PLANT COMMUNITY DEVELOPMENT, SITE QUALITY ANALYSIS AND RIVER DYNAMICS IN THE DESIGN OF RIPARIAN PRESERVES ON THE MIDDLE SACRAMENTO RIVER, CALIFORNIA[1]

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Abstract: Loss of riparian habitat along the Middle Sacramento River, over the last 100 years, has reduced a once contiguous riparian forest to a series of disjunct remnants of varying size and quality. With limited financial resources to purchase and protect some of the remaining riparian plant communities, it has become necessary to develop methods to select which of the remaining habitats are to become protected. A site evaluation method was developed that included vegetation quality, type and rarity, size, viability, unique features, rare plants, shape, and potential for growth. Using this method 240 plant community sites that included 5 plant community types were evaluated and ranked. The evaluation method and the results are outlined and a critique of the method discussed in light of long term riparian nature preserve design.

The loss of riparian vegetation and habitats in California has resulted in the need for an immediate coordinated effort by government agencies and private organizations to develop a plan to preserve what little remains. However, the cost of preservation, in conjunction with the unwillingness of some riparian land owners to sell, restricts the amounts and locations of land that can be acquired. In order to develop a strategy for the preservation of the remaining riparian habitats in California three pieces of information are needed: 1) location and types of remaining riparian vegetation, 2) the quality of individual contiguous riparian areas and 3) a preserve plan for which areas should be acquired.

The middle Sacramento River, between Keswick Dam and Verona, is a riparian corridor 167 kilometers long. The combined impacts from agriculture, levee building and bank stabilization (rip-rap) has reduced this once contiguous riparian gallery forest to a series of disjunct riparian islands. Previous studies have made a qualitative determination of the types of plant communities that remain along some sections of the middle Sacramento River (Conard and others 1977; Katibah and others 1984; Roberts and others 1977; Sands 1977; Thompson 1961; Warner and Hendrix 1984). Only one previous study by Michny (1984) quantitatively determined that approximately 4,000 hectares of riparian "woodland" have potential for habitat preservation. Previous studies have not, however, compared all the riparian sites as to plant community type, determined the quality of these sites, their size, and ranked them to identify specific areas for preservation.

Current riparian preservation strategies for the middle Sacramento River have focused primarily on areas that support rare species. Only rarely have sites been preserved based on vegetation or other features (see Katibah and others 1984). It also appears that the preservation strategies have not considered the long term viability of the sites chosen. The dynamics of the Sacramento River are sufficiently well documented to suggest that many of the largest riparian forests along the river today will likely not persist beyond 20-75 years from now (Scott and Marquis 1984). Further, the normal successional sequence of riparian forests prevents us from assuming that the type of community preserved today will be the same type 20 or more years later (Strahan 1984).

Study Objectives

This paper has two purposes: 1) discuss a method to evaluate and rank individual riparian communities, and 2) discuss the selection of individual riparian sites for preserves considering the dynamics of the Sacramento River.

The reason for developing the evaluation method was to provide a riparian community site quality analysis and ranking for the Sacramento River Riparian Atlas (1988).

Methods

The site quality evaluation method developed for the middle Sacramento River study was designed to account for all levels of site quality and size excluding active agricultural land. The study required a vegetation quality analysis for individual plant communities.

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Site Variables

Eight variables were used to evaluate overall site quality: 1) vegetation quality, 2) community rank, 3) size of community, 4) viability, 5) unique features, 6) rare plants, 7) shape of community stand, and 8) potential for stand expansion.

Vegetation Quality

Five plant communities occur in the study area that have been classified in the California Department of Fish and Game's natural community system (Holland 1986). These communities are: great valley mixed riparian forest, great valley cottonwood riparian forest, great valley valley oak riparian forest, great valley willow scrub and coastal and valley freshwater marsh. A description of the three riparian forest communities is included elsewhere in these proceedings (Holland and Roye 1989).

Vegetation quality was primarily evaluated based on the biological features of the community structure that were determined from field surveys. The four features considered were: 1) tree density i.e. canopy closure, 2) species diversity 3) extent of seedling establishment, mainly for areas of disturbance now undergoing regeneration, and 4) maturity of the community. Vegetation quality was evaluated on a scale of 1 through 4 (i.e, 1=poor, 2=fair, 3=good, 4=excellent).

Community Rank

Vegetation quality was weighted using a plant community ranking value that reflects the level of rarity for each community. The California Natural Diversity Data Base (CNDDB) has ranked some of the rarer plant communities in California including the riparian forest and the freshwater marsh. The valley oak riparian forest is ranked highest by CNDDB due to its rarity. The cottonwood and mixed riparian forest and freshwater marsh are all ranked equally and lower than the valley oak riparian forest. The willow scrub community is not considered rare and has not been ranked. Community ranking values used were 1 through 3, with 3 representing the rarest community type. These community rankings were multiplied by the vegetation quality values.

Size of Community

Community size is important in preserve design since it is related to the capacity of an area to buffer external threats (Lovejoy and others 1986). The stand sizes used in this study were for individual plant communities. Four size classes were used and point values assigned as follows: 1 =< 50 acres, 1.5 = 50-75 acres, 2 = 76-100 acres, 3 => 100 acres.

Site Viability

The viability of a site is its potential to survive natural or human-caused forces over time. This variable mainly represents the survivorship potential from river realignments. Impacts from river erosion was based on the level of river bank cutting. Viability values ranged from 0 through 5, with a high level of viability equal to 5.

Unique Features

Sites were assigned points for a variety of features that mainly correspond with overall site diversity. For example ox bow areas that had an associated freshwater marsh were given 3 points, mixed riparian communities that included valley oak as a subdominant were given 2 points. The highest number of points given in this category was 5 for an individual site, but technically the category had no a priori maximum value.

Rare Plants

Although no rare plants were found during the study, 5 points would have been given for their presence. This category includes state or federally listed species, as well as non-listed rare plants. The point assignment was determined relative to other categories where the value of 5 also was the maximum value.

Shape of Community Stand

The shape of a preserve has been recognized as an important factor in determining the effects of external disturbances or threats (Janzen 1986, Lovejoy and others 1986). In particular, so-called "edge effects" from neighboring areas having contrasting land use can be important potential threats (Harris 1984, Janzen 1986).

Two major areas of potential edge effects for the Sacramento River are river course changes on one side and human-caused disturbances on the other. Site quality of a particular plant community with respect to shape was determined using a circumference-to-area ratio index (CAI). The assumption is that areas having a small CAI have the least amount of exposed vegetation to external threats such as circular shaped areas. In contrast narrow strips of vegetation have a high level of external exposure (high CAI) and a higher potential external threat. Values based on shape range from 1-5 with 5 representing a perfect circle.

Table 1- Riparian sites and total area in each quality level by plant community, middle Sacramento River, California, 1988.

	Quality				
Riparian Community	Excellent No. Sites	Good No. Sites	Fair No. Sites	Poor No. Sites	Total Area(ha)
Cottonwood	10	15	26	12	1,320
Mixed Riparian	6	8	7	3	614
Willow Scrub	2	6	10	2	352
Freshwater Marsh	10	-	-	-	121
Totals	50	69	82	33	5,907

Potential for Stand Expansion

Site evaluation of potential revegetation areas was determined independently for the Sacramento River Atlas project (Kraemer 1988). However, some assessment was included to evaluate potential expansion of a riparian community stand. This determination was based entirely on the amount of neighboring habitat. Values ranged from 1 through 5 were added for potential growth as follows: 1 point was given for potential expansion less than doubling the current size; 2 points for doubling the current size; 3 points for tripling the current size etc.

Site Values

Two hundred forty riparian community sites that included the 5 plant community types were evaluated and ranked. Each plant community site was given a site value based on the following relationship:

$$Q_s = V_q \times R \times S_i + V_i + U + P_r + S_h + P_g$$

where Qs = community site quality, Vq = vegetation quality, R = community rank, Si = community size, Vi = viability, U = unique features, Pr = rare plants, Sh = community stant shape and Pg = potential for stand expansion.

Site Ranking

Each of the 240 site values were used to develop a distribution bar graph for each of the plant communities. Coastal and valley freshwater marsh which had only ten sites were ranked equally. The site value distribution curves often had distinct breaks in value groupings making it relatively easy to assign a four category quality rank. The four quality levels were excellent, good, fair and poor. Each of these levels were given a corresponding letter (i.e., A = excellent, B = good, C = fair, and D = poor). The reason for the grade-type ranking was due to the requirements of the Sacramento River Riparian Atlas project. The Sacramento River Riparian Atlas mapped each riparian community using a letter grade code. In addition, the program's philosophy was only to consider excellent and good quality sites in choosing areas as potential preserves.

Results

A total of 240 community sites were evaluated including 123 mixed riparian forest, 62 cottonwood riparian forest, 24 valley oak riparian forest, 21 willow scrub, and 10 freshwater marsh community types (Table 1). The total area for all riparian community stands is 5,907 hectares (Table 1).

Only 23 percent of the site are off excellent quality, 29 percent of the sites are good quality, 34 percent of the sites are fair quality, and 14 percent of the sites are poor quality. Only 12 percent (720 hectares) of the 5,907 hectares of remaining riparian vegetation on the middle Sacramento River is publicly owned. Approximately half of the publicly owned riparian vegetation can be considered protected. Most of the remaining riparian habitat along the Sacramento River is subject to deforestation which currently is at a rate of about 170 hectares per year (Department of Water Resources 1979).

Discussion

This study has provided a detailed analysis of the extent and quality of the riparian plant communities

that were found along the middle Sacramento River in 1987. The results of the analysis found that it was relatively easy to determine site quality classes using a numerical method. The large number of sites and the range of site quality was the key to this study. The the large variation in site quality produced a good distribution from which to segregate quality classes. Site quality characterization for large numbers of sites, such as in this study, should consider a numeral evaluation method such as this. However, comparison of only a few sites (i.e., < 25) to determine the quality could more easily be done without a numerical analysis.

The method presented here was used in the Sacramento River Riparian Atlas (McCarten and Patterson 1988). The vegetation information in conjunction with wildlife habitat analysis, spawning gravel data, and potential revegetation site data have provided an assessment of the location of "high quality" riparian habitats. Similarly, The Nature Conservancy has utilized the vegetation quality data for their riparian preserve program (Phelps 1988). For The Nature Conservancy program Mr. Tod Wells and I added the community site values for all contiguous communities to produce a single cummulative value. The site vegetation values for contiguous riparian areas were then compared with other factors to determine areas for potential riparian preserves (Phelps 1989).

The vegetation quality analysis method used here has proved useful for choosing riparian sites that are high quality and under the current philosophy for preserve design help target particular locations for preserves. The results of this study provide the basis on which to develop a long term preserve plan for the Sacramento River. That plan should not only consider the larger more mature sites (i.e. those ranked as "excellent"), from each plant community type. Nor should the focus of land acquisition only be toward rare species. Harris (1984, p. 158) has outlined criteria for selecting specific "habitat islands" as follows: 1) geographic position within the system, 2) intrinsic diversity, 3) particular species, e.g., rare species, 4) contribution to within species genetic diversity, 5) presence of endemics, and 6) contribution to the system of "habitat islands." In essence, the selection of a particular site should be considered on the basis of its overall contribution to the system being preserved.

The successional ecology of the riparian plant communities, in response to river course and substrate depositional changes over time, requires a dynamic view of a Sacramento River riparian preserve. Due to the island nature of the remaining riparian sites in conjunction with the dynamics of the system, the concept of "long-rotation islands" (Harris 1984, p. 155) may be useful in preserve planning. This concept has been applied to old growth forest systems (Harris 1984), but aptly applies to the formation, successional changes and eventual loss of riparian habitats at particular sites.

Recommendations

When considering plant community sites that have been ranked as excellent, good and even fair for preserves other factors must be taken into account. Selected sites should include those that have potential for stand expansion; are buffered from river course changes i.e., ox bow islands; have broad contiguous stretches along the river; have both young and mature vegetation i.e., early and late successional stages such as willow scrub and mixed riparian forest; have rare plants and animals; represent examples from all plant communities that are well distributed along the river; and have incipient depositional areas where the river course is moving away from the new habitat.

These recommendations promote the view that the goal of a riparian preserve system should consider more than location, size and quality of the present habitats as they appear. The preserve design should also consider the location, size and quality of habitat years from now. Large riparian gallery forests preserved today are likely to be located in the middle of the Sacramento River bed within the next fifty years. On the other hand small patches of willow scrub and developing cottonwood riparian forest will be the gallery mixed riparian forests in the future.

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