

The Hudson's Bay Company Brigades of 1832-33 and the Malaria Epidemic in California

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Abstract

The ecological and cultural impacts of the Hudson's Bay Company fur brigades to California were long term and important. The expedition of 1832-33 led to a catastrophe comparable to the Jewish Holocaust or the Palestinian Nakba. The fur trappers inadvertently spread a malarial "intermittent fever" leading to mortality rates from 50-90 percent or more. It is possible that more than 30,000 people died from the fever in the affected areas of California, with many tribelets simply wiped out. In addition to this social and cultural tragedy the removal of the Native American land managers and beaver initiated many changes at the plant-community, ecosystem and landscape scales. If we wish to understand the landscape we see today, we must try to understand what has happened in the past, and these two years deserve much greater attention.

Introduction

Few Californians and even fewer Americans are aware of California's historic fur trade. The Russians learned the value of sea otters first (1742), and were active on the coast for many years before the British and Americans arrived. British and American sea otter hunting began in earnest after 1779, when prime skins from the Cook expedition brought a return of £90 on an investment of

one shilling on the market in China. Profits of 500 percent or more found ready investors in Boston and England and the fur trade in California grew quickly. As new fur resources, or as the Russians so aptly put it, "soft gold," were discovered, they were exploited as well.

Trade in seal skins and beaver pelts followed the sea otter rush, involving Russian, American and British companies, independents, Spanish residents, missionaries and native people. The first rumors of fur trappers from the north working in California were raised as early as 1820-21, but the first official Hudson Bay Company's (HBC) brigade, led by Thomas McLeod, reached the Klamath River in northern California in 1826. Jediah Smith's party was the first American group, arriving through the southern desert the same year. By 1843, after less than 20 years, the 'soft gold' rush in California was essentially over.

Many of the fur trapping parties left no records. As Robert Cleland noted, "the very nature of the men who made up these expeditions also adds to the difficulty of the task. The fur hunter, like most pioneers, was a man of action rather than a chronicler of events..." We know much more about the HBC brigades because the chief traders were required to maintain careful records and most of their journals have been preserved. The Hudson's Bay Company brigades seeking beaver were the most impressive fur trade enterprises in California, beginning in earnest in 1827 and continuing until 1843, when the market had collapsed due to changing fashions, causing tremendous ecological and cultural impacts on the environment and the people.

Cultural impacts of the fur trade

The Intermittent Fever

Arguably the most devastating expeditions took place in 1832-33 under the leadership of Chief Trader John Work and Michel LaFramboise. After returning from an expedition to the Snake River country on July 27th 1832, Work was ordered to make a quick turn-around, to head up the outgoing California brigade and to keep an eye on a smaller California brigade under Michel LaFramboise.

Unlike the American fur trapping parties, small and almost all male, these HBC parties were large, well organized and very effective trappers, often with more than 100 people, including wives, children and babies, and hundreds of horses, figure 1. These brigades moved south from Spokane or Fort Vancouver (now Vancouver, Washington) into California, reaching as far as the Gulf of California over the course of many months or as long as two years. The men might be salaried workers (*engagés*) or freemen (called free trappers by the Americans), paid on a per fur basis. The women played a critical role in processing furs, enabling the men to devote their time to trapping. The brigades often over-wintered at Camp de los Franceses (now

French Camp just south of Stockton). More like a village on the march than our common perception of fur trappers as solitary or small groups of mountain men, they moved slowly, trading with native people, as well as setting their own traps. They worked their way up and down the state's rivers, streams, and wetlands with expertise honed in the Snake River country and the desire to create a 'fur desert' that would discourage American trappers and slow the American advance.

The ecological and cultural impacts of the 1832-33 expedition included not only the traditional heavy pressure on the beaver population, hunting for food and sport, but more critically the introduction of a fatal disease that traveled with the 1832 brigade. The "intermittent fever," apparently malaria, made its way into the western fur trade through Fort Vancouver and surrounding tribes beginning in 1830. It is possible that a sailor named Jones on the American Brig *Owhyhee*, captained by John Dominis, was the source of the disease. He had probably been infected in Hawaii or China. The native people in the Columbia region were convinced the fever was brought by the ship *Owhyhee* and Captain Dominis. However, this might have been early political spin by



Figure 1. The California brigade heads north from Sutter's Buttes, 1833.

the HBC in an effort to blame their competitors. The disease persisted in the area around Fort Vancouver for several years, reaching peaks in spring and fall when the *Anopheles* mosquitoes were most abundant. It was still a problem when Ewing Young headed north from California in 1834 with a band of horses and Hall Jackson Kelly. Kelly almost died, but was saved by help from the Hudson Bay leaders who had experience with the disease.

Impacts near Fort Vancouver were catastrophic in 1830-31, with many villages abandoned and later burned by Hudson's Bay Company employees to dispose of the bodies. The Chinook village downstream from the fort was hard hit. Within a few years the noble chief Casenove, a friend to the whites, was the only survivor of a tribe which had once mustered four or five hundred warriors. Other tribes disappeared completely, "many others (tribes) have been swept off entirely by this fatal disease, without leaving a single survivor to tell their melancholy tale." Thousands died and as people fled the epidemic they helped spread it. In 1831 the disease was carried around the Northwest by fur traders and native travelers. Most Europeans were sickened, but recovered thanks to quinine, better treatment, and innate resistance; but mortality ranged from sixty to ninety percent or higher in the native population. Like the Jewish Holocaust and the Palestinian Nakba – everything changed as communities were destroyed almost overnight.

Fever on the march

"I am going to start with my ragamuffin freemen to the South." John Work to Francis Ermantinger, 27 July 1832

The first case of intermittent fever in 1832 was reported at Fort Vancouver on July 5, the day the first brigade left for the Snake River Country en route to California. John Work and his brigade left on August 17 with 26 men, 22 women (including his wife, Josette), 44 children (including Work's three young girls), and six Indians. Sadly, they carried the fever with them. His clerk, Francis Payette, was so sick he had to be left at Fort Nez Perce, and the illness delayed their departure until September 9th. Work was dosing ten people for the fever when he left the fort. Michel LaFramboise's smaller brigade of 63 people, with 22 trappers and 41 Indians, departed earlier but was also carrying the disease. The epidemic rose and fell over Work's yearlong expedition, with almost everyone sick at some time. In August 1833 Work notes, "Some of those who have been longest ill are a little better, the greater number of others are very bad and 7 more are taken ill during the last night and today making in all 72 ill." Two men, an Indian and two children died along the way despite Work's use of medicine (which ran out long before they returned) and care.

As these large parties traveled through the countryside trapping beaver on rivers and side streams and hunting for meat, native people would also meet them bringing the disease carrying outsiders in contact with many local people. Work's brigade went down the eastern route (Ft. Nez Perce, Malheur Lake, Pit River) and LaFramboise started down the coastal route but switched to the Siskiyou trail (Willamette, Umpqua, Shasta) and both returned up the Siskiyou trail after trapping the Sacramento, San Joaquin and coast range, figure 2. An American fur trapping party under Ewing Young met the HBC brigades, and in turn picked up the intermittent fever and spread it through their travels. Two

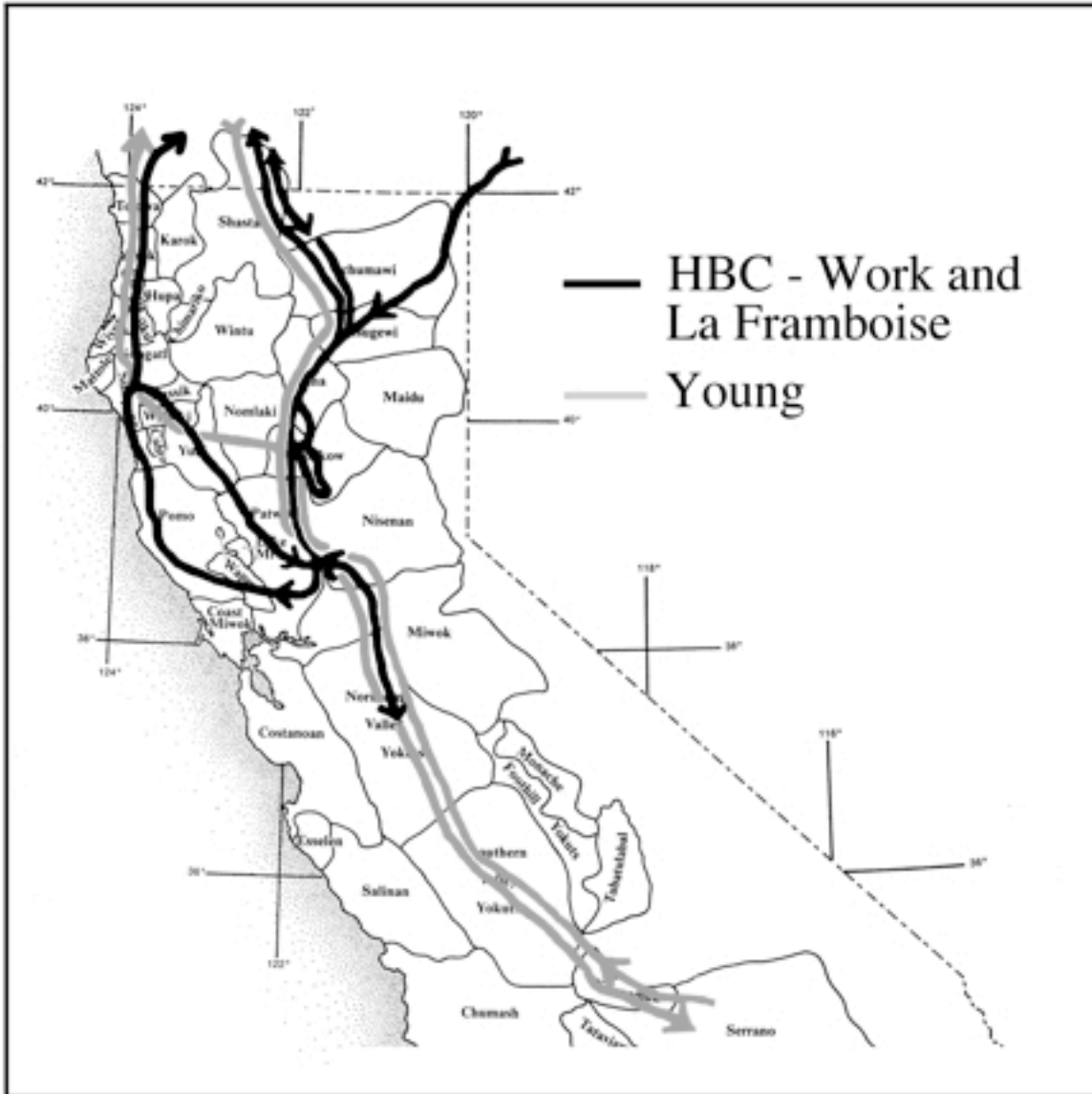


Figure 2. The fur brigade routes in California 1832-33.

people in Young's much smaller party died, and Young became very ill.

There were plenty of mosquitoes as Work noted on June 1, 1833 "We are much annoyed by muscatoes, they are very numerous." Three days later he added, "Muscatoes are like to devour us in every situation that is sheltered a little from the wind." The impact of the disease was catastrophic, figure 3. The disease spread most quickly and was most devastating in low-lying areas with more

mosquitoes, and diminished on the coast and in the mountains.

The Catastrophy

The impact of the disease was clear even as the brigades returned north in the fall of 1833, sick themselves. In his journal, 6 August 1833, Work noted, "Some sickness prevails among the Indians on the feather river. The villages that were so populous and swarming with inhabitants when we passed

that way in Jany or Febry last seem now almost deserted & have a desolate appearance. The few wretched Indians who remain seem wretched they are lying apparently scarcely able to move. We are unable to learn the malady or its cause.” From a letter Work sent ahead of the brigade on the way home. Dr. McLoughlin noted in a subsequent letter, “Mr. Work writes me that nine-tenths of the Indian population from here

(Vancouver) to there (the Sacramento Valley) is mostly destroyed.”

Estimates of deaths are problematic, because so little was known about many of these tribes before they were gone or severely affected, figure 3. Many tribelets probably just disappeared. The San Joaquin and Sacramento Valleys were valleys of death. As George Yount later recalled, “The bodies of untold thousands lay whitening the plains and fertile valleys.... Deserted and desolated

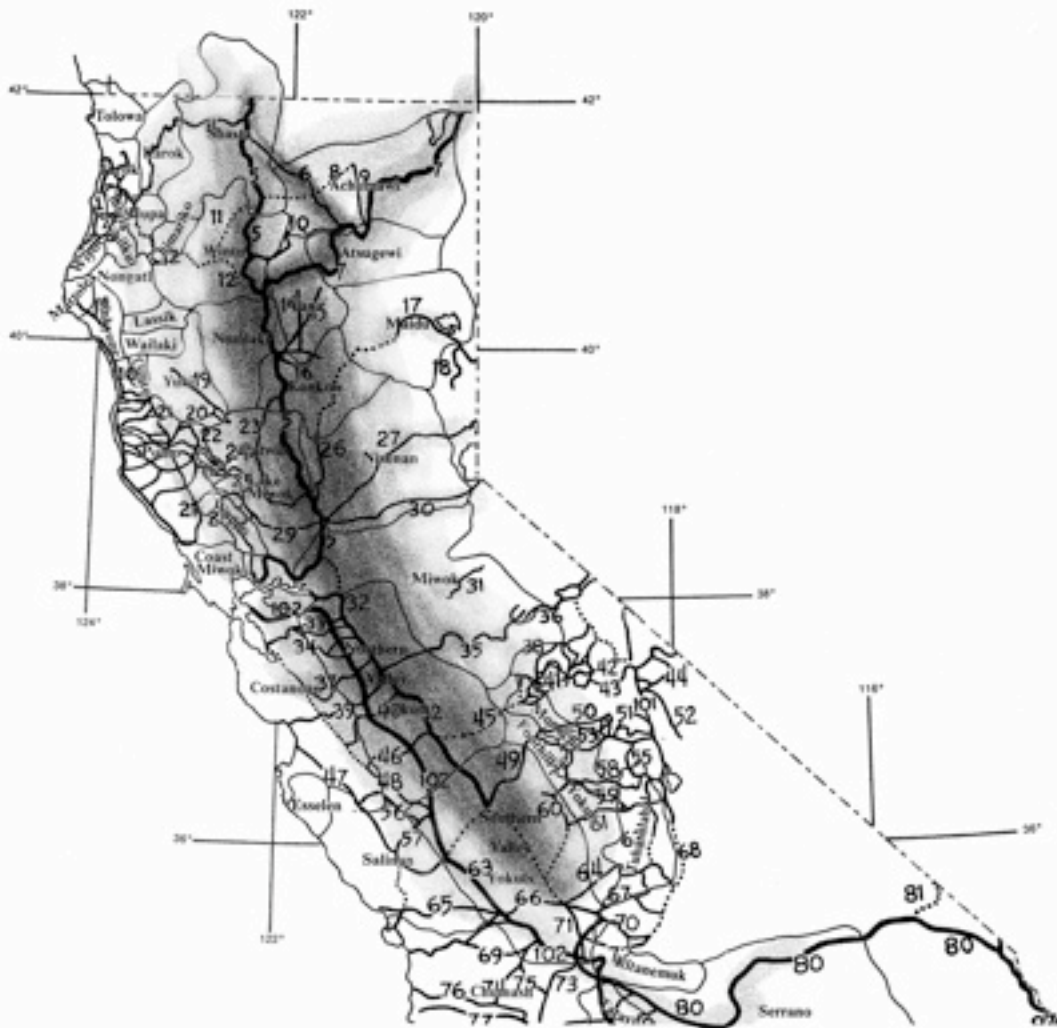


Figure 3. Map of the probable “intermittent fever” epidemic and impact. Impacts were more severe at low elevations and areas with extensive wetlands.

village sat tenantless all over the valleys...” Jonathon J. Warner remembered the before and after, “The banks of the Sacramento River, in its whole course through the valley, were studded with Indian Villages, the houses of which, in the spring, during the day time were red with the salmon the aborigines were curing... On our return, late in the summer of 1833, we found the valleys depopulated. From the head of the Sacramento to the great bend and slough of the San Joaquin, we did not see more than six or eight live Indians, while large numbers of their skulls and dead bodies were to be seen under almost every shade tree, near the water, where the uninhabited and deserted villages had been converted into graveyards.” At the junction of the Feather River and Sacramento the U.S. Exploring Expedition found “the ground strewn with the skulls and bones of an Indian tribe, all of whom are said to have died.”

Tens of thousands of people died from the epidemic in the Sacramento and San Joaquin Valleys. The mortality rates were generally estimated at from sixty percent but entire groups were killed in some cases. The pestilence spread over a much larger area as refugees fled and natives traveled the traditional trade routes through the malarial areas. Anopheles mosquitoes are widespread in California, from sea level up to 6,000 feet. The final death toll was tragically appalling, stretching from the Columbia River south to the San Joaquin Valley. The infected members of the trapping parties may also have carried malaria to the Rockies and southwest as they traveled to the Rendezvous of 1833 and 1834.

This catastrophe had profound impacts on many tribal groups. Some disappeared completely, others were reduced to starvation and perished, others became refugees, spreading the disease still further, and some

reconsolidated into new groupings. The intermittent fever remained in California and was a persistent problem for the Gold Rush miners, who passed through and occupied the same areas.

Changes in the land

The loss of the land managers

Perhaps the most important impact of the brigades of 1832-33 was the removal of the native land managers who had applied their intelligence, energy and expertise to improve the productivity and value of their lands for thousands of years. The human cost was tragic, but so was the loss of knowledge and management skills and practices. Native people had acted as agents of environmental change in three important ways: agents of habitat modification, dispersal, and genetic modification. These affected populations and plant communities at the ecosystem and landscape scale. Controlled burning was probably the most important form of habitat modification, but many large and small decisions and management activities had long-term effects on ecosystem structure and function.

As large areas were partially or totally depopulated by the fever, the use of fire to manage ecosystems declined. Selected areas had been burned regularly at different seasons and frequencies to improve hunting, facilitate harvesting of acorns and other tree and shrub seeds, to produce desired materials, such as numerous straight willow shoots for weaving, to favor preferred food plants like perennial grasses and bulbs, and to maintain open travel and vision. The park-like quality of the western landscape began to fade. Diseases and insects that had been controlled by burning increased. As Klamath River Jack noted, “Old acorn on ground have lots of

worms; no burn old acorn, no burn old bark, old leaves, bugs and worms come more every year. Indian burn every year just same, keep all ground clean.”

The elimination of periodic burning (often on a short return frequency) contributed to dramatic changes in plant communities. In many areas open savanna oak and pine turned into brush fields or thickets susceptible to severe fire storms. The way fire had been managed developed an open landscape most of us would prefer even today. The magnitude of the changes can be hard to imagine. In Ponderosa forests in the Southwest, stem counts increased from 23 to more than 800 trees per acre in some areas and comparable changes were also found in California.

The burning, harvesting (seeds, fruit, craft materials, medicinal plants, plant material for homes and tools, firewood, wildlife, insects, fish), planting, thinning, pruning, seeding and transplanting that the Native Californians had done was reduced or eliminated. Species that needed special care from humans to prosper, declined or disappeared. Vegetation changes were also triggered by the changes in hunting pressure as villages vanished. Herbivory increased as rabbits, deer, antelope and other favored food animals were released from hunting pressure. These changes would have been incremental but profound over much of central and northern California where the intermittent fever struck.

The Loss of the Beaver

The removal of the beaver was also ecologically significant. The 1832-33 HBC brigades of John Work and Michel LaFramboise alone brought back almost 2000 beaver pelts. The best fur quality was found in the spring when trapping was pursued vigorously. The impact was described by

Peter Skene Ogden in the Snake River country on May 28, 1829, “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. They quickly drew down and often wiped out the beaver populations taking male, female and young. Here the goal was to get all the beaver possible as quickly as possible to create a ‘fur desert’ that would discourage American trapping parties and slow their advance. As Governor George Simpson wrote to John McLoughlin in July, 1826, “It is intended that a strong Trapping Expedition be kept up to hunt in the country to the southward of the Columbia ... and to leave it in as bad a state as possible.” Peter Skene Ogden felt some remorse, “It is almost a sin to see the number of small beaver we destroy and to no purpose. Some of the females taken have no less than five young ... [and] rivers subject to overflow their banks require double and treble the time to recruit after being trapped.”

Beaver activity is easily identified and trappers became very skilled at catching them. Female beavers do not mature for three years and do not produce large litters until even later, so a repeated trapping effort can easily wipe out a population. As the adults were trapped out, the young beaver would often be unable to fend for themselves. Widely dispersed survivors may have had trouble finding each other, and even if a colony restarted it would often be taken in the next year or two as trapping pressure continued high for many years. The rapid decline in population can be seen in decreasing returns from the Snake River country and the California parties. For example, when they revisited a previously

trapped area they took two beaver when earlier eighty had fallen.

The total beaver harvest in California will never be known. Virtually all of the parties were in the field illegally or attempting to avoid taxes and tariffs, including HBC. Inland American trapping parties, including Jedediah Smith, Ewing Young and others who covered much the same ground as the HBC, often carried or shipped their pelts east. Those who went through Santa Fe faced additional risks, with many furs confiscated by Mexican authorities. Coastal trading by ships from several nations, sometimes legally, but more commonly illegally, also shipped out many pelts, including beaver. Many hundreds or thousands of pelts were also lost or spoiled by poor handling in transit, poor caches, theft or accidents. When the traps were not set correctly beaver would chew off their foot to escape the trap and subsequently die.

Records suggest that the total take for the Hudson's Bay Company parties in California was probably around 20,000 beaver. The total for all parties trapping in California in this period might exceed 40,000, comparable to the 35,000 HBC took out of the Snake River country. Many thousand were also trapped and sold by the Spanish settlers and missionaries. Counting subadults and kits that died after adult females were trapped and animals that were killed but not recovered, may push the total to 50,000 from the trapping efforts in California in the 1820s and 1830s. Their removal initiated change in watersheds and ecosystems through the beaver lands, reaching from the San Francisco Bay area, south to the southern San Joaquin Valley, along the western Sierra streams, through the coast range north to Oregon and throughout northern California. Beaver may also have been extirpated on the east side of the Sierra. The Sacramento river

delta and north San Francisco bay were rich in beaver as Thomas Farnham noted, "There is probably no spot of equal extent on the whole continent of America, which contains so many of these much sought after animals."

Beaver play important hydrologic and ecological roles in watersheds and their removal leads to undesirable changes. As Outwater noted, "Beavers do more to shape the landscape than any other mammal except human beings..." Well-maintained beaver dams help stabilize streams and rivers, retaining more water in the watersheds, figure 4. They are especially important in arid and semiarid regions like California and southern Oregon where they help capture and retain spring snow melt and minimize damage from intense summer storms. One beaver dam in Wyoming was found to store 75 million gallons of water and could provide water flow for 117 days.



Figure 4. Beaver dam and pond

Dams also capture sediment and reduce erosion. Water samples from above and below ten dams showed almost two-thirds of the sediments were captured, about 185 pounds

per acre foot of water. Studies in the mountains of Montana revealed that a dam may be filled in completely within ten to fifteen years. Nutrient capture and retention is also important, with much higher nutrient levels in beaver systems. Total nitrogen increased seventy two percent in a watershed with beaver, while the more available NO₃-N more than doubled. Phosphorus loss increased three fold after dams were removed, and organic matter increased threefold after beaver dams were built. These combined effects typically improve productivity and reduce water pollution.

The number of dams per beaver, or beaver per dam is variable depending on stream and habitat characteristics. A typical beaver family might include the breeding pair, typically three to five kits, and yearlings. Beaver families may have no dam if they live in larger, low gradient rivers or lakes. In other areas several beaver may live in one large dam and canal complex, but on smaller, higher gradient streams they may develop a large number of dams even on small streams.

One research project in Wyoming released ten beaver into a river where they had been absent. By the following year they had constructed 55 dams. This is considerably larger than the estimated development of 2-5 dams per family of 6 beavers. Not all the beaver taken in California were in dam building country, but the beaver harvest probably resulted in the loss of tens of thousands of dams in central and northern California. Early biologists made many errors about beaver distribution because they had been eliminated so early. In addition down cutting of streams, channelization and habitat destruction obscured the original much greater range of the beaver.

Beaver dams may fail in intense storms, even if the beaver are present. But when

beaver dams are left unattended they degrade and become much more vulnerable to intense storms. When they fail, they may destabilize stream channels, increase flow velocity and make streams and rivers more vulnerable to erosion and channel down-cutting. Water storage starts to decline quickly after the beaver are gone; within a week or two the water level will drop six inches to a foot as maintenance work stops. In low gradient streams or rivers this can lead to rapid reduction in wetland area. When failures are catastrophic, erosion can be locally severe. Summer stream flows often decline or cease.

Beaver have finally been acknowledged as important agents for environmental repair, largely because of the value of their dams for water retention and flow stabilization. The benefits from beaver activity in an aquatic ecosystem, primarily through dam construction, include: improved water quality reducing treatment costs; increased water storage and stabilization of stream flows throughout the summer and droughts; protection of downstream croplands and urban developments from floods. Dams also enhance fish habitat in streams by increasing water depth, maintaining refuges of deeper cooler water, and production of aquatic invertebrates (for recreational fishing). They also provide improved habitat for waterfowl, big game, and game birds (for hunting); improved habitat for other wildlife through vegetative growth; and increased forage production, shelter, and water for domestic livestock.

The dam building and foraging of the beaver also shape ecosystems in many ways. If beaver population densities are high then cottonwoods, aspen, and other favored food species may be over-harvested, causing long-term habitat decline for beavers. If riparian restoration is undertaken cages to protect

newly planted or important existing trees from beaver are usually needed. Habitat decline may force the beavers to relocate. The extensive flooding behind dams will often kill pines and other trees in the impoundment. The often extensive beaver canals and channels help spread water across flood plains and increase growth of wetland and riparian plant species.

The beaver's stable ponds, channels and cleaner stream water downstream often improve fish habitat and reproduction. In some cases the dams and sediment deposition may adversely affect fish populations by blocking migration and damaging existing spawning areas. Water spreading and tree removal may also increase water temperatures and shift composition of fish, amphibian and insect species. A study of the amphibian, *Rana sylvatica*, suggests that beaver dam building may initiate evolutionary change relatively rapidly.

The larger wetland areas on beaver streams provide critical habitat for many other insect, plant and animal species. Beaver dams often provide essential habitat for waterfowl. Duck populations, for example, were seventy five times higher on streams with beaver dams in a paired study comparison in Wyoming. If the beaver are removed, the associated habitat quality declines as the dams gradually fail and disappear. If the beaver ponds are maintained they eventually fill in, creating first shallow marsh and then grassy meadows that may provide unique and rather rare habitat types in arid and semi-arid areas.

Hunting for sport and meat

The impact of the fur trapper brigades from hunting, presaged the consequences of the Gold Rush. Feeding more than a hundred

people with meat was no easy task in some areas, but when conditions were right the hunters did very well, "... 395 elk, 148 deer, 17 bears and 8 antelopes have been killed in a month which is certainly a great many more than was required, but when the most of the people have ammunition and see animals they must needs fire upon them let them be wanted or not," John Work, Feb 22, 1832. Work also complained about indiscriminate shooting by the freeman associated with his party on another trip, "30 (buffalo) were killed & not more than the meat of three were brought into camp." With two HBC parties and an American group in the field for a year the cumulative totals must have been impressive. So much shooting was done that the HBC brigades had to buy more ammunition. After no luck in finding powder and lead at Mission San Francisco de Solano they were able to bargain for some at Fort Ross. In the early 1840's the U.S. Exploring Expedition observed that in the area around the junction of the Feather and Sacramento rivers, "Game is represented to have decreased in this vicinity for the numbers destroyed by the parties of the Hudson Bay Company..."

A high cost for a small return

The Hudson's Bay Company fur brigades of 1832-33 returned with a modest profit, but at an exceptionally high cost. Certainly there was no intent to spread disease. Work, seeing the depopulation in December 1833, asked his party to avoid villages in case the disease was infectious. The trappers were generally married to, or traveling with, native women, children and often babies, and native trappers were usually included in the parties. It was sometimes claimed that brigade leader Michel LaFramboise had a wife in every tribe along

the California trail. The Hudson's Bay Company traders, engagés, and freemen worked and traded with natives throughout their lives. If attacked or provoked they would fight, but unlike many of the American trappers they were not generally "Indian killers." Yet inadvertently the brigades under John Work and Michel LaFramboise became agents of death through central and northern California and southern Oregon.

John Work returned to Fort Vancouver in the Fall of 1833, "I was reduced to a perfect skeleton and so much exhausted and debilitated I could scarcely walk." Work returned with only 1023 beaver and otter skins, yet may have inadvertently led to the death of 50,000 people. Twenty to fifty deaths per skin returned is a very high cost indeed. Work and LaFramboise may have suspected that the HBC company brigades had caused some death, but couldn't have imaged the full impact of their trapping parties. It is a cautionary tale for us today, as we still see companies scrabbling for profit without counting the external costs.

The over-harvesting of furs also illustrates the importance of tenure in sustainable land management. As Peter Ogden noted in 1827, "Did we not hold this country by so light a tenure it would be most to our interest to trap it only in fall, and by this mode it would take many years to ruin it." The problems of unclear or weak tenure and unowned resources remain critically important today.

The intermittent fever helped clear the way for the gold miners and settlers of California. As Cook noted, "the red race in the heart of California was so crippled it could offer but the shadow of opposition to the gold-mining flood which swept over it in 1849." Without the dieoff there would have been much more bitter conflicts as the miners reached central California. The result may

have well been the same for the beleaguered tribes, but perhaps not.

It would also be interesting to more carefully consider possible tribal alignments before the fever. If, as suggested, some villages were completely wiped out it is possible whole tribes were lost. This may be suggested by the tribal territorial area sizes on figure 3. The areas hardest hit by the fever appear to have larger tribal areas than those of surrounding less resource rich areas when we might expect the opposite. Tribelets and survivors may have combined after the catastrophe and been well enough settled by the time ethnographers arrived to appear more permanent than they really were.

While the dieoff of people was clearly seen, the interpretation of the resulting changes in landscape evolution and ecosystem processes remains little studied. The distribution of beaver as recorded by zoologists and game managers neglected the historical extirpation in many watercourses and areas of California. Many changes in ecosystems initiated by the fever die-off of Native people may still be seen today if we look closely enough. In addition to the abandoned village sites, still visible when not plowed out or covered over, figure 5, the



Figure 5. Konkow pit house depressions

changes in distribution of oak trees, forest density, and plant and animal community structure and composition can be found throughout central and northern California.

The effect of the intermittent fever on the native people resulted in many changes to the plant and animal communities, but the removal of the beaver (on this and many other expeditions) also triggered significant hydrologic changes. Streams that once flowed in the summer dried up. Increased flood intensity led to channel cutting, erosion and cut bank formation. Changes in river flow and channel stability and wetlands in turn affect a wide range of plant, insect, animal and bird species.

These many changes in population and ecosystems can be linked to the catastrophe that began to unfold as the Hudson's Bay Company brigades entered California in 1832. As environmental historians and landscape ecologists we need to better understand what happened in order to more accurately comprehend what we see today. This can enable us to develop better management strategies for a more sustainable future.

Figure 1. Image developed from paintings of the fur trade by Alfred Jacob Miller, retained by the Scottish adventurer William Drummond Stewart to document his travels in the American west, and photos by the author.

Figure 2. Developed from a range of resources on the travels of John Work and Ewing Young, and Robert T. Boyd, *The Coming of the Spirit of Pestilence*, 94, and Robert F. Heizer (ed), *Handbook of North American Indians: Volume 8: California*), ix.

Figure 3. Developed from maps and information in Sherburne F. Cook, "The epidemic of 1830-33 in California and

Oregon." *University of California Publications in American Archeology and Ethnology* 43(n3 1955):303-325; James T. Davis, *Trade Routes and Economic Exchange among the Indians of California*, (Ramona: Ballena Press, 1974), np.; and Robert F. Heizer (ed), *Handbook of North American Indians: Volume 8: California* (Washington, DC: Smithsonian Institution, 1978), ix.

Figure 4. Beaver dam and pond, photo by the author.

Figure 5. Pit house depressions from abandoned village site, photo by the author.

About the author

David A. Bainbridge was educated at the University of California in San Diego, Earth Sciences, and U.C. Davis, Ecology. He has published many books and book chapters in restoration, resource management and building and more than 300 articles, papers and reports, for audiences ranging from *Tree Planter's Notes* to the *Wall Street Journal*.

His interest in 1212 the sustainable management of deserts and dry lands led him to the Dry Lands Research Institute at U.C. Riverside, where he was coauthor of the groundbreaking guide to information on *Sustainable Agriculture for California* in 1991. His work on desert restoration began at UCR, then moved to San Diego State University and finally to Alliant International University, culminating in the book **A Guide to Desert and Dryland Restoration**, Island Press 2007.

His long term interest in economics and the drivers of management decisions has led him to focus on sustainability, sustainability reporting, resource management and environmental accounting in recent years, and **Rebuilding the American Economy with True Cost Accounting** was published in 2009. He has won awards for teaching, service and research.