 2003). The Cascade mountain range produces a significant rainshadow effect that affects the distribution of precipitation in the area. Mean annual precipitation in the Upper basin is 27 inches, and in the lower basin precipitation varies greatly reaching 100 inches in some areas. In the valleys, snowfall represents 30% of annual precipitation, and more than 50% at the higher elevations (Risley and Laenen 1999).

Figure 1.
Layout of the Klamath River Basin (from Mount 2003)

Water in the Klamath River Basin has been put to use by humans for thousands of years. Beginning with Indian tribes that lived in the area, who used the rivers for fishing through to the European settlers who used water for mining or agriculture, Klamath water has been recognized as a precious resource. Many conflicts have risen over the past two centuries as a result. This paper will discuss the uses of water throughout the history of the Klamath River Basin culminating in the Klamath Project and its effects leading to the current Klamath Basin 'crisis'.

INDIANS

For thousands of years, water flowing through the Klamath River System was an important part of life for the Indian tribes that inhabited the basin prior to Euro-American contact. In the lower basin lived the Karok, Hupa, Yurok, and Shasta tribes. In the upper basin lived the Modoc and Klamath people. For most of the tribes, fishing provided a way of life, and salmon was often the most important fish for subsistence.

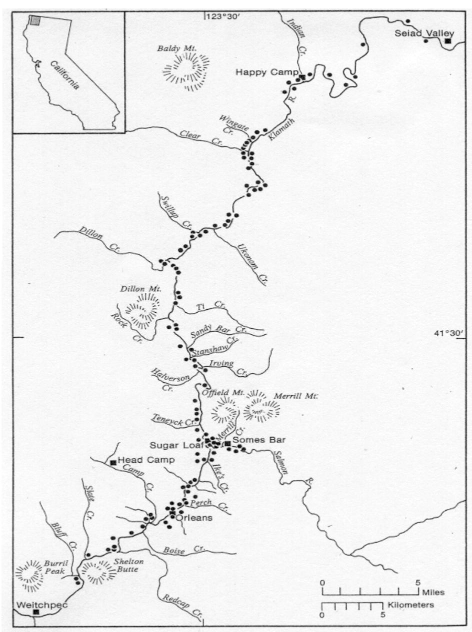

Figure 2. Karok villages. (Bright 1978)

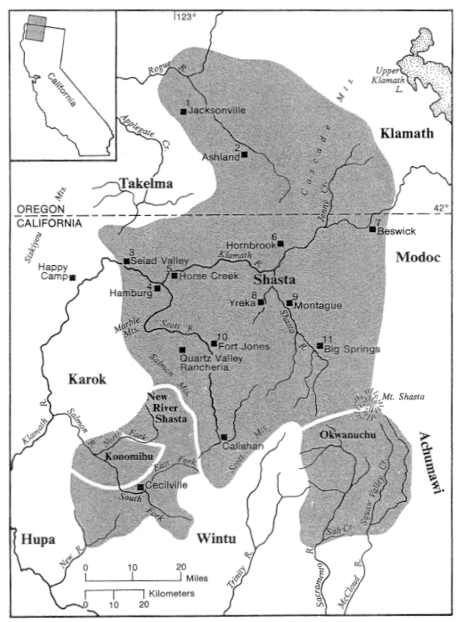

Figure 3. Shasta territory. (Silver 1978)

The middle course of the Klamath River, where it flows north to south, was occupied by the Karoks. They also had villages up the Salmon River, east from Somes Bar, and on Indian Creek, west from Happy Camp. Villages were either on the river or located on tributary streams. The Karok utilized several methods for catching fish and celebrated the salmon run upriver each spring with a ceremony. The most common way was with a fishing platform built on the edge of a stream. Salmon were caught with a tool called a lifting net that was lowered on an A-frame, and fish were killed with a club. Fishing platform sites were privately owned but could be rented for a share of the catch. Another method that was used less often was with a ‘plunge net’ on an oval frame that was used to scoop fish, including trout and steelhead, out of rapids. Nets were constructed from fiber extracted from wild iris leaves. Sometimes harpoons with detachable points were used by fishermen, or dip nets or gaffs were used to catch eel (Bright 1978).

In northwestern California, along the lower course of the Trinity River lived the sedentary Hupa. They demonstrated related techniques for catching the salmon that filled the Trinity river each spring and fall. When salmon came to spawn in the upper reaches during the spring run, similar platforms were erected over pools and eddies, and salmon were dipped out with suitable long handled nets. In the fall, when the river was low, a weir of withes and poles was built across it. Fish trying to swim against the weir were scooped up by men strategically positioned along the top. This was a communally constructed weir and was placed in alternate years near one of two main settlements. Gill nets in still pools, and long dragnets hauled by groups of men were also sometimes used (Wallace 1978).

The Yurok were situated along the Pacific coast between Crescent City and modern Trinidad and along the lower 45 miles of the Klamath River. Abundances of shellfish, candlefish, salmon, sturgeon, eel, surf fish, sea lions and acorns allowed for sedentary living. Although their villages were split between the coast and river, it is suggested that river culture was predominant and most people lived along the Klamath River. Watercraft were excellent for river navigation, but was never adapted to extensive sea travel. The Yurok stayed among close-lying rocks to hunt for sea mammals. They also built fishing dams, or weirs that simply created an obstruction from which to spear, harpoon or net salmon. Yurok could not catch and eat a salmon until after the First Salmon Ceremony which was performed by a specific tribesman each year (Beckman 1998).

The Shastan Peoples were on the upper reaches of the McCloud, Shasta, Scott, Klamath, and Salmon rivers. Villages were often located at the edge of a valley where a stream came out of a mountain. The first salmon of a run in the Shasta Valley was caught with a line, and after that they could be caught with spears. There was no special first-salmon observance for the

Shasta. Fishing methods for the Shasta included basket traps, weirs, long flat seine nets, and spears (Silver 1978).

The Modoc and Klamath tribes lived by the water most of the year, including creeks, springs, riparian areas, and marshes. Small community sizes allowed them to live sustainably with their environment and resources. Klamath River people did not begin fishing until the first salmon of the summer run was caught downriver by one of the tribes who performed a ritual. For all the tribes along the Klamath and it tributaries, the river was not just a source of water. It was an important food resource and provided an influence on life and culture. Tribes could sustain themselves year after year as reliably as the salmon that swam upstream every year.

FUR TRAPPING

Fur trappers began arriving in the basin in the early 1800's. It was reported that streambanks at that time were lined with different types of woody vegetation, including willow, aspen, alder, and cottonwood (Elmore and Bescheta 1987). Beaver cut down these trees and shrubs and created dams. Dams slowed water flow, withheld large amounts of sediment and rich organic matter in the stream channels, and helped regulate nutrient flows. Reservoirs of carbon were created by the retained sediments, which helped to buffer nutrient flows by releasing carbon more slowly than the surrounding areas. Beaver ponds were also responsible for prolonging the late-summer flow of streams, expanding floodplains and dissipating the erosive power of floods. A diverse range of vegetation communities were created throughout the entire Klamath basin by the various stages of beaver dam creation and decay (Langston 2002).

Early trappers from the Hudson Bay Company of Canada arrived in 1820, and to prevent imposing on tribal rights, they did not try to establish a permanent settlement in the area. The company's policy instead was to prevent American infringement by trapping beaver to extinction throughout the area. This widespread beaver trapping resulted in drastic changes to the hydrologic functions of streams and their adjacent riparian areas. Removal of beaver helped create fertile meadows that later became so appealing to settlers and created the ideal conditions for ranching. By the mid 19th century, the majority of beaver were gone and their dams began to give way due to lack of maintenance. Wetlands behind them drained and shortly after ponds filled in with sediments and fertile meadows were created (Langston 2002).

MINING

Following the discovery of gold in January 1848, miners began entering the Klamath Basin. In an effort to extract gold, they initiated changes to the rivers and streams not only through direct mining activities, but also indirectly through the establishment of permanent white settlements (Mount and Moyle 2003).

Initially alluvial deposits were worked with simple tools such as shovels, pans, picks, and elongated boxes known as rockers. However once the rich river bars were worked to exhaustion, the miners' attention shifted to the river bottoms. At enormous cost and high risk, streams were dammed and turned into new channels. Riverbeds were laid bare for long distances while miners worked their claims. In time, as the precious metal that was extracted from these placers and surface deposits was grew scarce; miners started searching for another source of gold (Hagwood 1981).

In 1853 a miner named Edward Matteson developed a technique to excavate deep placer gold deposits using high-pressure blasts of water. A brass nozzle attached to a rawhide hose would wash gold-bearing gravel down from hillsides into a sluice (Krist 2001). Before long this technique of hydraulic mining was used intensively throughout California. Mining companies were diverting entire creek systems into reservoirs that then fed water at high pressures through aqueducts and steel pipes to giant nozzles (Krist 2001). Huge amounts of the landscape were rearranged as a result of hydraulic mining. Entire hillsides of rock, soil, and forest were leveled at rates of 30,000 gallons per minute.

Debris from hydraulic mining was washed into sluices containing mercury to trap the gold. The gravel and sand left behind also known as "tailings" became contaminated with mercury and either leaked through the sluices or was washed away with flowing water. One of the most harmful contaminants released into the hydrologic system as a result of mining was mercury. A great deal still today remains in soils and sediments, and some are able to travel through the food chain in the form of methyl mercury. Increased turbidity, settleable solids, and nonfilterable and filterable solids were common effects of hydraulic mining and sluicing. Elevated concentrations of trace inorganics associated with gold-bearing minerals, such as copper, arsenic, lead and zinc, were also released to local streams by placer mining and have been shown to be toxic to early life stages of Coho salmon (Buhl and Hamilton 1990).

Hydraulic mining was largely put to a halt in 1884 due to a court ruling. However, by then 1.6 billion cubic yards of sediment had been put into California's waterways with drastic effects (Krist 2001). Fish habitats were severely altered; pools used by salmon were filled with silt that covered salmon redds suffocated and salmon eggs. In addition, production and abundance of in stream plant material decreased and invertebrate abundance declined. Finally, deforestation of adjacent streambank slopes occurred as a result of increased demand for lumber to build railroads, houses and other structures related to mining (Malouf and Findlay 1986).

Dredges that operated in the Scott Valley between 1934-1950 did some of the most visible damage done during the mining era. Large Yuba dredges, which also used mercury to process sand and gravel, excavated material 50-60 feet below the river channel and flood plains and created tailings piles more than 25 feet high downstream or the town of Callahan (Mount and Moyle 2003).

RANCHING

Following the trappers were the homesteaders and ranchers in the late 1800's. Rangelands and grazing practices in the Klamath Basin were similar to those used throughout much of the West and relied primarily on season-long or year-long land use. Rather than foraging on adjacent hillslopes, these practices allowed livestock to concentrate their foraging in riparian areas. However, in 1890, the government said that overgrazing was becoming a problem, so ranchers began to dike and drain wetlands, flood irrigate them, and plant hay to provide more forage for cattle. As a result, riparian areas were left in a state of degredation and disrepair. Streams that were once perennial water sources for early settlers no longer flowed in late summer. Channels that were once able to handle spring runoff and low summer flows became eroded and unstable. Extensive deep gullies remain today where channel gully erosion proceeded unchecked (Elmore and Bechetta 1987).

Many of the riparian areas left lack productive habitat for fish or other aquatic organisms and are no longer of any value for livestock forage. Their ability to dampen flood peaks and assist in recharging surface aquifers has been compromised. Sagebrush, cheatgrass, and plants similar to the adjacent uplands occupy what were once wet meadows (Elmore and Bechetta 1987). These plants, and non-native hay that replaced the native perennial grasses together with the soil compaction caused by cattle, could have led to an increase in erosion and higher peak flows.

Ranching and grazing can be found along the borders of Upper Klamath Lake and in the Scott and Shasta valleys where there is a high water demand for irrigated pasture and alfalfa. This has a significant effect on salmonid habitat as surface diversions and groundwater pumping creates low-flow and no-flow water conditions on the mainstem rivers (Mount and Moyle 2003). Reduced riparian and shade cover on the mainstem and tributaries is also seen in these areas as well as an increased temperature on agricultural return water. Because of high water temperatures, the Shasta River in summer supports mainly non-salmonid fishes.

TIMBER

Almost 80% of the Upper Klamath Lake watershed is forested and much of that has been harvested for timber either under federal, tribal, or private management, (Mount and Moyle 2003). There are two main methods of timber harvesting; clearcut, and selective harvesting. Selective cutting is where all trees above a certain diameter (often 12 inches) are removed and clearcutting is where all trees are removed from a designated area with the possible exception of certain trees protected for wildlife benefits (Chunko 1998). Both methods are harmful to forests however, clearcuts tend to have a greater impact on the immediate surroundings. Clearcut areas may range from small plots, up to much larger areas that cover small watersheds. Although this method has recently been under increased scrutiny, it still remains in use in many areas, especially the Pacific Northwest. Annual clearcuts in California alone total more than 4,000 hectares (Bartholow 2002). Effects of timber harvesting on hydrologic functions are numerous and include things such as changes in stream flow regime, temperature, nutrient movement, and bank stability.

A significant increase in overall water yield is often a result of logging. Clearcutting entire small watersheds in Oregon along the coast and mountainous regions can increase water yield up to 60cm (Rothacher 1970, cited in Harr *et al*. 1982). However, the increase is most often in peak flow magnitude, not baseflow volume or the seasonal timing of peak flows (Dose and Roper 1994). The largest relative flow increase (100-300%) of predicted flows occur in summer, but tend to diminish quickly as riparian vegetation establishes itself (Harr *et al.* 1982).

In a comparison of historical records with recent data, Dose and Roper (1994) found that increased flows and the simplification of the stream channel due to removal of wood by logging can result in an overall increase of channel width. Their study showed that stream widths differ significantly between the early and late 20th century and could be a factor in the declines of salmonid populations. Removal of vegetation by logging may also increase ground temperatures. Bartholow (2002) noted that temperatures between clear cuts and riparian areas can differ by as much as 17C at 20mm soil depth and 5C at 320mm soil depth.

Timber harvesting also often removes streamside vegetation that can result in loss of bank stability and increased erosion. Poorly designed roads on steep hill slopes of pumice or volcanic soils are subject to high levels of erosion. This leads to increases in fine sediment in rivers and streams and destruction of ideal fish spawning and rearing habitat. The U.S. Forest Service and California Department of Fish and Game have identified road and trail networks throughout the basin as significant sources of sedimentation and affecting salmonid habitat (Mount and Moyle 2003).

AGRICULTURE AND THE KLAMATH PROJECT

Major changes in irrigation and drainage began in the Klamath Basin in 1882, such that almost 13,000 acres were irrigated by 1903 when an engineer from USBR estimated that irrigation could water up to 200,000 acres (Mount and Moyle 2003). The Klamath Project was authorized in 1905 as Oregon and California ceded title of Lower Klamath and Tule Lakes to the Federal Government under provisions of the Reclamation act of 1903. On May 15, 1905 the Secretary of the Interior authorized construction for projects to reclaim and drain the lakebeds of Lower Klamath and Tule lakes, to hold irrigation water of the Klamath and Lost rivers, to control flooding of reclaimed lands, and to divert irrigation supplies. Project costs were to be repaid through the sale of water rights to homesteaders on reclaimed project lands (USBR 1995).

In March 1917, the first public lands were opened and sold for homesteading. In addition, land was also leased for farming before opening to homestead. This practice helped farmers develop the land while irrigation and drainage facilities were constructed that eventually allowed farm units and homestead entry. Areas at lower elevations were turned into sumps and reserved for drainage and flood control to protect the homestead areas from flooding (USBR 1995). These sumps also preserved existing marsh habitat which had been within the Klamath Basin wild refuges.[1]

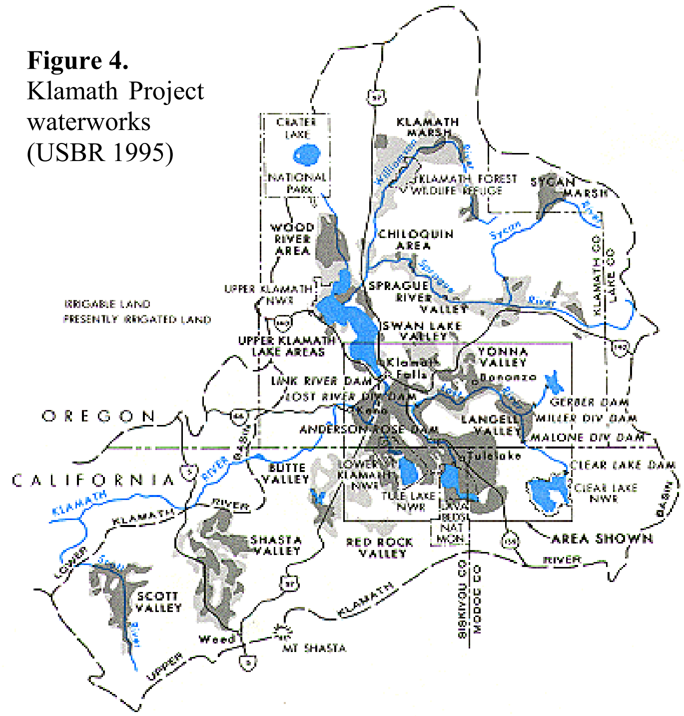

Figure 4. Klamath Project waterworks (USBR 1995)

The Klamath Project has two main water supply sources, the Klamath River and Upper Klamath Lake, and several smaller sources including Clear Lake Reservoir, Gerber Reservoir, and the Lost River which are located in a closed Basin. The project area covers 94,545 ha (233,625acres) of irrigable lands, of which 87,758 ha (204,492 acres) was irrigated by 1979 (USBR 1995).

There are multiple dams in the Klamath basin, including the Link River Dam which regulates flow from Upper Klamath Lake Reservoir. This reservoir is the principal source of water for the project and is located on the Link River at the head of the Klamath River. There are 18 canals, laterals and drains totaling a length of 298km (185mi), and five major pumping plants. Tule Lake Tunnel is a concrete-lined tunnel that conveys drainage water from restricted sumps at Tule Lake to Lower Klamath Lake. Klamath Straits Drain transports drainage water from irrigated land that has been reclaimed from Lower Klamath Lake as well as Lower Klamath National Wildlife Refuge. This drain removes excess winter flows and drainage from the lower basin to the Klamath River (USBR 1995).

The growing season in the Klamath Basin can vary considerably from year to year but normally averages 120 days extending from May 15 to September 15. The irrigation season tends to last from April to September. Principal crops grown in the area include alfalfa hay, cereal grains, onions, potatoes, sugarbeets, grass seed, and irrigated pastures for beef cattle. Farming in the Lower Klamath Basin occurs mainly in the Shasta and Scott Valleys. The Scott Valley alone includes 30,000 acres of crops and irrigated pasture, while in the Shasta Basin, 28%

[1] In 1908 by Executive Order, Theodore Roosevelt established the first Federal wildlife refuge in the Nation in the Lower Klamath Lake area. Today there are five national wildlife refuges in the Klamath Project area including: the Lower Klamath, Clear Lake, Tule Lake Upper Klamath, and Klamath Forest. They not only provide wildlife

of the watershed is irrigable and supports a variety of crops (Mount and Moyle 2003). These benefits do not come without costs however.

Some of the major effects of agriculture and irrigation on rivers and stream conditions as a result of the Klamath Project are decreased water quality from drainage of wetlands and loss of fish habitat from the construction of dams and diversions and removal of riparian habitat. Excessive loading of nitrogen and phosphorus into waterways from agriculture leads to poor water quality. A study by Snyder and Morace (1997) suggested that effluent from drained wetlands has contributed to accelerated rates of eutrophication in Upper Klamath Lake. Lowering the water table when a wetland is drained can increase the aerobic decomposition of peat soils and liberate nutrients such as nitrogen and phosphorus. Oxygen can also be introduced into soils by ways of furrowing or disking, which also increases peat decomposition and the release of nutrients.

Due to the construction of various dams and diversions and the removal of riparian habitat, multiple fish populations have declined. Dams block fish migration pathways, as well as reduce flows, resulting in reduced access to upstream habitats and increased water temperatures. In addition, the deep pools, porous gravels and cold clear water that many fish require to spawn and live in have disappeared as a result of heavy sedimentation. Riparian areas that provide shade, cooler water and shelter from predators have disappeared leaving shallow, warm silt-laden channels that are unsuitable for spawning and rearing (Mount and Moyle 2003)

CONCLUSION

Starting with the first white explorers to the area at the beginning of the 19th century, almost every party that has used water from the Klamath River has left an impact. Fur trappers removed all the beaver and started creating fertile meadows. Mining transported huge amounts of sediments into waterways and released mercury into the environment. Ranching reduced riparian cover from streams. Logging altered peak flow magnitudes and increased erosion. Agriculture degraded water quality and increased flow temperatures. Together these effects have created a managed region of agricultural land with few barely functioning refuges in the Upper basin and a

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conservation but also help decrease crop predation in the Imperial and Central Valley by delaying the migration during crop harvesting (USBR).

warm, shallow river with warm high nutrient low flow inputs from tributaries. None of which provide suitable habitat for endangered or threatened salmon species.

Currently there are multiple parties vying for the water in the Klamath Basin. There are agricultural, tribal, municipal, and animal needs to consider and not enough water to go around. Even with Upper Klamath Lake full, if inflows don't hold up throughout the rest of the year, the Lake does not hold enough water to supply irrigators throughout the summer and maintain water levels for fish (Darling 2003). Despite the legitimate needs by tribal and wildlife interests, agriculture and irrigation tend to win in the priority battle over water in the basin. Since fish have the lowest priority, it does not bode well for conservation or fishery enhancement.

This conflict for water has been escalating for more than 150 years. With the threat of drought looming at the turn of every new water year, it has become imperative that changes are made in regard to water management. In order for a new equilibrium to be attained for the Klamath basin and all of its water users, significant regulatory changes will be needed and a balance between irrigation, tribal, and wildlife water use must be reached.

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