Environmental Science: Ecology
RIPARIAN HABITAT BIOASSESSMENT

Name: ____________________

The Value of Riparian Habitat

The riparian zone is characterized by a unique set of physical ecological factors in comparison to the surrounding regional landscape. These factors include flooding by the river, rich and productive soils, a water table that is within reach of plant roots, and species of plants and wildlife that are adapted to the timing of fluvial events such as flooding, drought, sediment transport and channel movement. This dynamic habitat creates a wide variety of growing conditions for riparian plants, and over time they develop into various structural forms (forests, woodlands, shrublands, meadows and grasslands) across the floodplain. The heterogeneity of riparian forests creates numerous habitat features that explain why riparian forests in California support a greater diversity of wildlife than any other habitat type. Riparian vegetation along river channels also functions as primary regional migration routes for most wildlife.

Riparian ecosystems support people as well as wildlife. Rivers and their floodplains provide many "river services" to the surrounding local community. These include: conveyance and delivery of water supply, effective conveyance of flood waters (native riparian plants on the floodplain attenuate flood waters and trap large debris), maintenance of water quality (a living river will improve water quality through biological processing of pollutants and physical filtering of sediments and organic material), wildlife habitat and regional migration corridor (vegetated floodplains provide cover for wildlife during migration), and recreation opportunities (fishing, hunting, boating, and wildlife viewing are enhanced by native riparian plants). River services are optimized when a river and its floodplain are healthy. Healthy rivers are free of intensive regulation such as dams and revetment and their floodplains support a mosaic of plant communities.

Riparian Decline

The rich soils and presence of water that make riparian areas biologically rich, also create productive lands for agriculture and desirable locations for urban development. In addition, sediment deposition by rivers over time has provided opportunities for gravel mining. The water that flows through rivers is often dammed and diverted for anthropogenic use and most of the large rivers function as primary flood conveyance structure for the purpose of human safety. These practices have removed the majority of riparian habitat available to wildlife and people and reduced the ability of rivers and floodplains to provide river services. It is estimated that 95 percent of pre-European acres of riparian habitat in California's Central Valley have been lost to recent human activities.

Transition of some of these lands back to a more natural state through riparian restoration benefits both the ecology and socioeconomics of a region. Often, rivers are seen only as a means to transport water to cities and farms, or as an unpredictable system that needs to be straightened and armored to prevent flood damage to developed areas. Healthy rivers and floodplains can protect developed areas from flood damage and provide water transport and other services to people that exceed the cost of replicating these services through human infrastructure.

Native plants are a necessary component of healthy riparian areas, and not simply because of their importance to native wildlife. Vegetated floodplains and the organisms they support can clean water by removing the nutrients that runoff from agricultural fields and into drinking water supplies. The presence of vegetation also aerates the soil and creates places for water to slowly percolate underground to recharge aquifers that supply water for urban and agricultural uses. The dense forests also offer shady respite and recreational opportunities not available in developed areas.

Riparian Restoration

Riparian restoration occurs at a broad range of scales depending on the size of the river, the ecological health of the site, and the regional landscape. The goals for a restoration project will also vary, from flood control benefits to invasive species removal, but the project can still be designed to maximize habitat available to wildlife. For example, large rivers in the Central Valley are managed today for irrigation water conveyance and flood-damage control. All are constrained by levees, with management and maintenance responsibilities carried out by local, state, and federal agencies. Consequently, river processes operate only within the floodway (a legally defined structure, often a levee-lined channel that is designed to convey a specific maximum flow during flood events). The floodway's primary design consideration is human safety and currently relatively little emphasis is given to riparian vegetation and habitat function. However, riparian vegetation can have beneficial flood damage control impacts by slowing bank erosion, directing flows away from structures, and directing sediment transport. Furthermore, the local influence of restored riparian vegetation can provide both flood control benefits and quality wildlife habitat.

Smaller rivers, such as those in the Sierra foothills and Coast Ranges, are tributaries to the larger rivers of California's Central Valley and have much smaller localized floodplains covering much smaller areas than those of large, meandering valley rivers. On these tributaries, levees are typically protecting small areas (rather than regional protection). The emphasis of human safety is usually not as strong on smaller rivers and in this way restoration design is influenced by river size. Restoration on small rivers typically involves manipulation/restoration of channel morphology and floodplain elevation (e.g., repairing abandoned open-pit gravel mines). In these cases, earth-movement may be a large part of the implementation budget, with less emphasis on the actual plantings. However, through restoration of river processes such as flooding and sediment transport, eventually native vegetation will establish and support local wildlife.

Mitigation

Mitigation is a regulatory process intended to offset the loss of natural resources resulting from human development. When mitigation is achieved through planting native species, it can superficially resemble restoration. Mitigation plantings are frequently permitted to serve as compensation for unavoidable "take" of imperiled species or habitats. Take refers to activities that will directly or indirectly harm individual wildlife species or habitat types, such as wetlands or vernal pools. Mitigation plantings are typically narrowly focused on the habitat requirements of individual species or in the case of imperiled habitat types, they focus on specific plant associations to recreate targeted ecosystem services. This narrow focus of mitigation is in contrast to the broad scope of most restoration projects, which aim to support multiple species and create plantings that will provide numerous ecosystem benefits.

All the text above was taken directly from "The California Riparian Habitat Restoration Handbook" at http://www.water.ca.gov/urbanstreams/docs/ca_riparian_handbook.pdf

Habitat assessment

The habitat evaluation process we will use is from the Environmental Protection Agency's Bioassessment Protocols Manual and involves rating different habitat conditions as optimal, suboptimal, marginal or poor based upon criteria (descriptions and a rating scale) included on the survey data sheets. The optimal category is a description of conditions that meet natural expectations; suboptimal includes descriptions of criteria that are less than desirable, but satisfies expectations under most circumstances; marginal is a description of moderate levels of degradation with severity at frequent intervals throughout the reach; and poor are descriptions of criteria for streams that have been substantially altered with severe degradation characteristics. You can find additional information in Chapter 5 of the US EPA's Rapid Bioassessment Protocols Manual.

Some terms you need to know: *Riffles, runs, and pools*

A mixture of flows and depth provide a variety of habitats to support fish and invertebrate life. Pools are deep with slow water. Riffles are shallow with fast, turbulent water running over rocks. Runs are deep with fast water and little or no turbulence.

This website has good addition definitions and figures to familiarize yourself with stream anatomy: http://www.lakesuperiorstreams.org/understanding/streambank.htm

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EPIFAUNAL SUBSTRATE/AVAILABLE COVER: Includes the relative quantity and variety of natural structures in the stream, such as cobble (riffles), large rocks, fallen trees, logs and branches, and undercut banks, available as refugia, feeding, or sites for spawning and nursery functions of aquatic macrofauna. A wide variety and/or abundance of submerged structures in the stream provides macroinvertebrates and fish with a large number of niches, thus increasing habitat diversity. As variety and abundance of cover decreases, habitat structure becomes monotonous, diversity decreases, and the potential for recovery following disturbance decreases. Riffles and runs are critical for maintaining a variety and abundance of insects in most high-gradient streams and serving as spawning and feeding refugia for certain fish. The extent and quality of the riffle is an important factor in the support of a healthy biological condition in high-gradient streams. Riffles and runs offer a diversity of habitat through variety of particle size, and, in many small high-gradient streams, will provide the most stable habitat. Snags and submerged logs are among the most productive habitat structure for macroinvertebrate colonization and fish refugia in low-gradient streams. However, "new fall" will not yet be suitable for colonization.

Habitat Parameter	Optimal 4	Suboptimal/Good 3	Marginal 2	Poor 1
Epifaunal Substrate/Available Cover (for animals around stream bottom)	≥70% good habitat for fish and other aquatic animals - submerged old logs, undercut banks, rocks, etc.	40-70% stable habitat. Could be new logs but are not rotting and ready for organisms to make their home.	20-40% stable habitat. Substrate disturbed or removed.	< 20% stable habitat. Substrate unstable or lacking.

EMBEDDEDNESS: Refers to the extent to which rocks (gravel, cobble, and boulders) and snags are covered or sunken into the silt, sand, or mud of the stream bottom. Generally, as rocks become embedded, the surface area available to macroinvertebrates and fish (shelter, spawning, and egg incubation) is decreased. Embeddedness is a result of large-scale sediment movement and deposition, and is a parameter evaluated in the riffles and runs of high-gradient streams. The rating of this parameter may be variable depending on where the observations are taken. To avoid confusion with sediment deposition (another habitat parameter), observations of embeddedness should be taken in the upstream and central portions of riffles.

Habitat Parameter	Optimal 4	Suboptimal/Good 3	Marginal 2	Poor 1
Embeddedness (How much are the rocks covered by fine sediment?)	0-25% of rocks and gravel surrounded by sediment. Layering of cobble provides diverse niches.	25-50% of rocks and gravel surrounded by sediment.	50-75% of rocks and gravel surrounded by sediment	75-100% of the rocks and gravel are surrounded by sediment.

VELOCITY/DEPTH COMBINATIONS: Patterns of velocity and depth are included for high-gradient streams under this parameter as an important feature of habitat diversity. The best streams in most high-gradient regions will have all 4 patterns present: (1) slow-deep, (2) slow-shallow, (3) fast-deep, and (4) fast-shallow. The general guidelines are 0.5 m depth to separate shallow from deep, and 0.3 m/sec to separate fast from slow. The occurrence of these 4 patterns relates to the stream's ability to provide and maintain a stable aquatic environment.

Habitat Parameter	Optimal 4	Suboptimal/Good 3	Marginal 2	Poor 1
Velocity/ Depth Regime (How many different speeds and depths of water flow out of 4?)	Shows all 4: slow-deep, fast-deep, slow shallow, fast shallow Slow= .3m/sec or slower Deep=.5m or more	Shows only 3 of the 4. If fast shallow is missing score lower.	Shows only 2 or the 4. If fast shallow or slow shallow are missing score lower.	Shows only 1 out of the 4.

Habitat Parameter	Optimal 4	Suboptimal/Good 3	Marginal 2	Poor 1
Sediment Deposition (sediment build-up in stream)	<5% of the bottom is affected by sediment settling. Little or no enlargement of islands or sand bars.	5-30% of the bottom is affected by sediment. There is a slight increase in sand bars.	30-50% of the bottom is affected by sediment. There is sediment build up near bends, pools, and obstructions	Over 50% of the bottom is affected by sediment. Pools nearly absent due to heavy sediment build up. Increased bar development.

SEDIMENT DEPOSITION: Measures the amount of sediment that has accumulated in pools and the changes that have occurred to the stream bottom as a result of deposition. Deposition occurs from large-scale movement of sediment. Sediment deposition may cause the formation of islands, point bars (areas of increased deposition usually at the beginning of a meander that increase in size as the channel is diverted toward the outer bank) or shoals, or result in the filling of runs and pools. Usually deposition is evident in areas that are obstructed by natural or manmade debris and areas where the stream flow decreases, such as bends. High levels of sediment deposition are symptoms of an unstable and continually changing environment that becomes unsuitable for many organisms.

Habitat Parameter	Optimal 4	Suboptimal/Good 3	Marginal 2	Poor 1
Channel Flow Status (How much water fills the channel)	Very little of the channel bottom is exposed (water fills the whole channel)	75-100% of the channel is filled with water	25-75% of the channel is filled with water. Substrate is close to the surface is many areas.	Very little water in the channel and it is mostly standing pools- not moving.

CHANNEL FLOW STATUS: The degree to which the channel is filled with water. The flow status will change as the channel enlarges (e.g., aggrading stream beds with actively widening channels) or as flow decreases as a result of dams and other obstructions, diversions for irrigation, or drought. When water does not cover much of the streambed, the amount of suitable substrate for aquatic organisms is limited. In high-gradient streams, riffles and cobble substrate are exposed; in low-gradient streams, the decrease in water level exposes logs and snags, thereby reducing the areas of good habitat. Channel flow is especially useful for interpreting biological condition under abnormal or lowered flow conditions. This parameter becomes important when more than one biological index period is used for surveys or the timing of sampling is inconsistent among sites or annual periodicity.

CHANNEL ALTERATION: Is a measure of large-scale changes in the shape of the stream channel. Many streams in urban and agricultural areas have been straightened, deepened, or diverted into concrete channels, often for flood control or irrigation purposes. Such streams have far fewer natural habitats for fish, macroinvertebrates, and plants than do naturally meandering streams. Channel alteration is present when artificial embankments, riprap, and other forms of artificial bank stabilization or structures are present; when the stream is very straight for significant distances; when dams and bridges are present; and when other such changes have occurred. Scouring is often associated with channel alteration.

Habitat Parameter	Optimal 4	Suboptimal/Good 3	Marginal 2	Poor 1
Channel Alteration (Is it a natural channel or human made?)	People have not built channels or dug out areas, stream has a normal pattern.	Very little channelization present, under roads, under bridges. The changes are not recent.	40-80% of the stream has been altered. The stream route has been changed and disrupted.	Banks shored with cement. Over 80% of the stream has been changed and disrupted.

FREQUENCY OF RIFFLES (OR BENDS): Is a way to measure the sequence of riffles and thus the heterogeneity occurring in a stream. Riffles are a source of high-quality habitat and diverse fauna, therefore, an increased frequency of occurrence greatly enhances the diversity of the stream community. For high gradient streams where distinct riffles are uncommon, a run/bend ratio can be used as a measure of meandering or sinuosity. A high degree of sinuosity provides for diverse habitat and fauna, and the stream is better able to handle surges when the stream fluctuates as a result of storms. The absorption of this energy by bends protects the stream from excessive erosion and flooding and provides refugia for benthic invertebrates and fish during storm events. To gain an appreciation of this parameter in some streams, a longer segment or reach than that designated for sampling should be incorporated into the evaluation.

Habitat Parameter	**Optimal** **4**	**Suboptimal/Good** **3**	**Marginal** **2**	**Poor** **1**
Frequency of Riffles (Riffles are a stretch of choppy water).	Lots of riffles and they are frequent. A continuous riffle means there are boulders, etc.to change the course of the water.	Some riffles, not many.	Only a few riffles or bends.	Generally all flat water, or really shallow riffles.

BANK STABILITY: (condition of banks) Measures whether the stream banks are eroded (or have the potential for erosion). Steep banks are more likely to collapse and suffer from erosion than are gently sloping banks, and are therefore considered to be unstable. Signs of erosion include crumbling, unvegetated banks, exposed tree roots, and exposed soil. Eroded banks indicate a problem of sediment movement and deposition, and suggest a scarcity of cover and organic input to streams. Each bank is evaluated separately and the cumulative score (right and left) is used for this parameter.

Habitat Parameter	**Optimal** **4**	**Suboptimal/Good** **3**	**Marginal** **2**	**Poor** **1**
Bank Stability (score each bank) (Are the banks stable or eroding away?)	Less than 5% of the banks affected by erosion. Banks really stable.	Small areas of erosion, mostly healed over. 5 -30% of banks are affected. Still pretty stable.	Pretty unstable, 30-60% of bank is affected. Could be eroded during storms and floods.	Unstable, over 60% of the banks are affected with erosion and evidence of past erosion.

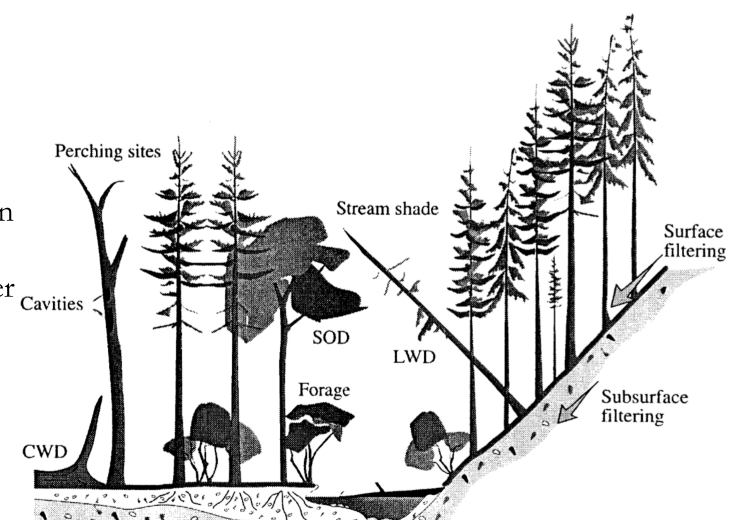
Ecological Functions of Riparian Vegetation

The characteristics of riparian vegetation can strongly influence the diversity and productivity of both aquatic and terrestrial biota, as well as the stability of the streambank and channel. Removal of the natural riparian vegetation can impair the functional role of the riparian zone in providing stable and diverse physical and biological conditions within the adjoining terrestrial and stream ecosystems. Ecological functions of the riparian vegetation include:

✓ regulation of the physical structure of the stream channel by determining the input and characteristics of large woody debris (LWD),
which partly controls sediment storage and transport; local flow characteristics; and the creation of fish habitat

✓ maintenance of bank and channel stability by provision of solid root mass and ground cover

✓ regulation of stream temperature by providing shade



✓ regulation of instream biological production by determining the inputs of small organic debris (SOD)(leaves, detritus, terrestrial insects, large woody debris, dissolved organic C) to the channel
✓ regulation of instream algal production by controlling the amount of sunlight (for photosynthesis) reaching the stream
✓ buffering the stream from fine sediments by intercepting surface flow
✓ provision of wildlife habitat features, including coarse woody debris(CWD), wildlife trees, nest and perch sites, and summer and winter dennings
✓ provision of summer and winter forage for terrestrial fauna

BANK VEGETATIVE PROTECTION: Measures the amount of vegetative protection afforded to the stream bank and the near-stream portion of the riparian zone. The root systems of plants growing on stream banks help hold soil in place, thereby reducing the amount of erosion that is likely to occur. This parameter supplies information on the ability of the bank to resist erosion as well as some additional information on the uptake of nutrients by the plants, the control of instream scouring, and stream shading. Banks that have full, natural plant growth are better for fish and macroinvertebrates than are banks without vegetative protection or those shored up with concrete or riprap. This parameter is made more effective by defining the native vegetation for the region and stream type (i.e., shrubs, trees, etc.). In some regions, the introduction of exotics has virtually replaced all native vegetation. *The value of exotic vegetation to the quality of the habitat structure and contribution to the stream ecosystem must be considered in this parameter.* In areas of high grazing pressure from livestock or where residential/urban development activities disrupt the riparian zone, the growth of a natural plant community is impeded and can extend to the bank vegetative protection zone (see next parameter). Each bank is evaluated separately and the cumulative score (right and left) is used for this parameter.

Habitat Parameter	Optimal 4	Suboptimal/Good 3	Marginal 2	Poor 1
Vegetative Protection (score each bank) (How much vegetation is covering the stream and the banks?)	More than 90% of the stream bank and riparian area is covered by mixed native vegetation (tall trees, tall shrubs, short plants, etc.)	70-90% of the area is covered by native vegetation but one class of plants not well represented (i.e. tall trees)	50-70% of the area is covered. There is visible disruption, with patches of bare soil or vegetation all of one height.	Less than 50% of the area covered in native vegetation. Lots of disruptions, very little diversity in type and structure.

RIPARIAN VEGETATIVE ZONE WIDTH: Measures the width of natural vegetation from the edge of the stream bank out through the riparian zone. The vegetative zone serves as a buffer to pollutants entering a stream from runoff, controls erosion, and provides habitat and nutrient input into the stream. A relatively undisturbed riparian zone supports a robust stream system; narrow riparian zones occur when roads, parking lots, fields, lawns, bare soil, rocks, or buildings are near the stream bank. Residential developments, urban centers, golf courses, and rangeland are the common causes of anthropogenic degradation of the riparian zone. Conversely, the presence of "old field" (i.e., a previously developed field not currently in use), paths, and walkways in an otherwise undisturbed riparian zone may be judged to be inconsequential to altering the riparian zone and may be given relatively high scores. For variable size streams, the specified width of a desirable riparian zone may also be variable and may be best determined by some multiple of stream width (e.g., 4 x wetted stream width). Each bank is evaluated separately and the cumulative score (right and left) is used for this parameter.

Habitat Parameter	Optimal 4	Suboptimal/Good 3	Marginal 2	Poor 1

Riparian Vegetative Zone Width (score each bank) (How wide is the riparian area? How much is unaffected by people?)	Distance from the stream to the edge of the riparian zone is >18meters. Roads and human activities have not affected the area.	Distance from the stream to the edge of the riparian zone is 12-18meters. There is some human impact on the area.	Distance from the stream to the edge of the riparian zone is 6-12meters. There is human impact.	Distance from the stream to the edge of the riparian zone is less than 6meters. There is little or no vegetation due to human activities.

This assessment protocol is from the United States Environmental Protection Agency:

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

The entire document can be downloaded at http://www.epa.gov/OWOW/monitoring/techmon.html