BIOLOGICAL RESOURCES STUDY

5.2 ECOLOGY OF RIPARIAN HABITAT

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Introduction

The summary of ecological processes of riparian habitats that is presented here is provided as an introduction to the description of historical changes and present conditions in the Cache Creek study area. This presentation is limited to processes and conditions that are relevant to a riparian system such as Cache Creek. Major relevant characteristics of this system include the occurrence of an extremely wide range of flow rates from very low or no flow in summer to discharges of many thousands of cubic feet per second (cfs) under flood conditions, and the fact that sediment transport and deposition are correspondingly large.

Physical Basis of Riparian Ecosystems

The word riparian is derived from the Latin root *ripa*, meaning stream or river (this word being indirectly of the same origin). When applied to species or ecosystems, the term therefore refers to all those which are associated with flowing water, not merely to the woody plant communities to which the word is most commonly applied in central California.

The biological resources found in riparian zones and the nearby lands are dependent on a fluctuating hydrologic regime and, especially in depositional segments of streams, on a mosaic of variously sorted, regularly replenished substrates. Alluvial materials vary from large cobbles down to silts, which are horizontally sorted according to the velocity of water flows that transported the particles and that pass over them subsequently.

Unless confined by bedrock or constructed levees, all creeks in low-gradient valleys (such as that of lower Cache Creek) meander to some extent. Deposition of new substrate occurs primarily on the inside curve of meanders, both outside the typical flow channel and in shallow portions of it. Sediment deposition also occurs downstream of obstacles. The character (grain size) and hydrologic regime of substrate determines the plant community that initially becomes established. Subsequently, the vegetation itself changes the pattern of water flow and especially sediment deposition: the local resistance to water flow that is offered by dense vegetation slows down the flow and results in the deposition of fine sediments, that, in turn, promotes the growth of more plant species that may otherwise be unable to establish themselves on the new gravel bars or may not compete well in those sites.

Establishment of vegetation also tends to stabilize the banks of both low-flow and high-flow channel profiles. This in turn affects the pattern of water flow by narrowing channels and accelerating or laterally extending the formation of meanders. These processes increase the difference in flow velocities and sediment types between the channel and its floodplain, leading to a greater diversity of plant community types. Removal of vegetation tends to cause channels to become straighter and wider; increased velocity of flood flows then results in downcutting of the channel and abandonment of what was once the flood plain. Thus, vegetation has many effects on and interactions with geomorphologic processes, constituting a very important element in achieving and maintaining channel stability and in the predictability of consequences of regular flooding.

Physical Parameters of Riparian Habitats

Several interrelated parameters of the physical environment control most of the biological character of any particular riparian area. These include the pattern of water flow, the nature of the substrates (which is to some extent a consequence of surface hydrology), and the depth and seasonal fluctuation of the groundwater (which, in part, affects the pattern of surface flow).

Hydrology

The depth of water flow is less important than duration, because most riparian plant species are tolerant of deep inundation for a brief period of time, as occurs in lower Cache Creek. As discussed in the streamway report, both the attainment and post-peak reduction of high flood flows occurs very rapidly, typically in a matter of days. Flood flows also tend to be highly oxygenated, lessening the effects of temporary inundation. The most critical aspect of stream hydrology for vegetation is the duration of the post-flood and low-flow period, as it is during the late spring and summer that nearly all growth of riparian vegetation occurs. The enormous influence that the duration of flow has on vegetation can easily be seen in Cache Creek: even in the limited areas within losing subreaches that are not subject to frequent surface disturbance from aggregate mining, the development of high quality riparian vegetation is slow or limited in potential structure, whereas the perennial-flow subreaches support dense and diverse riparian vegetation.

Change in Riparian Habitat

One of the most prominent characteristics of riparian habitat is its dynamic character, both short- and long-term. This continual change results from a variety of causes, primarily the fluvial geomorphological processes identified above. In a system where water flows change as rapidly as in Cache Creek, and even more so if the channel profile has been locally and generally constrained, locally intense bank erosion is the primary cause of loss of vegetation. The present Cache Creek high-flow channel boundaries are much more confined than in the past, which results in extreme erosion under flood conditions. In both 1986 and 1995, bank erosion extending along the creek, or laterally from it, removed hundreds of feet of land and vegetation in individual flood events. This process cannot be prevented by means of vegetation establishment or maintenance, but requires improvement of the overall physical circumstances of the streamway. On the other hand, well-established vegetation that becomes submerged is rarely uprooted, with the occasional exception of clumps of giant reed, a relatively shallowly rooted non-native species that grows to great density and height.

Deposition of new sediment bars initiates most plant colonization and succession processes. In a system with flashy hydrology and a high sediment load, such as lower Cache Creek, this occurs often and rapidly. Consequently, the stream channel may migrate frequently, and/or multiple overflow channels may form: in 1906, at the Esparto bridge site, Cache Creek consisted of three main channels in a wide floodplain with diverse vegetation (refer to Figure 3.4-12).

Major changes in channel plan and profile may also result from strictly biological causes, primarily beaver. Their damming of channels is the major natural factor initiating migration of meandering stream channels in low gradient valleys. The ponds and extensive saturated areas are rapidly vegetated by fast-growing woody species, esp. willows, which are preferred beaver food. Even after beaver dams are blown out by lack of maintenance and high flows, or when areas are dewatered by other dams upstream, this woody riparian vegetation may persist for many years after the surface inundation drops, even if the new hydrologic conditions would not be conducive to its establishment.

As a result of all of these dynamic processes, riparian ecosystems are composed of a variety of very different habitat types, closely juxtaposed; this concentrated diversity is one of main reasons for the high biodiversity and habitat values of these communities. The vegetation that is observed at any one time represents a single frame removed from a movie of a set of processes of continual change, rather than a fixed pattern of plant community types. Some types of vegetation are more stable over time, but, in systems such as Cache Creek, rapid change is the rule rather than the exception. This principle has important implications for conservation and restoration planning.

Vegetation

Riparian vegetation includes but is not limited to habitats dominated by woody plant species. As noted above, many, but not all, of the subtypes of riparian vegetation are merely successional stages. However, recognition of specific subtypes of riparian vegetation is valuable for characterizing existing conditions and evaluating restoration opportunities and actions. Riparian vegetation includes all of the following types of vegetation, when found in the vicinity of streams or rivers:

- *Herbaceous Riparian Habitat*. This type includes areas that are vegetated by herbaceous hydrophytic (water-loving) vegetation, including tules, cattails, several species of rushes, a variety of grasses (including undesirable invasive non-natives such as giant reed), and many forbs such as mugwort, smartweeds, sneezeweed, and water hemlock. In areas where water flow is slow, herbaceous riparian vegetation resembles or constitutes an inclusion of the wetland habitat type, described in a subsequent narrative.

- *Mixed Woody/Herbaceous Riparian Habitat*. This type is generally an unstable vegetation type, where woody species occur within herbaceous vegetation areas either as scattered individuals (e.g., western buttonbush) or as incipient colonists of other successional stages (willows).

- *Willow Thickets*. In Yolo County, willow thickets are primarily composed of sandbar willow, red willow, yellow willow, and Goodding's (black) willow. Thickets may be all willows or may include other shrubs or trees. Differences in species composition are generally based upon substrate, and to a lesser extent upon geomorphic history of the specific site. Willow thickets that become established on relatively coarse substrates with shorter seasons of flooding and saturation are usually composed of low-growing species (e.g., sandbar willow). These communities may become thicker or slightly taller over time, but do not undergo succession and become tall riparian forest. Under present hydrologic conditions but in the absence of mining disturbance, willow thickets probably constitute the ultimate potential natural community of the losing reaches of Cache Creek. Willow thickets composed of other species (e.g., red willow and Goodding's willow) colonize finer substrates where inundation and saturation are of longer duration. These communities represent an early successional stage of mature riparian forest.

- *Riparian Forest*. This type is the familiar mature expression of the riparian habitat successional process and is characterized by the presence either of scattered emergent trees or of a continuous closed canopy of willows, Fremont cottonwood, or valley oak. In some locations, riparian forest is floristically relatively simple, as, for example, a bottomland valley oak forest. In other locations, this habitat type exhibits great structural and taxonomic complexity, including many other woody species in the canopy, in the understory, or at the fringes: box elder, California grape, Oregon ash, Northern California black walnut, and elderberry. Separate riparian forest vegetation types that are recognized by other classification systems often intergrade, whether related by ecological succession or not.

Other Elements

A variety of riparian habitat elements are valuable, or even vitally important, to a variety of common and special-status species (see Section 5.5). These elements include eroding vertical banks, sand and gravel bars, snags, and downed woody debris. All occur spottily both in location and in time, albeit with different periods of the cycle of appearance and disappearance. For example, eroding vertical banks occur along the same reach of a river or creek for relatively long periods of time, whereas sandbars may appear and disappear as frequently as several times in a single rainy season. Generally, however, these special elements appear suddenly and become vegetated (disappear) over a period of years.

Aquatic Habitat Elements

The riparian ecosystem borders and interacts with the aquatic stream habitat. The structure and composition of the aquatic habitat is both affected by and affects the structure and composition of the riparian ecosystem. The riparian ecosystem (1) affects the amount of light reaching the stream, thereby affecting stream temperature and productivity; (2) provides organic litter and a food source for the aquatic community (i.e., invertebrates); (3) provides streambank stability; and (4) adds to aquatic habitat complexity in the form of large woody debris.[1] Habitat complexity, necessary for a healthy and diverse aquatic community, is determined by the diversity and quantity of habitat elements, including the type of habitat units (i.e., pools, riffles, runs), in-stream cover objects such as submerged logs, uprooted willow root wads and undercut banks, submerged vegetation, overhanging vegetation, water temperature, water quality, and bottom type. Each fish species, and even the various life stages of each fish species, require a unique set of habitat elements. For example, salmonids (salmon, steelhead and trout) generally require cool water temperatures with moderate to high dissolved oxygen content, depending on the life stage. For successful spawning, salmonids require adequate passage flows to reach upstream spawning grounds and gravel deposits that are free of fine sediments and are of a relatively narrow particle size range, in which the eggs are deposited. For successful egg incubation and hatching, a constant supply of clean, highly oxygenated water is necessary. Also, the gravel must remain free of fine sediments which can act to smother the eggs by eliminating free-flowing, oxygenated water through the interstitial spaces in the gravel bed where the eggs are deposited. Upon hatching, the young fry require gravel and cobble interstices for escape cover to avoid predators.

Warm water fish species generally do not have as strict water quality requirements as cold water fish. For example, carp and catfish are generally not affected by high turbidity, can withstand low dissolved oxygen values, and can thrive in waters high in organic content.[2] In contrast, most bass species require relatively clean water conditions for spawning. Often, warm water species require dense vegetation for egg deposition and have a higher metabolism rate than cold water species, thereby requiring ample food resources.

The effects of a reduced riparian ecosystem, largely through deforestation, as well as the effects of water development, flood control measures, and mining activities have resulted in lowered streamflows, increased water temperatures, increased turbidity, streambed siltation, and alteration of aquatic microhabitat in Cache Creek. Habitat for those species requiring cool water temperatures, low turbidity, and habitat complexity has virtually been eliminated in Cache Creek. Current habitat conditions are more suitable to introduced, warmwater species. In addition, it is possible for introduced species to eliminate native species through direct interactions, such as competition, predation, habitat interference and hybridization.[3]

ENDNOTES

1. Flosi, G. and F.L. Reynolds. *California Salmonid Stream Habitat Restoration Manual.* Inland Fisheries Division, California Department of Fish and Game, The Resources Agency. 1994.

2. Bell, M.C. *Fisheries Handbook of Engineering Requirements and Biological Criteria.* Fish Passage Development and Evaluation Program, Corps of Engineers, North Pacific Division, Portland, Oregon. 1991

3. Moyle, P. *Inland Fishes of California.* 1976.