An Ecosystem-Based Approach to Valley Oak Mitigation[1]

Marcus S. Rawlings[2] **Daniel A. Airola**[2]

Abstract: *The Contra Costa Water District's (CCWD's) Los Vaqueros Reservoir Project will inundate 180 acres of valley oak habitats. Instead of using replacement ratios to identify mitigation needs, we designed an approach that would efficiently replace lost ecological values. We developed a habitat quality index model to assess the value of lost wildlife habitat and effectiveness of mitigation options. Application of the model indicated that restoration of 238 acres of woodland and savanna would fully replace lost habitat values in 75 years.*

Our mitigation planning process was effective because it provided demonstrable benefits to CCWD and resource agencies. The planning processes could be adopted for use in other habitat restoration, mitigation, or mitigation banking projects.

In 1988, Contra Costa Water District (CCWD) proposed construction of the Los Vaqueros Project, a 100,000-acre-foot reservoir in eastern Contra Costa County, California. One of the few major, unavoidable consequences of the project is the loss of a large number of mature valley oaks (*Quercus lobata*) along and adjacent to Kellogg Creek within the reservoir inundation area. To secure the required permits, CCWD prepared an environmental impact report and environmental impact statement and supporting documents that identified environmental impacts associated with the project and appropriate measures that would be implemented to mitigate those impacts (Contra Costa Water District and U.S. Bureau of Reclamation 1992).

During early planning phases of the Los Vaqueros Project, CCWD committed to its ratepayers and the involved state and federal agencies that it would fully mitigate for significant impacts of the project on biological and other resources. CCWD also committed to its ratepayers to mitigate at a reasonable cost. Consequently, CCWD sought to develop a method for assessing project impacts on valley oaks and developing a mitigation program that is biologically defensible and economically efficient.

CCWD elected to use an ecosystem approach to planning the mitigation program. The approach established the primary mitigation goal as the replacement of the ecological values of the valley oak community. We believe this approach to establish mitigation needs is better than using typical tree or habitat acreage replacement ratios because it is based on sound ecological principles, is equitable, and satisfies requirements of regulatory agencies. It is also applicable to projects that affect other important ecosystems, including wetland and riparian habitats. The goal of this paper is to describe this approach to mitigation development using the Los Vaqueros Project planning process as an example.

The Planning Process

We used a phased planning process that resulted in three separate documents: a conceptual mitigation plan, a detailed mitigation plan, and a bid specifications and plan drawings package. Each of these documents addressed valley oak

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[2]Wildlife biologist and wildlife ecologist, respectively, Jones & Stokes Associates, Inc., 2600 V Street, Suite 100, Sacramento, CA 95818-1914.

mitigation issues with progressively greater specificity. The first two documents were used for interagency discussions, and the third was used by CCWD to contract for the construction and initial maintenance of the mitigation.

Conceptual Mitigation Plan

The conceptual mitigation plan described and quantified the project impacts, identified and justified goals for mitigating those impacts, and identified potential areas for implementing valley oak mitigation.

Impact Assessment

To assess the project's impacts on valley oaks, it was necessary to describe the valley oak habitats and the wildlife habitat functions and values provided by each valley oak habitat that would be affected by the project.

Description of Valley Oak Habitats

Two valley oak habitat types were readily distinguishable in the project area, based on landscape position and canopy density: woodland and savanna. Valley oak woodland supports a relatively dense canopy (typically greater than 65 percent) formed by narrow bands of trees that grow in and adjacent to intermittent drainages at lower elevations in the project area. Valley oak savanna occurs on valley floors away from creek channels and supports a sparse canopy (typically less than 5 percent) with an extensive understory dominated by annual grasses.

A standardized method was used to delineate woodland and savanna polygons on aerial photographs and determine habitat acreage. First, several criteria were established to describe the readily observable differences in spatial (i.e., distance between trees) and structural characteristics (i.e., landscape position and canopy cover) of woodland and savanna. Second, field surveys were conducted to determine the number and diameter at breast height (dbh) of trees in each valley oak habitat affected by the project. Approximately 830 woodland and 140 savanna trees would be affected by the inundation and dam footprint. The mean dbh of savanna trees was 43 inches; 95 percent of savanna trees exceeded less than 10 inches. The dbh of woodland trees averaged 28 inches, and 90 percent exceeded 10 inches.

Establishing a clear methodology for defining and mapping habitat acreages was important because boundaries between the two habitat types are not distinct. The acreage of valley oak savanna, in particular, could vary substantially depending on whether the mapping criteria used included or excluded open grassland that occurred between the sparse oak overstory. Affected acreage also could vary depending on where polygon boundaries are drawn in relation to canopy edge. These mapping criteria could ultimately affect mitigation acreage requirements and design.

Mean canopy width (43 feet, determined by measuring canopy size for a representative sample of trees from aerial photographs) and distance from stream channels were the basis for mapping distinct woodland, savanna, and grassland polygons. Woodland and savanna types were defined as follows.

Valley Oak Woodland—Areas with two or more trees growing within two mean canopy widths of each other and within one mean canopy width of stream channel banks. Areas of annual grassland within one mean canopy width as measured from the canopy edge also were mapped as valley oak woodland.

Valley Oak Savanna—Areas with three or more trees farther than one mean canopy width from stream channel banks and within at least four mean canopy widths of each other. Annual grassland within four mean canopy widths from the canopy edge also was mapped as savanna.

Valley oak trees that did not fit the criteria for woodland or savanna were considered as single trees within annual grassland habitat. Because loss of valley oak trees was considered a significant impact of the project, removal of single trees also required mitigation. Consequently, single trees were assigned an impact acreage area representative of the average per tree in savanna habitat.

Application of this method indicated that approximately 50 acres of woodland and 130 acres of savanna habitat (including single trees) would be affected by the project. The method also allowed for comparison of habitat acreage under four scenarios:

- current conditions,
- future conditions with no project,
- future conditions with project implementation and no mitigation, and
- future condition with project implementation and mitigation.

Wildlife Habitat Functions and Values

We developed and applied a habitat quality index (HQI) model to quantify the wildlife habitat functions and values of woodland and savanna that would be lost with project implementation. The HQI model is designed to represent the range of habitat values that are characteristic of woodland and savanna. The model uses a formula structure similar to the species-specific habitat suitability index (HSI) models of the U.S. Department of the Interior, Fish and Wildlife Service's habitat evaluation procedures (HEP) methodology (1980, 1981) that combines quality ratings for a set of habitat characteristics that are important in determining habitat quality. The HQI model quantifies wildlife habitat value based on two structural characteristics of valley oak habitats: mean tree dbh and mean percent canopy cover (Jones & Stokes Associates 1991).

The HQI variables were selected because they represent most wildlife habitat values provided by valley oaks and are easily measured. Mean percent canopy cover was determined from aerial photographs and represents wildlife habitat values associated with foliage (e.g., leaf surface area for foraging birds and for nesting cover). Mean dbh was determined from direct field measurements of all trees in the project area and represents habitat values associated with tree size (e.g., acorn production [Garcia and others 1991, Koenig and others 1991], bark furrowing [Jackson 1979], and the availability of nesting cavities [Wilson and others 1991]).

The model provides a per-acre quality value by combining ratings for percent canopy cover and dbh variables. Quality ratings for each variable are determined by assigning a numerical value of 0.0-1.0, with a value of 1.0 representing the highest quality attainable for that characteristic. The per-acre HQI value is multiplied by the number of acres of habitat to produce an overall quality rating in habitat units (HUs). Average annual habitat units (AAHUs) are the average number of HUs annually produced from target year (TY) 0 (the year that project construction is initiated) to any specified future TY. Changes in preproject and postproject AAHU values reflect the magnitude of habitat quality change that can be expected with project implementation and the amount of mitigation necessary to offset those impacts. Application of the model indicated that a total of 48 woodland AAHUs and 87 savanna AAHUs would be lost with project implementation.

Historic trends in woodland and savanna conditions were used to predict future habitat extent and condition if the project were not implemented. Aerial photographs of the project site taken between 1939 and 1987 were analyzed to determine historical densities of valley oaks in the project area and the mean annual net rate of tree loss during that period. During this period, the number of woodland trees remained stable while the number of savanna trees declined (from mortality and lack of regeneration) at a rate of about 0.6 percent per year. This rate of decline is similar to the 0.45 percent per year rate observed elsewhere for valley oak by Brown and Davis (1991). The HQI model was used to quantify the resulting decline in wildlife habitat value expected in the future without project implementation, assuming continuation of the tree loss rate observed between 1939 to 1987 (*fig. 1*). Application of the HQI model indicated that 12 savanna AAHUs would be lost during the next 75 years.

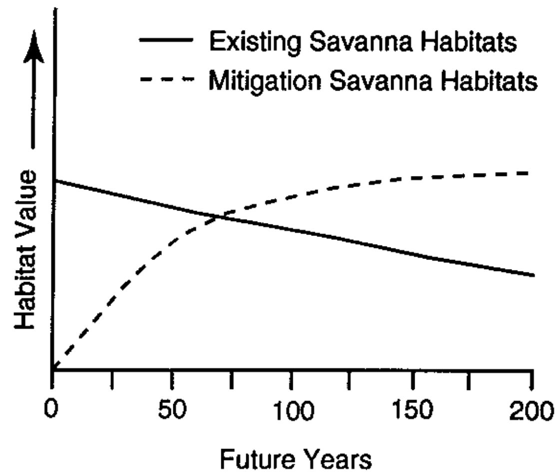

Figure 1—Predicted habitat value of existing valley oak savanna without project implementation and mitigation valley oak savanna with project implementaion in future years.

Mitigation Goals

Four goals were established in interagency discussions to guide the process of valley oak impact mitigation.

1. Use Restoration Techniques That Are Economically Efficient and Can Be Sustained on a Long-Term Basis—This goal was adopted to recognize that funding and staffing resources are limited and must be effectively applied in the mitigation process. The use of methods that require substantial funding and staffing may be appropriate initially, but mitigation stands should be sustainable without intensive, long-term maintenance (e.g., continuous irrigation).
2. Preferentially Replace Habitats That Have Been Most Detrimentally Affected by Regional Land Uses—Analysis of historic aerial photographs of undeveloped lands in the surrounding region and distribution of trees by dbh class showed that savanna was declining while woodland remained intact. The savanna type, therefore, appeared to be in the greatest need of augmentation as a regional landscape component. Restoration of savanna to mitigate for some of the losses of woodland was recommended and accepted.
3. Protect Mitigation Sites in Perpetuity—This goal was adopted to ensure long-term management and protection of mitigation sites from future habitat loss or effects of adjacent land use. This goal was achieved by using mitigation site selection criteria that ensured the selection of only the land that could reasonably be afforded long-term management and protection.
4. Design Mitigation Plans to Replace Lost Wildlife Habitat Values—This goal directed the pattern of planting to ensure that the structure created in the mitigation areas would correspond to the structure typical of healthy native habitats. For example, the canopy closure level chosen to represent the highest quality of savanna habitat was

15 percent (higher than the 5 percent observed at the site) to account for past canopy reduction.

To achieve these goals, the HQI model was used to identify mitigation acreage requirements and the growth period necessary to replace lost habitat values. To apply the HQI model, growth projection curves were developed (using tree dbh and canopy width data collected from the project area) to predict future mean canopy and mean dbh of valley oak trees planted for mitigation. HQI model results indicated that approximately 240 acres of valley oak must be planted to replace lost wildlife habitat values (i.e., 135 woodland and savanna AAHUs) within 75 years (*fig. 1*).

The HQI model incorporates an explicit mechanism to allow some tradeoff between habitat quality and quantity in determining total habitat values for existing and mitigation stands. Trees planted as acorns in the mitigation areas cannot achieve the same characteristics, and hence wildlife value, as the older trees for several hundred years. The model, however, attempts to explicitly quantify judgments of agency and consultant biologists regarding the relative tradeoffs between habitat quality at various points in time and habitat quantity (i.e., acreage) and thereby encourage consensus on the appropriate mitigation acreage.

Creation of some of the habitat characteristics of older stands (e.g., nesting cavities and down wood) will also be accelerated by installing and maintaining bird nest boxes and brush piles in mitigation areas to replace some of these values until they can be provided by the maturing mitigation stands.

Mitigation Site Selection

A three-step process was developed and implemented to identify, evaluate, and select potential mitigation sites.

First, a large regional area, consisting of CCWD project lands and eight valley bottomlands immediately to the north, was initially evaluated, which provided a wide range of potential mitigation site choices. The second step in the process was to identify soil types in potential mitigation areas that were suitable for valley oak establishment and growth and to rate them as having a low, moderate, or high capability for sustaining valley oaks.

The last step in the process was to select final mitigation sites. Several ecological and economic criteria were applied to lands possessing suitable soil types. The criteria and their rationale included:

- Proximity to the project impact area (resource agencies preferred that mitigation be established as close to the impact area as feasible),
- The amount of mitigation achievable at the site (larger areas of mitigation would be more cost effective to implement and provide greater wildlife habitat values than smaller areas),
- Proximity to other protected lands (establishment of valley oak habitats adjacent to existing protected habitats would increase overall habitat values by contributing to creation of a larger protected area of habitat and would reduce the likelihood of potential future adverse effects on mitigation habitat from adjacent land uses),
- Apparent health of existing onsite trees (as an indicator of a site's suitability for valley oak establishment),
- Depth to groundwater,
- Availability of irrigation water sources, and
- The estimated cost for land and mitigation implementation.

Application of this process resulted in selection of three different mitigation sites located within and immediately adjacent to the Los Vaqueros watershed.

After completion of the draft conceptual mitigation plan, CCWD presented the mitigation concept to permitting and resource agencies for comment. The conceptual mitigation plan provided background information and ecological justification for the proposed mitigation approach. The conceptual planning process enabled CCWD to clearly justify land requirements, including some lands that needed to be purchased specifically for mitigation. The plan also identified the procedures that could be used to meet interagency requirements.

Detailed Mitigation Plan

Following agreement by agencies with CCWD's conceptual mitigation approach, a detailed mitigation plan was developed (Jones & Stokes Associates 1993). The detailed plan described the "what, where, when, and how" of the mitigation program. Six major program elements were described in the plan:

- A detailed description of project impacts, mitigation goals and objectives, and selected mitigation areas;
- A planting plan that described the source and type of planting material, planting densities and layout, planting methods, and site maintenance;
- A mitigation implementation schedule that described the period over which mitigation would be implemented relative to the project implementation schedule;
- A mitigation monitoring plan and schedule that described how and when mitigation sites would be evaluated to determine the mitigation's success;
- Mitigation performance standards, established for future years, that must be met if mitigation is to be considered successful. (CCWD established performance standards to achieve at least 60-percent and 50-percent plant survival at years 5 and 10, respectively, following implementation of mitigation. Performance goals also were established for interim years to enable CCWD to determine whether plant survival was sufficient to ensure that the year 5 and 10 performance standards would be met.); and
- A description of potential remedial measures (e.g., replanting unsuccessful portions of mitigation sites or acquiring and planting additional mitigation lands) that could be implemented if any of the plantings do not achieve performance standards.

The first step in preparing the detailed mitigation plan was to conduct site-specific investigations of selected mitigation sites to confirm the presence and boundaries of suitable soil types and to identify potential constraints that were not identified in earlier evaluations.

At the request of permitting agencies, we evaluated "natural management" and "active management" approaches as options for implementing mitigation. The natural management approach relies on using management practices to increase the likelihood for natural reestablishment of valley oaks. Active management involves active, direct cultivation of oaks. Management actions using a natural approach can include changing grazing patterns that may be suppressing valley oak regeneration, improving hydrologic conditions for valley oak establishment by enhancing stream channels, or modifying other ecological factors (e.g., gopher control).

CCWD adopted an active management approach and rejected the natural approach because its dependence on natural regeneration to replace lost habitat values in the 75-year mitigation period could not be reasonably ensured. To increase the likelihood that mitigation goals will be achieved, CCWD's approach includes planting acorns and seedlings, providing irrigation for at least 2 years, removing livestock during seedling establishment, installing tree shelters to reduce herbivory, and initiating a 2-year weeding program. Using this approach requires greater initial costs than using less intensive management methods (e.g., planting acorns without irrigation or other maintenance) but is expected to achieve mitigation objectives more quickly and avoid the long-term costs of remediation associated with the less intensive method.

CCWD is also implementing the phases over time. The first phase was implemented in December 1995 on the mitigation site with the least favorable site conditions. The remaining mitigation sites will be planted after completion of dam construction, which is likely to be in winter 1997-1998. Monitoring of the initial plantings will allow mitigation techniques to be evaluated without risking potential failure at all the sites. The rationale for this phased approach is that methods proven successful on the least favorable site will ensure the success of the remaining, better sites. If one or more elements of the program are unsuccessful, however, this phased approach allows CCWD to adjust the program before investing in the remaining mitigation sites.

Following completion of the draft detailed mitigation plan, CCWD again met with the agencies involved to ensure that the proposed mitigation implementation and followup procedures were sufficient to reasonably ensure that mitigation goals agreed to in the conceptual mitigation plan could be achieved.

Detailed Bid Specifications and Plan Drawings

The final planning element was preparation of detailed bid specifications and plan drawings. Bid specifications and plan drawings provide sufficient detail for a habitat restoration contractor to construct and maintain the mitigation. These documents also provide the basis for competitive bidding by prospective contractors. Major elements of CCWD's specifications package included:

- Detailed descriptions of materials required for installation,
- The irrigation system layout,
- The planting layout and methods, and
- Mitigation maintenance requirements.

Mitigation Implementation

Mitigation implementation was an unencumbered and straightforward process because all mitigation issues had been resolved in the planning process. CCWD initiated Phase 1 of its mitigation in winter 1995, which consisted of planting approximately 1,000 acorns and seedlings on 55 acres. Monitoring survey results of the planting area may require slight adjustments to techniques used to establish subsequent mitigation phases.

Conclusion

We believe that the mitigation planning process developed and implemented for the Los Vaqueros Project is applicable to a variety of other projects and habitat types. The process can achieve a more ecologically meaningful and economically efficient result than is obtained under typical formula-based oak mitigation approaches. The process benefits project proponents by:

- Reducing mitigation costs;
- Increasing the certainty of mitigation success; and
- Ensuring that mitigation requirements are realistic, equatable, and scientifically based.

Involving resource agencies in a sequential planning process also reduces potential for delays during permit approval. Agencies, which frequently lack sufficient staff for detailed project evaluation, recognize benefits from development of clear, defensible methods to assess project impacts and identify project-specific mitigation. This should reduce reliance on the expedience of using predetermined tree or habitat acreage replacement ratios to establish mitigation requirements, which may not replace affected resource values.

We also believe that this planning process or a modified form of it can be used by a wide variety of landowners, land management agencies, and planning departments for habitat enhancement and restoration programs. The process may also provide the basis for establishing regional mitigation banks to replace oak woodland and other habitat types.

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