Beyond Gilbert: Environmental History and Hydraulic Mining in the Sierra Nevada[1]

By David Beesley

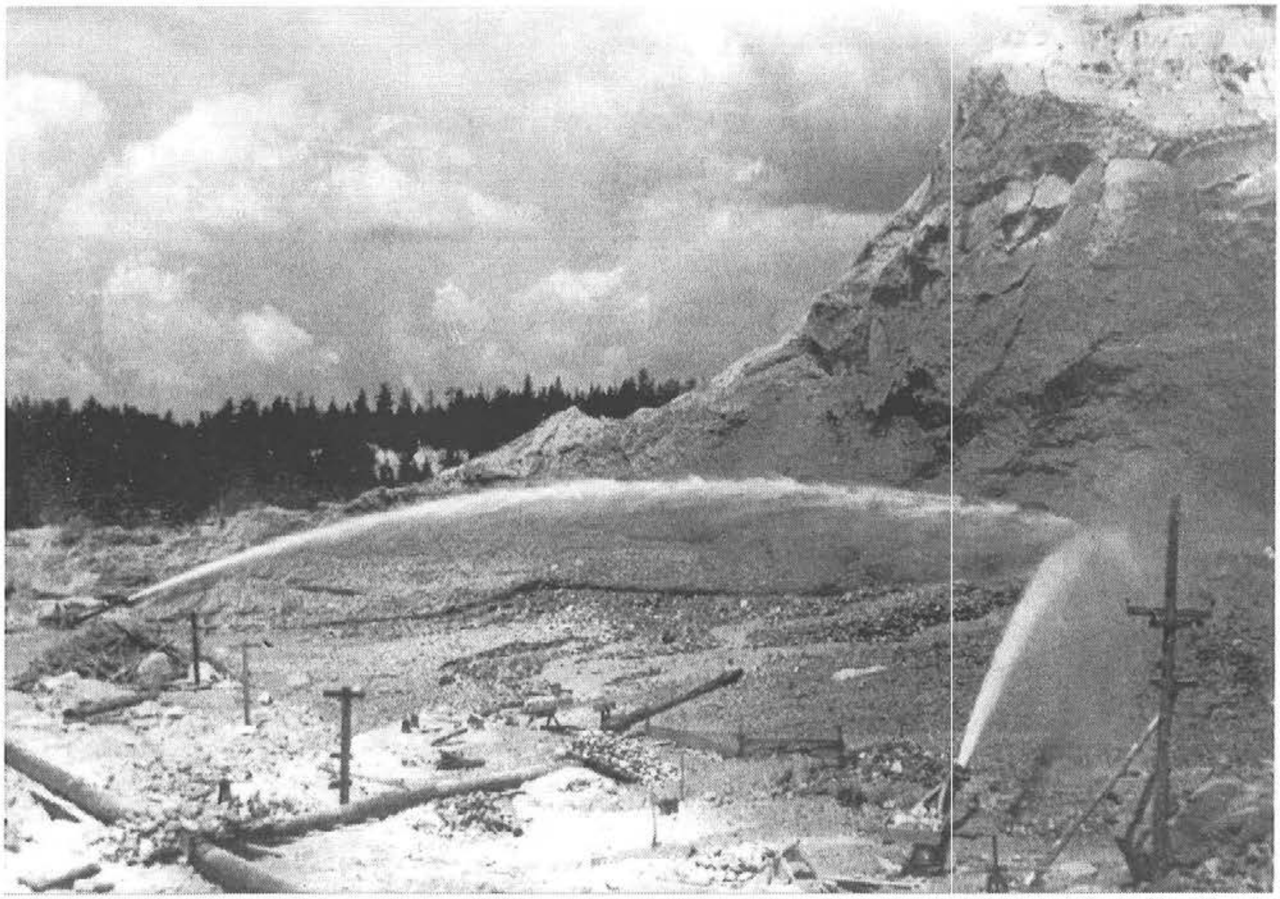
Nearly all the phases of the economic questions connected with the debris from hydraulic mining are concerned with quantities. It is desirable to know (1) how much detritus—gravel, sand, clay—was excavated by the miners and started toward or down the streams; (2) how much detritus the streams received from other sources; (3) what is the present distribution of this material; (4) what changes are in progress and toward what results do they trend.[2]

Grove Karl Gilbert's landmark study *Hydraulic-Mining Debris In The Sierra Nevada* still stands as a monument to careful scientific study of stream processes. Published in 1917, it gives us today one of the most reliable estimates of the amount of mining debris washed into Sierra Nevada streams by hydraulic mining. It also provides historians, geographers, and other students of stream processes an estimate of the amount of debris deposited in Sierran streams by all the other kinds of nineteenth-century mining, including placer, drift or lode, and hard-rock mining.[3] His path marking quantitative analysis of the amount of debris that hydraulic mining corporations bequeathed future generations still stands after more than eighty years. and forms the base-line for modern studies.[4]

Where there is disagreement with Gilbert, it is primarily with the last of his four-part statement quoted above. There is some question about his prediction that after fifty years that Sierran stream processes and sediment loads would return to normal.[5] There is evidence that in some cases much of the material washed out by hydraulic mining, contained in various terraces, floodplains. and sediment reservoirs, is still making its way into Sierran streams and the reservoirs that have been built after Gilbert's time.[6] One current estimate of hydraulic mining debris deposited in the Bear River claims that removal of hydraulic deposits will continue into the next millennium, clearing around the year 3000.[7]

Admitting that Gilbert's study of hydraulic mining in the northern half of the Sierra Nevada remains an invaluable tool in the reconstruction of some of hydraulic mining's environmental effects, I want to quibble a bit with this giant of stream science. He and other stream scientists are doing what they do best-focusing on fluvial processes. Although Gilbert does raise his eyes a bit to see and mention some other effects of hydraulic mining on the surrounding Sierra Nevada landscape, especially its contribution to the destruction of forest land,[8] for the most part he is locked in on stream, valley, delta, and bay effects. In this regard, he is also like the historians who have written on hydraulic mining in California.

The historiography of hydraulic mining to this point has focused primarily on two key points: first, on the political effects that grew from the damages inflicted by hydraulic mining corporations on Sacramento Valley farmers, flooded towns, and navigation interests. From this political controversy came the famous federal court injunction in 1884 that effectively brought the industry to its knees. Secondly, historians have examined the actions of the California Debris Commission that initiated effective regulation on what was left of the industry in the injunction's aftermath.[9] Thus, whether stream scientist or historian, the focus is primarily on downstream is-



Hydraulic Mining Created Massive Effects on Sierran Landscapes as Well as On Valley Farming Interests. Federal Action Stopped Large-Scale Development in 1884. Hydraulic Monitors at Work. Photo Courtesy of the Nevada County Historical Society.

sues. Environmental historians of hydraulic mining in the Sierra Nevada must move beyond Gilbert who looked primarily into the streams and bay-delta, and those who have mainly focused on politics of hydraulic mining.

For those of you non-social scientists reading this article who might be wondering at this point just what an environmental history of anything might be, I want to assure you that you are not alone in your puzzlement. It is O.K. to be ignorant about environmental history's exact definition. Please do not hold your head in shame or manifest any of the normally acceptable public expressions commonly associated with the acknowledgement of abject ignorance by the truly humble person. The specific branch of history known as environmental history is quite young. It only began to define itself in the late 1950s and 1960s. As a learned discipline it is still undergoing definition, sometimes sparking conflict between those who count themselves as being "true" environmental historians, while at the same time denying others that sacred mantle.[10] So let me then tread on thin ice and advance a bare bones definition for the non-initiated, as to what environmental history really is. I will then apply this definition in an analysis of the historic effects of hydraulic mining on the Sierra Nevada.

For my working definition I want to refer to the mission statement of the journal *Environmental History*, a journal jointly published by the American Society of Environmental History and the Forest History Society. This international journal devotes itself to "exploring the history of human interaction with the natural world."[11] Most of those working in the field will accept this stated commitment to the investigation of how humans have interacted with and changed the natural world over time as a good beginning point for defining the purpose of environmental history. In the time from the late 1950s to the 1970s a general consensus emerged. Many historians writing in the field explored topics such as the history of conservation and the idea of wilderness in the American mind. They developed biographies of significant environmental leaders such as John Muir, detailed the unique American cultural attitudes that led to the creation of National Parks, and developed histories of various landscapes such as the Sierra Nevada's Lake Tahoe.[12] All of these studies tended to take the idea of human interaction with nature or natural spaces at face value. That is, nature was something tangible, humans lived in it, and natural places were changed as a result of human activities.

As the discipline of environmental history evolved and was redefined in the 1980s, the "idea" of *nature* itself also underwent evolution. Originally accepted uncritically as that original "non-human" or "pre-human" world acted upon by humans, many in the profession became troubled by a lack of clarity. In addition, large cities seemed to be unintelligible and separate from what had been accepted as the natural world, even as they cast enormous influence upon it. At this point William Cronon moved the debate effectively forward in his monumental work *Nature's Metropolis: Chicago and the Great West*. In order to explain the complex relationship of nineteenth-century Chicago with the huge regions to its west that were being transformed because of the development of transportation systems and an integrated market economy, he used "nature" in two clearly defined ways. There was, to be certain, a non-human world or a "first nature" that was being acted upon and changed by Chicago's merchant capitalists and politicians. But there was also developing a "second nature" of the city itself, with its complex infrastructures, that was being erected atop the vast prairie lands that lay to the City's west.[13]

The general acceptance of this new viewpoint by other environmental historians seemed to open up the floodgates, and an outpouring of ideas erupted to explore new possibilities as this line of enquiry evolved. It is not my intent to examine any of these new themes. But I recommend for those interested to sample a collection of essays edited by William Cronon entitled *Uncommon Ground: Rethinking the Human Place in Nature* to get a feel for the new possibilities.[14] But even as the subjects associated with environmental history have been expanded, the core focus on human influence on changes in the natural world, whether first or second, continues to define the core of the discipline.

With this general understanding of what constitutes an environmental history before us, I want to return to an investigation of the environmental effects of hydraulic mining on the Sierra Nevada. I believe that an effective environmental history of that industry's effect on the range must include an examination of stream effects, using and supplementing Gilbert as needed. But it also must raise its sights to include the other numerous effects on the range that resulted from this extremely aggressive form of industrial mining. It is my belief that an environmental history has to be more holistic in its approach, reaching out to include more than just Sierran streams.

To fully understand the environmental impact of hydraulic mining on the Sierra Nevada, the legacy of the industry must be placed in context. Hydraulic mining was only part of a larger picture of development of Sierra Nevada resources in the time from 1848, when gold was discovered at Sutter's mill, to the 1880s, when federal court action effectively ended hydraulic mining as a large-scale industry in California. In the half-century that followed the discovery of gold, Sierra Nevada mining, timber, water, rangeland, and animal resources were industrially developed. The gold mining industry was the essential stimulus that drove this economic development.[15]

Mining history in the Sierra Nevada before the 1880s can be divided into three chronological periods, recognizing that some overlap occurred. During the first of these, 1848-1851, deposits of placer gold were exploited primarily by amateurs who had few skills and employed only simple technology such as pans, "rockers," and simple sluices. In the second period, between 1851 and 1859, miners exhausted most of the surface deposits and turned to the exploitation of river beds, veins of gold embedded in quartz, and deposits of alluvial gravel. This change required more capital, new techniques (such as the use of wing dams and ground sluicing), and larger supplies of water. In the third phase, Sierran mining became a capital-intensive industry employing wage-earning miners and better trained or more experienced engineers. These were employed in deep mines and giant hydraulic operations.[16]

The development of large-scale hydraulic mining profoundly affected the Sierra. The largest operations were located in the northern part of the range where water was more plentiful, in the Feather, American, Bear, and Yuba River drainage systems. The center of the industry was the Yuba's three major forks, where experimentation and improvements in focusing water under high pressure freed alluvial gold from hard-packed Tertiary age gravels. The key to success in hydraulic mining was the control and application of huge volumes of water. Thus, by the 1870s and 1880s, "ditch" or water companies consolidated to create large corporate entities whose stock traded on the San Francisco exchange. The largest companies included the Milton Mining Company, the North Bloomfield Mining Company, the Eureka Lake and Yuba Canal Company, the South Yuba Canal Company, and the Bear River and Auburn Water Company. Towns developed near all these operations, and hundreds of miners and businesses became dependent on their wages for survival.[17]

The net effect of this development of the major extractive industries in this half-century was massive environmental change, probably on a scale that no other period of the ten thousand years of human contact with the Sierra Nevada can match. In comparison to other types of mining, and considering all the effects from industrial logging, grazing, and market hunting, hydraulic mining's impact may have been the most significant single force for environmental change of all these extractive industries in the areas where it was conducted. While stream systems in ordinary placer mining areas have adjusted and returned to some semblance of their former selves, and forested areas outside the hydraulic zones, while altered in composition, have spread back over former habitats, the areas affected by hydraulic mining remain severely altered to this day.[18]

The effects of the hydraulic mining industry in the Sierra Nevada were extensions of the general impact that placer and drift mining had. But the degree of environmental alteration is more than just a mathematical increase in the amount of debris that hydraulic operations created.[19] The impacts were not unlike the changes going on in business and industry at the end of the nineteenth-century in general, as corporations came to dwarf the large businesses and manufacturing operations that developed after the civil war.[20] The environmental impacts of this highly organized mining capitalism on the Sierra Nevada were enormous.

Briefly summarized, there are six major direct effects on the Sierra Nevada that came from hydraulic mining between 1853 and the 1880s. The first was the depositing of over a billion cubic yards of mining debris into the river systems of the range, altering them significantly beyond the effects that came from simple placer mining; second, creating significant erosion effects in the chaparral and forest lands directly in the path of hydraulic mining; third, increasing demand for commercial forest resource development in adjacent lands directly in support of hydraulic mining; fourth, impacting fish and fisheries by mining and the impounding of water in the river systems of the hydraulic mining areas; fifth, releasing huge amounts of mercury into the stream systems associated with hydraulic mining; and sixth, constructing thousands of miles of flumes, canals, and ditch systems to supply water for hydraulic mining. Their conversion to irrigation and hydroelectric uses after hydraulic mining ended permanently altered Sierran stream systems as a result. Let's examine these effects in more detail.

The most comprehensive analysis of hydraulic mining's overall effects on the Sierra Nevada streams, as noted, was made by G.K. Gilbert in 1917 as part of a United States Geological Survey (USGS) study of the debris issue. His conclusion was that over a billion and a half cubic yards of debris had been removed from Sierran hillsides and river canyons in an area stretching from the Feather River in the northern Sierra to parts of the Mokelumne River system to the south. Most debris was produced before the 1884 federal court action that ended large-scale hydraulic mining in California.[21]

In order to make this vast figure understandable, Gilbert stated that the amount of earth and rock moved by hydraulic mining amounted to eight times the quantity of earth that had been dug to complete the Panama Canal. He focused primarily on the Yuba River Basin for his detailed studies. He noted that the significant amount of debris and eroded materials that originated in ordinary placer mining, farming, road construction and use, trail development, and overgrazing in the basin were of lesser significance in comparison to the effects of hydraulic mining.[22]

Gilbert predicted that since hydraulic mining had stopped, the Sierra's rivers would continue to remove the debris deposited there, assuming that no large-scale mining resumed. He predicted that normal stream processes would continue to work, and that in about fifty years they would have cleared their beds. The streams would have moved these materials, depending on their size and consistency, down into the lower foothills, the lower river systems, the delta, and even to San Francisco Bay. As he said: "It is possible that none of the gravel now in transit will reach the bays as gravel, but it may be assumed that as the pre-mining slopes of the river channel are approached the character of the premining channel bed will also be approached."[23]

Current studies testing Gilbert's predictions have generally upheld his work as it applies to the Yuba and Sacramento rivers at their lower levels. However, in some of the mountain streams affected by hydraulic mining, such as the Bear River, significant amounts of mining debris still remain in terraces and flood plains. Rivers have incised through these "sediment reservoirs," as geologist Jeffrey Mount termed them, leaving them behind to be "reworked and added to the sediment load of these mountain rivers."[24] The construction of dams such as Englebright on the Yuba River just as it leaves the foothills of the Sierra Nevada has also disrupted the natural stream processes. It and other dams built on other tributaries of the Yuba and American, have been acting as collectors of debris, something beyond Gilbert's predictions. Eventually, the lives of these dams will be shortened as a result of this continued deposition of hydraulic mining debris. All dams are rapids in the making, if we take the long view, especially on those Sierran rivers still containing large amounts of mining debris.

The second environmental impact of hydraulic mining can be measured in another way, by looking at its effects on the forested lands washed away or buried by the actions of hydraulic monitors. In 1905 USGS scientist John B. Lieberg conducted a detailed study of the area included in a newly created forest reserve, in what would later become the Tahoe National Forest. He carefully analyzed the conditions and composition of the forests in the region, in effect creating a snapshot in time of those post-gold mining forest areas. In the introduction to the report that assessed the overall effects of hydraulic mining on forest areas in the reserve, he wrote: "Every acre of forested ground torn up by the hydraulic giants and covered by tailings, or converted into a dumping ground for debris, is an area of forest land irretrievably lost. Centuries will pass before the mounds of debris and crumbling bluffs of sand and gravel left by this class of miners will possess much forest cover."[25]

Leiberg listed four major "Destructive Agencies" contributed by modern humans to forest degradation in the Sierra Nevada. His ranking of these four horsemen of the environmental apocalypse were logging, fire, grazing, and mining, with hydraulic mining being of much greater significance than the earliest placer forms.[26]

Leiberg surveyed all of the major tributaries of the Feather, Yuba, Bear, American, and Rubicon rivers. In each he applied the same research report design, including a section on the forces of forest destruction that had been unleashed in the aftermath of the gold rush. The remarks about hydraulic mining's effects were consistent in all the tributaries of the first four river basins he visited where hydraulic mining had occurred. It would be useful here to sample his remarks, using examples from his observations on the Feather and Yuba rivers. Of the North Fork of the Feather he noted ". . . enormous holes have been torn in the Pleistocene or glacial gravel ridges." "Reproduction on worked out placer grounds [placer in context in these examples meant hydraulic] is poor. In such places the soil and humus have been washed away and only coarse gravel, bowlders, and bare rock remain." Regarding the North Fork of the Yuba, he wrote, whole ". . . hills and flats have been torn in all directions by hydraulic mining. . ." As to reproduction of the forest there, he wrote: "The logged areas in the western portion of the basin are restocking abundantly, except where the ground has been turned up by the placer miners and the soil washed away from underlying sharp, unproductive gravel and bowlder drift." On the South Fork of the Yuba he reported that hillsides ". . . have been torn up in all direction by the hydraulic giants. Vast masses of debris have resulted." As to reproduction, he stated: "The gravel heaps which mark the placer mines are practically without mold, or humus, and cannot produce much forest for hundreds of years to come." Remarks similar to these occur throughout his description of the Bear and American systems. Clearly, from the viewpoint of a forest scientist, hydraulic mining was a major destructive force that left little chance for forest recovery.[27]

Besides destroying forested land directly through the effects of erosion and deposition, hydraulic mining further affected Sierran forests by promoting large-scale, unregulated commercial logging. The largest operations utilized railroads both to log and connect to the mining operations. The development of a logging industry in the Sierra Nevada was a direct result of demand created by placer mining. After the decline of ordinary placer and lode mining by the mid-1850s, the development of hydraulic and quartz mining continued and expanded the need for commercial timber. No accurate account of the number of sawmills in the mining areas of the western Sierra exists. One estimate based on county histories and the State of California's Surveyor General's Report of 1860 lists 320 mills in operation throughout the state, many of these in the Sierra Nevada. For the counties of the Sierra north of Sacramento, in the heart of hydraulic mining territory from 1849 to 1900 alone, nearly 150 mills were at one time in operation. Undoubtedly there were many more, for in Nevada County alone in 1858 there were 42 mills producing 40 million board feet of lumber. Most of the mills in the early years were small in size and had single proprietors or perhaps two or three men acting as partners. But as the mining industry became more industrialized, larger mill operations supported by railroads or complex flume systems came to dominate.[28]

The hydraulic mining industry and the towns such as North Bloomfield, French Corral, and Blue Tent that grew around the larger operations utilized very large quantities of timber. Lumber and logs were needed to construct the large impound dams such as the English Reservoir serving the San Juan Ridge between the Middle and South forks of the Yuba River. Lumber and timber was needed to provide support for mining ditches, and to construct the large flumes that paralleled the steep river canyons or crossed intersecting ravines. It was used to build the large and complex sluices that trapped the washed gold. Lumber without knotholes, an expensive product even then, was used to build the flumes to transport water or to build the sluices because these boards prevented loss of valuable water and mercury. Much of the rest of the tree was unutilized as slash. As an example of quantities used, in order to build a simple V Flume to carry water to the mining areas, 135,000 board feet per mile was needed for construction alone. Several thousand miles of ditches and flumes were built to supply the hydraulic mines. The long lasting hydraulic mining communities such as Dutch Flat and Gold Run in Placer County, or Columbia Hill and You Bet in Nevada County are examples among scores of towns that consumed large quantities of lumber and cordwood for housing, and for daily use as well.[29]

By the 1880s, growing concern about the wasteful and highly consumptive use of California forests produced calls for state or federal regulation of the timber industry. A California State Forestry Board report of 1886 estimated that twenty years of cutting and fire had "consumed or destroyed" one-third of the Sierra's timber. The survey of the forests of the northern Sierra by John Leiberg that focused primarily in the regions associated with hydraulic mining stated that more than a million acres of timber land had been cut over or culled for mill timber. That acreage represented about 52 percent of the timberland in the region. Part of this mill timber and lumber was associated with the hard-rock mines, but much was associated with areas involved in hydraulic mining.[30]

A fourth example of the environmental effects of hydraulic mining returns to the streams, but focuses on the destruction of habitat and water pollution's effects on northern Sierran fish populations. All mining in the period after 1848 affected native fish populations. Hydraulic mining would make the problem even worse. While fish populations were reduced in the early, less destructive placer mining years, still they were seen in large numbers by miners. Spring Run Salmon, for example, were reported in the 1850s at headwaters of all the major river systems that fed into the Central Valley. Steelhead and salmon were reported all the way up to Downieville on a tributary of the Yuba until the 1850s. But hydraulic mining went well beyond simple placer mining in dealing a devastating blow to local trout, and the anadromous salmon and steelhead that used Sierran streams for spawning. Hydraulic mining debris silted over or covered with coarse debris the spawning beds necessary for future populations. Dams constructed to impound water for the industry interrupted natural runs. Hydraulic mining is generally charged with being the chief culprit in the decline of salmon and steelhead populations before the days of the large dams of the twentieth century.[31]

Another major environmental impact of hydraulic mining was its contribution to the level of mercury deposited in the streams of the Sierra Nevada. As with other impacts that began with placer mining, the hydraulic mining operations greatly magnified the effects. In order to trap the fine gold released by the hydraulic monitors, long sluices, sometimes thousands of feet long, were coated or charged with mercury. After being collected, the amalgam was heated, driving off the mercury, leaving the gold behind for further purification. In the sluicing process thousands of kilograms of mercury were used in the period from the late 1850s to the 1880s, the peak time of the Sierran hydraulic mining industry.[32]

The process of charging or coating the sluices required spreading the mercury on key parts of the sluice surfaces. One English-owned mining company operating in the Yuba River drainage used two tons of mercury in 1873, as an example. Much of the mercury and the finest surface amalgam was swept away into the streams during mining. It was obviously not the intent of companies to have this happen, because this represented a net loss of significant amounts of both gold and mercury. But because loss was inevitable, it was considered a part of doing business. One calculation by mining historian Hank Meals put the losses at about 12 and 1/2 to 15 percent of the total mercury used. The North Bloomfield mine on one Yuba tributary, as an example, lost a total of 21,512 pounds of the metal betwee the years 1876 and 1881.[33]

But what does this loss mean in environmental terms? For one thing it meant widespread accumulation of mercury in the rivers of the northern Sierra Nevada. Some rivers, in particular the Yuba and Bear, continue to have very large quantities of the heavy metal present in them. Urban authorities downstream such as the Sacramento Regional County Sanitation District have noted that what they call "hot spots," where mercury deposits are especially concentrated, exist on the Middle and South forks of the Yuba River and on the Bear River. The amount of bioaccumulation, that is, the concentration of methylmercury in the flesh of fish captured in some areas of the Yuba, exceeds the amount accepted as safe for human consumption by the National Academy of Sciences. The greatest accumulation of such fish and mercury is in dams such as Englebright on the Yuba. The dam accelerates concentrations in fish in the reservoir, while at the same time preventing the dispersal of mercury that would occur if the dams were not present.[34]

The last environmental effect of hydraulic mining in the Sierra Nevada came from the need to impound and transfer huge quantities of water. By the late 1860s and early 1870s, when the industry was reaching a mature state of development, the northern Sierra Nevada had a complex water delivery system in place. It consisted of thousands of miles of canals, pipelines, and ditches, and was fed by numerous dams. This system significantly altered the natural waterscape of the range. These thousands of miles of main pipelines and branch ditches brought millions of gallons of water to the mining areas. Flumes often bridged canyons and snaked along steep slopes or cliffs, funneling water to the powerful hydraulic monitors that were washing away whole Sierran hillsides.[35]

In addition to delivery systems, as noted, the hydraulic corporations also constructed numerous dams or raised natural lakes to store snow melt or rain at higher elevations. Connected to the ditches and flumes, they supplied a reliable supply of water to the hydraulic monitors. These dams ranged in size from small to very large, the latter with heights from 60 to 130 feet. The smaller ones were typically constructed of rubble, sand, and clay, while the largest were constructed of cedar or sugar pine with supporting wooden ribs and plank skins. Some of the largest dams included the English Dam as already mentioned, and the Bowman Dam that supplied water to operations at North Bloomfield. Both were in the Yuba River system.[36]

In 1884, the unregulated hydraulic mining industry in the Sierra Nevada was brought to an end as a result of a legal challenge from the farmers and property owners of the Sacramento Valley. After years of litigation in lower courts, Ninth United States Circuit Court judge Lorenzo Sawyer in San Francisco accepted a case brought against the North Bloomfield company and all other mining operations on the Yuba River. The plaintiff asked for a permanent injunction against further hydraulic mining. After two years of visitation to farms and mining areas and study of the issues, Sawyer ruled that further dumping of mining debris into the streams was forbidden. Attempts to get around the problem of river dumping failed. The death of the industry in California was remarkably swift. There was simply no practical way to contain the debris that was economically feasible.[37]

Within a few years some of the hydraulic water delivery systems began to decay and fall apart because they were not maintained. Some ditches and canals were destroyed later by logging operations. In an important transition, some of the hydraulic water delivery systems were taken over by hydroelectric companies such as Pacific Gas and Electric in the 1890s, or in some instances by irrigation districts that used the former mining ditches to deliver water to foothill orchards. These today also serve the expanding urban populations of the northern foothills with domestic water. In this regard, then, some of the converted ditches and water systems have become part of a permanent alteration of Sierran waterscapes.[38]

In summary, hydraulic mining was a major force in reshaping and changing the Sierra Nevada. In the time from the late 1850s to the 1880s it was probably the most significant single environmental force among many unregulated industries that were at work in the range. The reshaping of Sierran stream systems, the destruction of forest lands, the alteration of aquatic habitat, and the deposition of tons of mercury in Sierran streams continue to have environmental effects today. A quotation from stream scientist Jeffrey Mount is useful here to emphasize my point and bring this article to an end. Noting that the total value of gold extracted by hydraulic mining in California equaled some $5 billion dollars, or only a fraction of the value of just one year's production of oil in California today. He wrote: "No single industry in the history of California has generated more long-term environmental damage for such a meager economic return."[39] Undoubtedly the economic effect of that $5 billion was great, but it is actually quite small in even contemporary terms. Many do not know that by 1860, the value of California agricultural products had exceeded the value of gold produced in California. Thus the issue was that while hydraulic mining was efficient and profitable, the value of farming and commercial activities in the valley was greater and had been so for many years. Also, then as now, we seldom factor in environmental costs in determining profitability of industrial production. If we were to calculate in the uncounted costs to the river systems of the Sierra Nevada inflicted by hydraulic mining, Mounts' statement rings true.

Notes

1. This paper was presented at the 80th Annual Meeting of the American Association for the Advancement of Science. Pacific Division on June 20, 1999.
2. G.K. Gilber, *Hydraulic-Mining Debris In the Sierra Nevada*, Professional Paper 105, Department of the Interior, U.S.G. (Washington, D.C.: Government Printing Office, 1917), 38.
3. Gilbert, *Hydraulic-Mining Debris*, 43.
4. See Jeffrey F. Mount, *California Rivers and Streams: the Conflict Between Fluvial Processes and Land Use* (Berkeley, Los Angeles, London, : University of California Press, 1995), 205; David J. Larson, "Historical Water-Use Priorities and Public Policies, *Sierra Nevada Ecosystem Project, Final Report to Congress, vol. II, Assessments and Scientific Basis for Management Options* (Davis: University of California, Centers for Water and Wildland Resources, 1996, 183.
5. Gilbert, *Hydraulic-Mining Debris*, 31, 67-68
6. Mount, *California Rivers and Stream, 208*.
7. Jennifer A. Curtis, "A Sediment Budget of Hydraulic Gold Mining Sediment, Steephollow Creek Basin, California, 1853-1997," Masters Thesis, Humboldt State University, April 1999, 71-72.
8. Gilbert, *Hydraulic-Mining Debris*, 50-51.
9. The standard political analysis of the hydraulic mining controversy is Robert L. Kelley, *Gold vs. Grain: The Hydraulic Mining Controversy in California's Sacramento* Valley (Glendale, California: Arthur H. Clark Co., 1959). See also, Duane A. Smith, *Mining America: The Industry and the Environment, 1800-1980* (Niwot, Colorado: University Press of Colorado, 1993), 67-74; Norris Hundley, Jr., *The Great Thirst: Californians and Water, 1770s-1990s* (Berkeley, Los Angeles, London: University of California Press, 1992), 74-75. For a study of hydraulic mining and the California Debris Commission created by the U.S. Congress to control it see Joseph J. Hagwood, *The California Debris Commission* (Sacramento, California: U.S. Army Corps of Engineers, 1981).
10. For a useful discussion of environmental history and the struggle over its definition see John Opie, *Nature's Nation: An Environmental History of the United States* (Fort Worth, New York, London: Harcourt Brace College Publishers, 1998), 2-4, 6-7.
11. See *Environmental History*, Volume 4, #1 (January 1999), 2.
12. See for example, Samuel P. Hays, *Conservation and the Gospel of Efficiency* (New York: Atheneum, 1969); G. Michael McCarthy, *Hour of Trial: The Conservation Conflict in Colorado and the West, 1891-1907* (Norman: University of Oklahoma Press, 1977); Roderick Nash, *Wilderness and the American Mind* (New Haven and London: Yale University Press, 1967); Alfred Runte, *National Parks: The American Experience* (Lincoln and London: University of Nebraska Press, 1979), Stephen Fox, *John Muir and His Legacy: The American Conservation Movement* (Boston and Toronto: Little, Brown and Co., 1981); Douglas H. Strong, *Tahoe: An Environmental History* (Lincoln and London: University of Nebraska Press, 1984).
13. William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York and London: W.W. Norton and Company, 1991), xv-xvi, xv-xix.
14. William Cronon, ed, *Uncommon Ground: Rethinking the Human Place in Nature* (New York and London: W.W. Norton and Co., 1995), 11-22.
15. David Beesley, "Reconstructing the Landscape: An Environmental History, 1820-1960," *Sierra Nevada Ecosystem Project: Final Report to Congress, vol. II, Assessments and Scientific Basis for Management Options* (Davis: University of California, Centers for Water and Wildland Resources, 1996), 5-9.
16. Beesley, "Reconstructing the Landscape," 5.
17. Carmel Barry Meisenbach, *Historic Mining Ditches of the Tahoe National Forest, Report #28* (Nevada City, CA: Tahoe National Forest, 1989), 10-39.
18. Beesley , "Reconstructing the Landscape," 6.
19. Raymond F. Dasmann, "Environmental Effects Before and After the Gold Rush," *A Golden State: Mining and Economic Development In Gold Rush California* (San Francisco: California Historical Society and University of California Press, 1998-1999), 116-118, 120-121.
20. Maureen A. Jung, "Capitalism Comes to the Diggings: From Gold Rush Adventure to Corporate Enterprise," *A Golden State*, 73-74.
21. Gilbert, *Hydraulic Mining Debris*, 43.
22. Gilbert, *Hydraulic Mining*, 43-46.
23. Gilbert, *Hydraulic Mining*, 67-68.
24. Mount, *California Rivers and Streams*, 208-210.
25. John B. Leiberg, *Forest Conditions in the Northern Sierra Nevada, California. Professional Paper No. 8, Series H, Forestry, United States Geological* Survey (Washington, D.C.: Government Printing Office, 1902), 44.
26. Leiberg, *Forest Conditions in the Northern Sierra Nevada*, 38, 44.
27. All quotations in this paragraph are from Leiberg, *Forest Conditions in the Northern Sierra Nevada*, 55, 65, 98, 121, 131, 140, 147.
28. E.R. Stanford, "A Short History of California Lumbering," M.A. Thesis, University of California, Berkeley , 1924, 11-87; David Beesley, "Whistle Punks and Steam Donkeys: Logging in Nevada County and the Northern Sierra During the Age of Animal and Steam Power," *Nevada County Historical Society Bulletin*, 38, 4 (October 1984), 26-27.
29. Beesley, "Reconstructing the Landscape," 7; Barry-Meisenbach, *Historic Mining Ditches of the Tahoe National Forest*, 40; Hank Meals, *Columbia Hill Nevada County, California: An Interpretive History* (Nevada City, CA: Susan

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30. Beesley, "Reconstructing the Landscape," 6; Leiberg, *Forest Conditions in the Northern Sierra Nevada*, 39-40.
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