Part 5: Historical Aquatic Systems

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> *The rivers of the Front Range are dammed and diverted to provide water to the surrounding regions, and they are constricted by roads and railroads, stocked with fish, polluted by mining wastes and urban runoff. Yet many of the people who visit the Front Range for short periods perceive the landscape to be a nearly pristine wilderness because they are unaware of the historical impacts of human activities.* (Wohl 2001)

Anthropogenic Changes to the Hayman Area

Although there is little historical information on the aquatic ecosystems within the perimeter of the Hayman Fire, we have developed a probable description of them based on available sources as well as from literature and reports on other Colorado Front Range systems, particularly the recent scholarly work of Wohl (2001).

Three recent periods of anthropogenic change (including early Native American influence) influence the current structure and function of the aquatic ecosystems in the area of the 2002 Hayman Fire: (1) prior to 1811 before beaver trapping began; (2) between 1811 and 1859 during which the beaver were essentially removed through extensive trapping for the fur trade; and (3) from 1859 to 2002 during which more extensive and complex changes occurred in the aquatic system. The cumulative result of almost 200 years of change is an aquatic and riparian environment that was already substantially and probably irreversibly different in physical and biological structure and function prior to the 2002 Hayman Fire.

Pre-1811 – Before 1811 the effects of humans would have been relatively subtle in this naturally dynamic system as the influences of native inhabitants were thought to be small (Kaufmann and others 2000, 2001; Huckaby and others 2001). The geology, topography, and climate within the Hayman Fire area probably had the most influence on the processes and structure of the aquatic and riparian systems. The dominant geology of noncalcareous granite that forms relatively unconsolidated and highly erodible soils contributes to naturally high erosion rates. The steep canyons and a local climate that is influenced considerably by storm events in the late spring through early fall months exacerbate erosion potential. While early inhabitants may have altered the frequency of forest fires in the basins along the Front Range, the effects of these alterations on aquatic ecosystems and biota were probably small and localized. Influxes of sediment and wood would have entered the streams and rivers following natural fires, windstorms, or floods (Benda and others 2003).

These sediment and wood inputs would have enhanced the development of fans, terraces, wide floodplains, and side channels throughout the system, creating highly complex habitats in some areas. In addition, woody vegetation regeneration would have begun shortly after sediment deposition on floodplains and gravel bars. As a consequence of this disturbance, watersheds throughout the South Platte River drainage probably existed in a mosaic of conditions prior to Euro-American settlement.

Key disturbance processes affecting aquatic ecosystems before 1811 were most likely those common to other Front Range systems: floods, debris flows, and avalanches at higher elevations, drought, wind, and fire. The floods in this area primarily result from snowmelt or rainfall. Snowmelt floods occurred in late spring and early summer and generally lasted less than a month. Monsoon storms in July and August produced floods lasting 3 or 4 days (Wohl 2001). Windstorms probably occurred periodically in these areas as well, contributing wood to channels and affecting water, sediment, and nutrient storage and routing. Where fires exhibited high severity, but infrequent return intervals, there were probably pulses of debris and sediment associated with flood flows. It is likely that where fire severity was low, these effects were moderated both temporally and spatially.

Beaver also could have been considered a key biological disturbance process. Beaver were thought to be well distributed across the Front Range and would have had a significant effect on the structure and functioning of these streams and rivers (Wohl 2001). On streams with suitable habitat, beaver density might have averaged two or three colonies (six to 40 animals) per half mile (Wohl 2001). Suitable habitat for beavers include streams or rivers with constant or nearly constant flow, in valley bottoms on the order of 150 feet wide, channel gradients of less than 15 percent and near aspen or willow (Wohl 2001). We analyzed stream gradient in the Hayman Fire area and found that 84 percent of the stream miles had gradient less than 14 percent, and within this, 26 percent of the area was aspen dominated and an additional 19 percent was riparian shrub dominated (before the fire). While we are not proposing that the historic distribution of suitable beaver habitat was 45 percent of the area, there is good reason to believe that beaver were historically well distributed in the area. Beaver presence and activity probably would have resulted in a more enhanced braiding of stream channels in low gradient sections and more wetland habitat than are present today. Beyond the direct result of beaver on the structure of the perennial streams and rivers, a significant beaver presence would have resulted in riparian areas that were probably lush and moist in the broad valley bottoms and not as prone to severe fires except during longer periods of extreme drought. If these riparian areas did burn, they most likely did so in a patchy pattern (Arno and Allison–Bunnell 2002; Dwire and Kauffman 2003). Smaller, steeper, and drier drainages probably burned more often and more similarly to the adjacent hillslopes. The nature of the riparian development in the broad valley bottoms would have buffered downstream disturbance effects. Overall, these disturbances were likely to have been patchily distributed in time and space and describe the "natural variability."

Beaver have a significant effect on processes and functions in aquatic and riparian systems (Naiman and others 1988; Wohl 2001). Fine sediment from hillslope disturbance is generally trapped behind beaver dams. In general, stream reaches downstream of beaver ponds have been found to contain 50 to 75 percent fewer suspended solids than equivalent reaches without beaver ponds (Wohl 2001). Where beaver were present, they significantly altered the longitudinal profile of the streams, decreasing channel gradient, resulting in a stream with a more stepped profile. The presence of the beaver in large numbers would also have significant effects on the quantity and quality of water. Beaver impoundments locally elevate both surface and subsurface water levels. The increased water storage capacity within the system moderates the stream flow during high and low flows. This can bolster the growth of streamside vegetation, which further reduces flow and traps more sediment, allowing further expansion of the riparian environment. This riparian expansion would also enhance the lateral buffering of the streams from hillslope inputs. These streams would have been cool, clear, and well-oxygenated. Beaver ponds would have contributed to more moderated stream temperatures by keeping them generally cooler in the summer and more insolated in the winter (because of the increased stream depth and riparian canopy cover), but locally the increased surface area of the ponds can also increase stream heating.

The riparian environment would have included small, forested draws to narrow confined canyons with little or no riparian vegetation, to the broader valley bottoms with meadows and hardwoods. Their development and sustainability to a large extent was dependent on their relationship to surface and subsurface water as well as a function of topography, aspect, and channel gradient. It is probably safe to say that the riparian environment was much more extensive, diverse, and productive than it is today both longitudinally and laterally. These riparian areas would have provided a mosaic of habitats for both aquatic and terrestrial native plants and animals.

Beaver activity resulted in areas of impounded water between faster flowing sections of stream, increasing both the aquatic and riparian habitat diversity. The channels were probably well supplied with wood and nutrients, increasing habitat complexity. This environment probably supported a diverse macroinvertebrate community and substantial fish populations. By historical accounts, the native fish community of the South Platte River tributaries in the area of the fire consisted of greenback cutthroat trout (*Onchorhynchus clarki stomias*), longnose sucker (*Catostomus catostomus*), longnose dace (*Rhinichthys cataractae*), and white sucker (*Catostomus commersoni*) (Li 1968). The two sucker species and the dace could be considered habitat generalists and were probably widely distributed except in the smaller high-elevation streams. The greenback cutthroat trout is native to both the mountain and foothill waters of the South Platte River Basin. These fishes were broadly distributed in the basin and were known to make extensive migrations to spawn, rear, and overwinter (Young and others 2002; Behnke 2002). Overall, the aquatic biota were likely to have inhabited a system that was more diverse, more complex, and more productive. Populations of fishes were more connected between basins and able to recolonize areas following disturbances.

1811 to 1859 –

> *But it was not until the coming of the beaver trappers in the early decades of the nineteenth century that the activities of humans began to alter these systems substantially.* (Wohl 2001)

Significant changes occurred to Front Range systems between 1811 and 1859. By the 1840s beaver had been trapped to near extinction, reducing the number of functioning beaver dams and significantly altering the stream and riparian environments where beaver had been present (Wohl 2001). Channels probably experienced significant reorganization. Without the beaver to maintain the dams, the pools created by the dams presumably would have been compromised by high flows within the first decade. The sediment released would probably have been transported downstream, filling pools and reducing the overall habitat capacity for fishes both in the short and long term. Channels probably became laterally unstable, and channel bank stability would have been reduced as the water table associated with the pools dropped, killing some of the riparian vegetation.

The streams likely entered into a period of scouring and filling before they stabilized into a substantially different system, one with higher sediment loads and wider, shallower, less diverse channels. Removal of beaver dams probably resulted in lower base flows. Water tables were probably substantially lowered, and water retention in the system lessened. Changes in water quantity most likely resulted in increases in summer water temperature, changes in nutrient storage, and routing.

As the water table was lowered, there was likely a change in the riparian community structure from water-associated plant communities to drier site vegetation. The result would most likely have been changes in both the longitudinal and lateral extent of the riparian environment and altered energy and material flow in the river system. As the riparian area changed, the results would have been manifested as simplified channels, constricted riparian environments, and less storage of sediment, water, and nutrients. Increases in sediment in a geology that has naturally high erosion rates would have filled pools, creating less diverse and productive habitat for fishes and macroinvertebrates, and would have smothered plants and abraded surfaces. The final result, when viewed at the broad scale, was probably some change in the distribution and abundance of native fishes within the system, but the system was still well connected both laterally and longitudinally, and most major processes and functions were still intact allowing for potential recovery.

1859 to 2002 – The channel changes due to the removal of the beaver were significant but probably exacerbated by changes in land use that began with the mining in the 1860s. Both gold and silver were discovered in 1859, resulting in the influx of thousands of people over the next three decades into the Front Range. Following the miners, others usually arrived to provide support services and built infrastructure and railroads. Settlement of the early migrants and then their communities more often than not occurred along the rivers and streams beginning in the 1860s. The local landscape was changed as forests were harvested for the building of houses and homesteads, were burned, roads and trails were built, and streams were diverted for human uses. The miners diverted streams and used water in mining activities, changing the structure and functioning of the systems onsite and downstream. In addition, mining activities often included the use of mercury, cyanide, and other toxic chemicals, and these were commonly disposed of in or near the streams and rivers. The actual extent of these activities in the Hayman fire area is not known, but both the South Platte River and Tarryall Creek were active mining areas.

A variety of other human activities most certainly have affected the streams and riparian areas within the fire area. In addition to the fire history (part 1 of this chapter), both livestock grazing and timber harvesting were widespread throughout the area at the turn of the 20th century. Connaughton (1938) documented excessive erosion along the streams in the South Fork of the South Platte River and noted that the area was "cutover very heavily" before the creation of the National Forest. He also documented excessive erosion in Trail Creek due to timber cutting, a burned area and excessive grazing up until 1934. In Tarryall Creek, he noted excessive erosion and also that the area was heavily grazed by cattle. The reported levels of livestock grazing likely significantly influenced both riparian vegetation and stream bank integrity. Livestock grazing is limited in the area now, primarily because of forage limitations (David Winters personal observation). Where timber cutting was heavy or in riparian areas, the amount and timing of woody debris inputs in streams have been affected. The consequences are most likely similar to those described in other areas, a reduction in the number of pools, decreased pool volume, and a decline in habitat diversity and complexity. The overall and lasting result of all of these activities is a significant change in the landscape setting and a simplification of the form and function of the stream and riparian environments.

When the majority of the mining and related activities ceased in the early to mid-1900s, vegetation began to return to the valley bottoms and logged slopes began to revegetate, but changes to channels, water routing, and other impacts to aquatic and riparian systems were well established. Roads continued to be built to support the various activities of the developing Front Range and eventually in support of managing the National Forests.

In the Hayman Fire area there are currently more than 250 miles of identified roads, with an average density of more than 1 mile of identified road per square mile. More than half of these road miles are within the influence zones of streams and compromise the functioning of the riparian system. There are several other negative consequences of the extensive road development. Where roads cross the streams, culverts often create migration barriers to aquatic species and additional sources of sediment. Streams have also been confined and banks stabilized to protect roads, resulting in reduced connectivity to floodplains and habitat simplification. In addition to existing roads, off-highway vehicle (OHV) use has increased dramatically along the Front Range (David Winters personal observation). Trails created by these vehicles have similar direct and indirect influences to riparian and aquatic systems as formal road systems and often more because proper maintenance is rarely done. The overall result was a drainage system that retained less of its historical function, resulting in fragmented, often isolated populations of aquatic organisms. These influences dramatically limited the ability of fish and other aquatic biota to recolonize after disturbance.

In addition, rivers and streams within the area have been dammed, diverted, and augmented for agricultural and municipal purposes. Dams and river regulation have reduced the environmental variability downstream of the reservoirs. Several impoundments exist within the Hayman Fire area, the largest being Cheesman Reservoir. Cheesman Dam was completed in 1905, resulting in major permanent physical disruption of the system. This has also resulted in an economically valuable tailwater fishery for introduced trout species below Cheesman Dam.

Native greenback cutthroat trout that historically inhabited the region approached extinction by 1937 because of extensive overharvest, the widespread stocking of nonnative brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*), and other subspecies of cutthroat trout (*Oncorhynchus clarki*), and habitat alteration (Wiltzius 1985; Young and others 2002). The introductions of nonnatives and other subspecies of cutthroat trout were believed to have caused the final elimination of greenback cutthroat trout from nearly all of their historical range (Young and others 2002). While greenback cutthroat trout are believed extirpated from the streams within the Hayman Fire area, a small population exists in the portion of Wigwam Creek upstream of the Lost Creek Wilderness Area boundary and beyond the area affected by the Hayman Fire.

At the time of the Hayman Fire, the fish fauna in the area consisted of three native species, longnose dace, longnose sucker, and white sucker; and four nonnative trout species, brook trout, brown trout, rainbow trout, and nonindigenous cutthroat trout. The highest quality fishery for these introduced trout was in the South Platte River where flows are regulated, although good recreational fisheries for introduced trout also existed on smaller streams in the area. Whirling disease, introduced to United States waters from Europe, affects native and nonnative trout populations in Colorado and is present in the introduced trout species in the basin. Whirling disease is spread by fish stocking as well as by movement of infected gear and equipment between waters. It is more likely to expand its distribution within basins if water temperatures increase.

In summary, the watersheds within the Hayman Fire area just prior to the fire were a mosaic of conditions that ranged from functioning systems that exhibited higher integrity, to highly altered, fragmented, and poorly functioning systems. Although beaver returned to the system, they are not abundant and population expansion is often in conflict with humans (along the Front Range beaver are estimated to be at approximately one-tenth of their historic population). Prior to Euro-American influence, fire and other disturbances were patchy in time and space, resulting in complex, heterogeneous ecosystems; in contrast, the current system is fragmented and relatively homogenous as a result of almost 200 years of human influence. Nevertheless, aquatic ecosystems are a critical component of the Hayman landscape and the fisheries for nonnative trout are highly valued by visitors. Rehabilitation and restoration efforts in terrestrial and aquatic habitats will need to be adapted to the variety of human influences on key biological and physical processes that affected their condition even before the 2002 Hayman Fire.

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