County of Placer

Natural Communities Conservation Plan
Habitat Conservation Plan
Phase One

Report of the Science Advisors

January 8, 2004

Preface *

This document is a requirement of the Natural Communities Conservation Plan Act (Act) of 2002 (California Fish and Game Code 2800-2840). Independent scientific counsel and input is required to advise the Natural Community Conservation Plan (NCCP) planning process and help provide sound principles for conservation, species protection, and adaptive management. The Science Advisors were selected by Placer County based on criteria provided by the California Department of Fish and Game (CDFG) in *Guidance for the NCCP Independent Science Advisory Process* (August 2002). Members of the Science Advisors were selected due to their expertise in a particular field of landscape ecology or biology, strong publication record and/or record of scientific leadership, objectivity, and ability to function well within a team. Science Advisor qualifications were reviewed and approved by the CDFG. The following Science Advisors were selected:

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Joseph Medieros, Sierra College
Bruce Pavlik, Mills College
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The Science Advisors met independently to discuss the Placer County NCCP, review available data, and determine their collective recommendations for the NCCP planning process, which are outlined in the following report. This report was prepared by the Science Advisors independent of review or modification from any outside party and has been reproduced in its entirety.

* This preface was prepared by the Placer County Planning Department.

Report of the Science Advisors

For the Placer County Natural Communities Conservation Plan and Habitat Conservation Plan

Planning Principles, Uncertainties, and Management Recommendations

January 8, 2004

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Table of Contents

Introduction

Placer County is in the process of preparing a Habitat Conservation Plan (HCP) and a Natural Communities Conservation Plan (NCCP) as a practical way of meeting county-wide conservation challenges. The Natural Communities Conservation Planning process was established in California in 1991 as Assembly Bill 2172 and codified in Section 2800 *et. seq*. of the State Fish and Game Code. The goal of Natural Communities Conservation Planning is to conserve healthy functioning ecosystems and the species that are supported by them. At present the planning process is concentrating on the western part of the county where vernal pool-grassland complexes, streams and their associated riparian areas, freshwater emergent wetlands, and oak woodlands are the primary conservation targets.

Multi-species habitat conservation planning must be done in a context that includes population, community, and ecosystem processes. Although covered species are the focus of habitat conservation plans, the ecological factors that directly or indirectly affect their populations often result from processes that occur at several levels of biological organization. Thus, the development of multi-species conservation plans must proceed from the autecology of individual species through the community- and ecosystem-level processes that affect their populations. Planning also must be done within the constraints of available conservation options.

Unfortunately, no simple recipe exists for this process. Wildlife biologists have traditionally used indicator species (or indicator guilds) to draw inferences concerning habitat conditions; the northern spotted owl in the coniferous forests of the Pacific Northwest is a classic example. However, current data suggest that conservation actions focused on a single species or a small group of species is unlikely to confer protection to all species region-wide. Thus, the County must consider all available biological information on all target species such as habitat preferences, specific mortality risks, and dispersal abilities in the design of the NCCP/HCP.

For many species, the success or failure of the HCP/NCCP will depend upon land use and land management patterns in adjacent counties. A regionally coordinated conservation strategy has a far better chance of achieving biological success than county-by-county planning. NCCP implementation should include the County working closely with state and federal agencies and neighboring counties to achieve coordinated multi-county conservation planning, management and monitoring. Without region-wide planning, even excellent landscape-level plans may fail (Bestelmeyer et al. 2003).

Planning Principles

Planning Phases

Because Placer County covers a large area and conservation is more urgent in some parts of the county than others, it was decided to do the HCP/NCCP in three phases. Phase 1, to be implemented first, includes the western part of the county from the headwaters of the major creeks that drain the area (e.g., Coon Creek, Auburn Ravine Creek, Dry Creek, etc.) to the county lines. Phase II includes the developing areas in the foothills east of the Phase I area (Colfax and Foresthill) plus the area from the Sierra crest east to the Nevada line, excluding the Tahoe Basin.

Phase 3 is the area in the middle of the county that is experiencing much slower rates of growth and contains much public land. This report covers Phase 1 only.

Network of Conservation Areas

The County's first task is to locate conservation areas that will provide adequate representation of the full range of ecosystems and community types in the Phase 1 area. Conserving these areas not only will ensure the continued provision of ecological goods and services from these ecosystems but also will facilitate the redistribution of species along environmental gradients in response to future disturbance and climate change. To facilitate locating conservation areas, a number of geographic information system (GIS) coverages must be developed. One set of coverages should be watershed-based; watersheds are the optimal planning units for aquatic and riparian species and communities. The second should be based on land cover types; these are the most appropriate units for terrestrial species and communities.

Watersheds

There are many advantages to organizing data by watersheds, including:

- In Placer County many of the special-status species and sensitive habitats are associated with aquatic systems.
- Watershed boundaries are coincident with the boundaries of many key ecological processes such as surface water flow and most nutrient inputs.
- Aquatic and riparian systems are good indicators of the health of the overall ecosystem.
- In California, water is the most limited and limiting resource for both the natural and human economy.

Watersheds defined by smaller stream systems (first- to third- or fourth-order) already have been mapped by CalWater. These watersheds range from about 5,000 to 15,000 acres and are relatively large for sub-county level analysis. However, they were used by Davis et al. (1996) for the Sierra Nevada Ecosystem Project, and thus have the virtue of continuity with this major effort and are recommended.

The following landscape-scale indicators of environmental status and quality should be developed for each CalWater watershed in the western part of the county, and metadata for each coverage need to be fully developed. This approach will provide a first cut at the identification of watersheds that are particularly favorable for conservation.

1. General watershed statistics provide necessary background information for subsequent analyses. These include, but are not limited to:

- area
- elevational range
- ecological subregion, section, and subsection (Miles and Goudey 1997)
- average annual precipitation
- means and variances of precipitation and temperature over the past 50 years
- land ownership and land use
- road density
- number of road crossings

2. Aquatic habitat types should be classified according to the system developed by Moyle and Ellison (1991), and crosswalked back to the other habitat classifications used in this analysis (e.g., WHR, see following section). Maps and data required are:

- miles of permanent and intermittent streams
- extent of lakes or other lentic waters
- number of dams and diversions
- miles of free-flowing versus impounded streams
- ditches, canals, reservoirs, and other artificial modifications to the natural flow regime
- extent of Aquatic Diversity Areas
- extent of Pacific River Council Critical Aquatic Refuges
- isolated springs, wet meadows, fens, bogs, seeps

3. Riparian extent and distribution are key indicators of habitat quality within a watershed. Some coverages are available; in most cases accurate information for mapping will have to come from aerial photographs. While the vegetation can be classified initially by using WHR units, field measurements of local habitat conditions, (e.g., the presence of special habitat elements such as snags and large woody debris) ultimately will provide the assessment of habitat quality. Maps and data required:

- extent of riparian habitat

4. Buffering around riparian areas is important for conservation. Fixed-width buffers tend to be more politically expedient, but variable-width buffers are more biologically realistic (Kondolf et al. 1996).

- maps with various fixed buffer widths
- maps with variable buffer widths
- roads in riparian zones as defined by both vegetation type and by various buffer widths

These GIS coverages should be evaluated to determine the conservation value of the watersheds in western Placer County. The watersheds need to be ranked by a clearly described protocol, and high-ranking areas can be considered to be high priorities for management as conservation areas.

Land Cover Types

Watersheds have two major limitations as conservation planning units; terrestrial vegetation types do not stop at watershed boundaries, and many species move freely from one watershed to another. Thus, a second set of coverages must be developed for land cover types.

1. Land cover composition and pattern will be a mosaic of native and cultural vegetation types. Dominance of agricultural or other human-modified ecosystems not only reflects land use pressure but also the potential for erosion and low water quality (Hunsaker and Levine 1995). The most useful classification scheme for land cover is the California Department of Fish and Game's California Wildlife Habitat Relations (WHR) (Zeiner et al. 1990). In addition to native vegetation, WHR cover types include cultural

vegetation such as pasture, cropland, orchard-vineyard, and urban. The WHR coverage needs to be prepared at the same scale so it can be overlaid on the watershed maps, and summary statistics (e.g., X% blue oak woodland, Y% orchard-vineyard, etc.) need to be prepared for each cover type in western Placer County. If more detailed coverages than WHR become available (e.g., Cal Veg), the same procedure should be followed for them as well. Maps and data analyses required include:

- land cover
- acreage and percentages of urban, agricultural, and natural vegetation
- acreage and percentages of different types of natural vegetation
- areas with large size classes of oak woodlands

2. Land cover patch sizes are important predictors of the habitat value of a given watershed to a particular species or group of similar species (Ritters et al. 1996). In general, large habitat patches support higher densities and diversities of plants and animals than do small patches. Maps and data analysis required are:

- cover types
- frequency histograms of WHR cover type patch sizes

3. Small patch communities. Some species of conservation concern are confined to small community types of a few acres or less that are imbedded in larger land cover types. These species, such as many rare plants, invertebrates, reptiles, and amphibians, often have low dispersal powers. Maps and data required are:

- soils
- geology
- maps and extent of serpentine/gabbro substrate, if any
- maps of caves, cliffs, and rock outcrops

The Nevada County Natural Resources report obtained much of the information on small patch ecosystems by digital orthophotos and field mapping (Beedy and Brussard 2002). A similar process should be used by Placer County.

Other Coverages

In addition to watersheds and land cover types, a number of other coverages will be necessary to develop a conservation network.

1. Percentage of land in public ownership or private protected status within western Placer County provides an indication of the feasibility of aggregating large blocks of land into conservation areas. Lands in conservation easement status adjacent to protected public lands (e.g., state parks and wildlife areas) have especially high potential for inclusion in regional conservation planning efforts. Data and maps required:

- extent of public lands and private conservation easements
- extent of sites given high priority by conservation NGOs (e.g., TNC, local land trusts, etc.)
- average parcel sizes of private land not in conservation easements
- number of owners (often the same individual owns multiple adjacent parcels.

In terms of the complexity of conservation, the number of owners and the size of patches under one owner is important. See Stoms et al. (2001).

- average parcel sizes of private land not in conservation easements

2. Existing parcel sizes and their General Plan designations within each watershed, along with summary statistics and histograms of the frequency of each type of parcel size, should be prepared.
    - parcel sizes, general plan designations, and summary statistics and histograms

3. Roads and transportation corridors fragment habitats, and roads in particular can be major sources of erosion (Trombulak and Frissell 2000). Therefore, the extent and number of areas larger than 100 ha that are not transected by roads or transportation corridors are major indicators of the conservation potential of an area. Maps and data analyses required are:
    - road network
    - miles of roads by road type per square mile of watershed area
    - miles of major transportation corridors
    - miles of utility corridors
    - areas without maintained roads > 100 ha.
    - erosion potential of major soil types and slopes

Road density (or miles per area of any linear feature) may be less informative than a measure of "road affected area" based on modeled road effect zone. Such an approach is described at the following website: http://www.nceas.ucsb.edu/nceas-web/projects/4040/TerrBiod_framework-report.pdf.

4. Percentage of residential or agricultural land on slopes greater than 5% is an indicator of potential soil loss and runoff. Maps and data required:
    - 30 meter Digital Elevation Models (DEMs) to derive slope, elevation, and aspect.
    - agriculture and development on steeper slopes

5. Land use and disturbance history is important for understanding ecosystem composition, structure, and functional organization. For example, supposedly "pristine" oak woodlands in Placer County were orchards as recently as 60 years ago, according to aerial photographs taken in 1938. Useful maps and data would be:
    - logging history
    - agricultural history
    - mining history
    - fire history

Historical land use maps are notoriously hard to produce, and archival photos may not be early enough to pick up signatures of late 19th century and early 20th century agriculture and mining. Post-1950 fire history is already available in GIS form from CDF FRAP but would need to be checked and refined.

6. Records of occurrence of all special-status species in the County and an assessment of total vertebrate species richness by habitat type are obvious determinants of conservation priorities. Maps and data analyses required:

- NDDB and other locality data for all special-status species
- total vertebrate species richness by habitat type (estimated from WHR models)

Design of Conservation Areas

The GIS coverages described above should be used to identify a viable but also efficient (in terms of cost and/or area) regional conservation network that will (1) provide adequate representation of ecosystem and community types within the county, (2) conserve most of the species associated with these ecosystems and communities, and (3) ensure adequate protection for most listed and sensitive species. Design of this network must focus simultaneously on watersheds, landscapes, and small-patch ecosystems. (4) The planning process also must give particular consideration to certain species that are at immediate risk of extirpation in the County (nesting colonies of bank swallows, for example). These species are so rare that they very likely will not be adequately represented in conservation areas or landscape linkage areas and will need to be protected in special reserves outside of the main conservation network. These reserves must be matched in grain and scale to the species of concern.

The following basic tenets of conservation biology are central to conservation planning.

1. Species that are well-distributed across their native ranges are less susceptible to extinction than are species confined to small portions of their ranges. This means that the recovery of many target species will depend on conservation programs throughout the State and that their dynamics will be strongly influenced by activities outside of Placer County. Thus, it does not make sense to set specific numerical targets for those species within Placer County conservation lands. Instead, maintaining appropriate habitat for these species within the context of broader ecological goals (e.g., improve or maintain desirable vegetation structure and hydrological regimes, eliminate invasive exotics) is the most important conservation action.

2. Although some species can be conserved in a “working landscape,” most sensitive species require protection in reserves where conservation is the major land-use goal. Existing patches of habitat that support populations of sensitive species should be provided with reserve-level protection, and these areas should be managed to maintain the structure, composition, and processes found in the natural community.

3. Large conservation areas containing large populations of the target species are superior to small conservation areas containing small populations. While the persistence of all populations is subject to the effects of normal random environmental events (environmental stochasticity) and catastrophes such as wildfires and severe drought, the persistence of small populations is additionally threatened by random variations in birth or death events (demographic stochasticity) and random changes in genetic composition (genetic stochasticity). Large areas with high quality habitat for target species tend to mitigate the combined effects of these factors. Thus, acquisition of conservation areas should preferentially add to existing protected areas.

Conservation areas should be designed to maximize the viability of local populations of area-sensitive species. For the most part, species with limited aerial requirements will be accommodated within conservation areas designed for species with more extensive home ranges.

4. Conservation areas that are close together are better than those far apart. An arrangement of conservation areas that facilitates dispersal of individuals among these areas is necessary to encourage demographic rescue effects (whereby dwindling populations are supplemented by migrants), and continued genetic interchange. All else being equal, conservation areas that are close together are more likely to support sensitive species for longer time periods than will isolated areas; thus, if it is not possible to acquire new conservation areas that add to existing ones, acquisitions should be made in proximity of protected areas. In the absence of suitable landscape linkages, conservation areas should not be separated by gaps of unsuitable habitat greater than the normal dispersal distances of the least vagile target species.

5. Interconnected conservation areas are far better than isolated ones. Interpopulation dispersal is important for regional species persistence. Because of the amount of habitat that already has been developed in western Placer County, populations of most species are badly fragmented. Therefore, it is critical to identify areas that can provide connections between conservation areas to increase the likelihood of successful dispersal. Such dispersal not only enhances the persistence probabilities of sensitive species (Wiens et al. 1993), but it also helps maintain the overall diversity of plants and animals within a given area (Hansen and Urban 1992) and allows the entire regional habitat network to function as a healthy ecological community.

Multiple linkages among conservation areas are optimal because they provide alternative movement pathways for species. Redundancy is particularly important in areas subject to high rates of disturbance, such as fire. Since connectivity and fragmentation are habitat- and species-specific, an analysis of landscape permeability (e.g., Singleton et al. 2002) should be done for each special-status species.

Conservation areas in the western part of the county should be linked to National Forest lands to the east whenever possible to provide for viable populations of large vertebrates and migratory species and to allow for dispersal of species in response to potential changes in regional climatic conditions.

Connectivity and degree of fragmentation also can be significant determinants of the spread and magnitude of disturbance factors including fire, disease, and flooding (Turner et al. 1989, EPA 1994), and these also factors must be considered in conservation planning.

6. Landscape linkages function better when the habitat within them resembles habitat that is preferred by target species. The network of conservation areas should make use of naturally existing movement corridors in the landscape (such as riparian strips or traditional wildlife migration routes), and whenever possible, natural linkages between conservation areas should be restored through restoration or improved management.

Landscape linkages wide enough to contain resident individuals of target species must be established to connect conservation areas farther apart than the species' normal dispersal distances. These corridors must include habitat components to meet all of the species' life history requirements.
Where doubt exists concerning optimal widths, linkages should be designed to be as wide as possible. The creation of narrow, weedy corridors should be avoided.

Low-impact buffer zones should be planned between developed areas and landscape linkages. Use of off-road vehicles and other disruptive human activities should be prohibited in these buffer zones.

7. Habitat for a particular species within a conservation area that occurs in less fragmented, contiguous blocks is preferable to habitat that is fragmented. Conservation areas should minimize internal fragmentation and barriers to species movement. Viable populations of many species require large blocks of habitat where the presence of disruptive edge-dwelling species, such as cowbirds and house cats, is minimized. Habitat highly fragmented by disturbed or developed lands has relatively little conservation value for species that exhibit high habitat specificity. Species that are susceptible to the deleterious consequences of edge are more likely to retain populations in habitat patches that are rounded or squared than in patches that are elliptical or rectangular when those patches are surrounded by disturbed or developed land. In such circumstances, small, linear strips of habitat that maximize the ratio of edge to area are least desirable.

8. Blocks of habitat that are roadless or otherwise inaccessible to humans serve better to conserve target species than do roaded and accessible habitat blocks. Human contact is thought to be a major cause of decline in certain sensitive species, so populations of these species in habitats that are inaccessible to motorized recreation or similar activities are more likely to persist than those in habitats where human access is less restricted.

Currently roadless areas and other wildlands should be maintained in an undeveloped state; unnecessary roads should be closed whenever possible, the County should not permit new roads to be built within roadless areas.

Access and human use of conservation areas and landscape linkages must be restricted to protect species sensitive to human disturbance. Trails should be diverted from sensitive areas, such as rare plant populations. Fencing and control of domestic dogs and cats may be necessary.

Where landscape linkages are intersected by roads that cannot feasibly be closed, tunnels, underpasses, or other wildlife crossings should be provided at sites documented to be commonly crossed by animals that are vulnerable to roadkill. The width of such crossings should be roughly proportional to the size of the animal; for example, three-foot-wide tunnels are adequate for amphibians and small mammals, hundred-foot underpasses may be necessary for large mammals. Fences or other barriers can be used to funnel animals into road crossings.

9. Whenever, possible, maximize heterogeneity in conservation areas. Areas that have diverse topography, soils, and vegetation tend to capture a variety of different habitat types and thus support a richer biota than more homogeneous areas. As presently

described, the Conservation Opportunity Areas are confined to agricultural habitats in the western Phase 1 area. Exchange strategies to conserve some lands to the east and south of the hard line would increase heterogeneity substantially.

10. Stakeholders must participate in conservation planning and decision-making. Community-based conservation is a relatively new way of approaching natural resource challenges. It entails seeking a much broader consensus in management actions by involving the greater community in all phases of conservation: planning, implementation, and adaptive management. A wide representation of stakeholder groups is essential to this effort; engaging the broader community serves an important educational function, helps develop ownership in conservation goals and objectives, and often provides a corps of volunteers to do some of the work necessary to implement conservation actions

11. Conservation is expensive, and the costs don't end with land acquisition. Either the developers, landowners, taxpayers, or some combination of the three will have to tithe to meet the requirements of an HCP/NCCP. Once conservation lands or easements are acquired, they must be managed, and management requires a permanent source of funding.

12. There is a tradeoff between area and management intensity. Small conservation areas require much more active management, and thus are more costly on an ongoing basis, than do large areas. These trade-offs should be weighed when particular parcels are being considered for inclusion in the conservation network.

13. There is considerable uncertainty in conservation planning and management, and the more endangered a species, the more uncertainty there is in its recovery. Conservation actions are always implemented with imperfect information on the species, its habitat, and the greater ecosystem in which it occurs. Climate change and other forces outside of corrective action add to this uncertainty. Thus, the precautionary principle demands a conservative approach to all conservation actions.

14. The matrix matters. Reserves with hard boundaries are a critical component of conservation plans. However, activities outside of reserves affect processes and events inside them. Thus, it is critical to assess the likely impacts that surrounding land uses will have on reserves. In many cases it will be desirable to establish a "soft edge" around reserve boundaries to minimize the impacts of nearby roads, urbanization, and agriculture. Much of this could be accomplished by requiring more conservation-friendly development; for example, green belts should be put on the edges of projects, not in their centers, and new roads should be constructed adjacent to developed areas and not transect open space. Public information programs should be developed that explain the values of conservation lands to the general public. A better-informed public will come to regard conservation lands as highly valued assets rather than trash dumps.

In summary, designing an effective and efficient system of conservation areas is a very complex process that involves consideration of biological resources, threats, costs, and opportunities. Many tools have been developed to help conservation planners and stakeholders design and evaluate alternative conservation systems (e.g. http://www.biogeog.ucsb.edu/projects/tnc/toolbox.html , http://www.biogeog.ucsb.edu/projects/wb/TAMARIN_Manual.pdf and http://www.natureserve.org/aboutUs/dss.jsp). We encourage the County to use modern conservation planning support software to help integrate, visualize and analyze GIS data and craft a conservation plan to meet the stated NCCP objectives.

Linking Covered Species to Conservation Areas

Covered species can be linked to conservation areas by proceeding down two separate but eventually convergent pathways.

The first path involves the compilation of species profiles, envirograms, and a multi-species ecological assessment. Species profiles need to be constructed for each species that could potentially be included in the HCP/NCCP. Data on regulatory status, basic life history, distribution, threats, and potential conservation strategies should be obtained from the published literature, web sites, and other available sources. The species profiles are not intended to be detailed compendia, but they should contain adequate information to identify their life history and habitat needs in western Placer County. The species profiles that have been prepared for the County are adequate.

Envirograms are then created for each species from the information contained in the species profiles. An envirogram is simply a tool that sharpens our understanding of the most important ecological factors that affect a population or group of populations of a particular species. The concept was developed originally by Andrewartha and Birch (1984), and envirograms were first applied to conservation planning by James et al. (1997) who used them to identify factors limiting the abundance of endangered Red-cockaded Woodpeckers in the southeastern United States. The version described below is modified somewhat from these previous applications.

An envirogram consists of a "centrum," components of the environment that directly affect a species' chances to survive and reproduce, and several "webs," distal factors that act in sequence to affect the proximate components of the centrum. The centrum consists of four major categories, resources, reproduction, hazards, and dispersal. Each of these can be subdivided as necessary. For example, resources could be subdivided into foraging habitats, breeding habitats, and food; reproduction could be divided into finding mates, nesting, and fledging. Hazards can be divided into predators (an animal that consumes the subject species in whole or part) and "malentities" (organisms or events that can adversely influence the subject species in other ways such as a cow stepping on a dispersing western spadefoot or the premature drying of a vernal pool). Dispersal also can be subdivided since it can occur at different times in a species' life cycle and it can be either local (such as moving from one habitat type another) or long-distance.

The web identifies the underlying ecological processes or human actions that influence each centrum component. The idea is that distal factors in the web flow in to activate proximate components of the centrum. Each of these flows is called a pathway. Pathways in the web are constructed from right to left, with Web-1 factors directly affecting centrum components, Web-2 factors affecting Web-1 factors, and so on. It is usually unnecessary to have more than three webs to track a centrum component along a pathway to its ultimate underlying influence.

A web factor can have both positive and negative aspects. For example, precipitation is critical to vernal pools. Too little rain results in pools that dry up before their dependent species can complete their life cycles, but greater than average rainfall can result in flooding and dispersal of individuals among pools—an event necessary for gene flow and to replenish dwindling populations.

The centrum components of the envirograms should be accurate reflections of the information in the species profiles, and the web pathways should be logical linkages of indirect environmental components to the proximate drivers of population processes in the centrum. Envirograms are not intended to be stand-alone documents but should be used in conjunction with species profiles and maps showing the distribution of populations and suitable habitat. They are considered to be "works in progress" and always can be modified by new and better information. For example, the vernal pool plant envirograms are a bit too simplistic at present. In particular, they need to tie life stage and phenology to resources and hazards more effectively.

Once the envirograms have been constructed, the multi-species ecological assessment is prepared in the form of a spread-sheet that lists and organizes the centrum and web factors identified for each species. This process facilitates the recognition of resource overlaps and commonalities (e.g., several species use the same habitat), conflicts (e.g., one species requires an early successional habitat while another needs a late successional habitat in the same community), and biological interactions (e.g., one species is a predator on another).

The second pathway involves species-specific surveys, qualitative population viability analyses (PVAs), and a multi-species spatial assessment.

A PVA is an assessment of the persistence probability of a population based on habitat and population parameters. A PVA can be applied either to a single population or a population system (metapopulation). Well-connected populations are usually treated as metapopulations, but single, isolated populations are generally dealt with separately.

The basic assumption of a PVA is that the population is stationary or increasing or, if not, that systematic mortality can be controlled. If the population is declining or systematic mortality cannot be controlled, a PVA is not necessary. The population will go extinct at a rate directly proportional to its decline and the longevity of individual organisms.

A PVA must be based on specifically-stated goals. For example, the goal for one PVA might be simply to assess the immediate probability of extinction of a population, while the goal for another PVA might be to assess its probabilities of extinction under various levels of protection. PVAs are treated as hypotheses, subject to future refinement as new data come in or a better understanding is gained of underlying processes. PVAs can either be quantitative or qualitative.

Quantitative PVAs can be applied either to single populations or to metapopulations. At a minimum, necessary data include variation in population size over time, age-specific recruitment and mortality, annual variation in life history characteristics, and the frequency and severity of events that affect population growth (e.g., variation in weather patterns). For a metapopulation PVA, data on these parameters must be available for each subpopulation.

Once these data are in hand, a deterministic population model is constructed, usually by using one of several "canned" programs (e.g., Ramas, Stella). Stochastic variance is then incorporated in the model. Individual demographic stochasticity is estimated from annual variation in life history characteristics, and environmental stochasticity is estimated from the frequency and severity of events that affect population growth. Simulation modeling is then used estimate time-to-extinction from random forces. Thus, a specific prediction of population persistence time can be made in the form of, "this population (or population system) has an X percent probability of persistence for Y number of years." If data are available, predictions of persistence times under various management strategies also can be made.

Clearly, quantitative PVAs are very data intensive. In most cases the relevant data are not available, and time and money are usually far too short to obtain them. However, a qualitative PVA risk assessment can be performed by organizing whatever information is available on habitat and population parameters and by obtaining missing information in the form of expert opinion from knowledgeable and experienced biologists. This approach will yield a verbal descriptor of extinction risk probability in a short, but meaningful, time frame: high, moderate, or low. Information should be organized as follows:

I. Habitat/population distribution and status (displayed as a base map with a series of overlays)
   A. Current habitat availability
      - Vegetation types
      - Spatial/temporal variation in quality
      - Occupied or unoccupied
      - Connectivity
      - Land ownership/management
   B. Current population status
      - NDDB and other historical records
      - Current records and survey results expressed as qualitative estimate of population size, e.g., *abundant:* in numbers; *common*: always to be seen, but not in large numbers; *fairly common:* very small numbers or not always seen; *uncommon:* seldom seen but not a surprise; *rare:* always a surprise, but not out of normal range; *casual:* out of normal range; *accidental:* far from normal range and not to be expected again
      - Qualifiers can be added to these descriptors if appropriate, e.g., *irregular:* not found every season; *erratic:* found only a few seasons each decade

II. Potential habitat distribution and condition in the future
   - Systematic factors that will result in habitat loss (e.g., residential or infrastructure construction)
   - Systematic factors that may degrade habitat quality (e.g., invasion of exotic species, conversion of rice to vinyards)
   - Random factors that may degrade habitat quality or quantity (e.g., estimated probability of a major flood)

- Habitat improvement under different management alternatives (e.g., restoration, status quo)

III. Single population dynamics
- Trend – is the population increasing, decreasing, or stationary over time?
- Potential take (numbers)
- Impact of take on total population
- Other systematic factors – how do things over which management has control potentially affect population numbers (e.g., grazing, predator management)?
- Random factors – estimated probability of various stochastic factors that might influence vital rates (e.g., droughts, spring hailstorms)

IV. Population system dynamics
- Patch arrangements (maps to accompany spatially-resolved data)
- Potential take (populations)
- Impact of take on metapopulation
- Likely correlations in systematic factors
- Likely correlations in random factors

Considerable "hypothesis testing" can be done with these maps and associated data. In addition, this procedure provides an assessment of current knowledge and the information needed to push the analysis further.

The surveys are intended to help determine the present status and distribution of each potentially-covered species. Data should be obtained on current habitat availability and occupancy and, if possible, on current population status and trends. Since the relevant data for quantitative PVAs on any potentially-covered species are not available and the time and money are too short to obtain them, qualitative PVAs should be done on these species by organizing whatever information is available on habitat and population parameters and by obtaining missing information in the form of expert opinion from knowledgeable and experienced biologists. This approach is expected to yield a verbal descriptor of the extinction probability of each potentially-covered species in the county in the immediate future: *high, moderate*, or *low.*

The data from the qualitative PVAs for each species is then combined with GIS coverages of potential conservation lands and landscape linkages. Again, considerable "hypothesis testing" can be done with the emergent maps and associated data. The results of this analysis should be combined with the results of the multi-species ecological assessment to create a draft of a preliminary conservation plan. If the goals and objectives of this plan clearly contribute to the recovery of a listed species or provide adequate protection to a non-listed species, the species can be incorporated into the HCP/NCCP.

All steps in this process are considered to be works-in-progress, subject to revision as more or newer data become available. Because species profiles and envirograms are basic to this process, outside review of these documents should be obtained.

Data Gaps and Uncertainties

Placer County has expended a great deal of effort and money to obtain the data necessary to proceed with the HCP/NCCP. Contracts have been awarded to verify land cover and rectify historical and current aerial photographs, study biodiversity in riparian zones, and assess the status of oak woodlands, freshwater marshes, vernal pools, small patch ecosystems, wintering waterfowl, and salmonid habitat. As a result, the accumulated database is impressive.

Despite these efforts, we do not know what the original complement of biodiversity was in western Placer County and what has been lost already. Therefore, it is impossible to predict the effects of removing 90% of the natural communities in this area, and consequently, we do not know what level of mitigation is sufficient to compensate for this loss. (We do know that the areas that have been impacted the most need the highest mitigation ratios.) The second major data gap is that the distribution and ecology of most of the target species is not well enough understood to evaluate their viability under different conservation alternatives. To lessen these uncertainties, it will be necessary to (1) survey and (2) conduct adaptive management trials on both Conservation Opportunity Areas and lands scheduled for development as soon as possible.

Surveys are necessary to prioritize mitigation lands, obtain scientifically defensible mitigation ratios, and determine where populations of covered species are persisting. Access to make such surveys should be part of the HCP/NCCP agreement, and incentives to make surveys more palatable to landowners should be developed. For example, a no-cost survey of a Conservation Opportunity Area might result in a higher price for the land, and a "No Surprises" agreement would provide security to a developer. Similarly, the County should negotiate to have lands that are scheduled for development become areas where adaptive management trials are conducted at no cost—or risk—to the landowner. These trials would be designed to assess the impacts of different management regimes on sensitive species' habitats and population trends before the habitats are lost. The US Fish and Wildlife Service should make "Safe Harbor" agreements available to participating landowners, and the County should establish a system of incentives to encourage participation. Simplifying and streamlining these process will be critical.

Major Land Cover Types and their Management

Introduction

The network of conservation areas will be embedded in a landscape that has been greatly impacted by past and ongoing human activities. Many natural ecosystem processes have been altered, and natural and human-generated disturbances will continue. Some management prescriptions are universal and include (1) the explicit management of conservation lands to meet ecological goals and the long-term protection of natural values, (2) the restoration or enhancement of landscape linkages, (3) the maintenance of native vegetation within conservation areas and landscape linkages, (4) the eradication or control of invasive non-native species, and (5) the provision or enlargement of buffer zones ("soft edges") between developed areas and conservation lands.

The Conservation Opportunity Areas are confined to agricultural habitats in the western Phase 1 area. None of the alternatives propose changes in zoning or conservation goals to benefit oak woodlands or riparian areas although these communities will bear the brunt of future development in this area. In fact, the current strategy calls for significant urban impacts on two-thirds of remaining riparian areas. Unless this is a GIS artifact, it means that the County will lose more riparian than it will conserve. Given their ecological importance and historical losses, riparian environments should be conserved and restored w herever possible in all parts of the Phase 1 area, and they need the highest mitigation ratios. Furthermore, the success of aquatic and riparian conservation depends on what goes on upstream within the watershed, but this is not addressed in the current strategy.

Below are descriptions of and management guidelines for the major land cover types involved in the Phase 1 HCP/NCCP in Western Placer County.

Oak Woodlands

Introduction

Oak woodland consists of a zone of oak-dominated communities growing between Valley grassland and montane forest or chaparral. The dominant trees are deciduous oaks, *Quercus lobata* (valley oak), and *Quercus douglasii* (blue oak). The lower elevational border of oak woodland is well defined by the absence of oak trees and the appearance of true grassland. The upper border, where an increasingly dense woodland becomes forest, is more difficult to define. Relict forest trees well within the present woodland zone and eroded forest soils that are now supporting woodland suggest that the upper border may have moved upward after destructive logging and severe burning of the lowest elevation forests occurred.

Since European settlement, oak woodlands have been managed primarily for livestock production, and over 80% are in private ownership. Historically, losses of oak woodlands occurred because of clearing for range improvements and agriculture; the major losses now are from intensive residential and industrial development. Poor oak recruitment and regeneration is a major problem in many areas.

In addition to their value as rangeland, oak woodlands are important wildlife habitat, and they provide public recreation and aesthetics. Since virtually all of the state's water flows through or is impounded in the oak woodland belt, these communities are also very important to water quantity and quality.

Vegetation

Oak woodland in the Phase 1 area is conventionally divided into two different vegetation types, valley oak woodland, blue oak woodland, and blue oak-foothill pine woodland.

Valley oak woodland. On deep, well-drained alluvual soils, usually in valley bottoms, valley oak forms nearly pure, parklike stands of large trees (mature valley oaks range in height from 50-115 feet). A few live oaks (*Q. wislizenii*, interior live oak) may be mixed in. These stands blend into riparian forests (Valley Oak type of Valley Foothill Riparian) along stream courses and on active floodplains. The understory of valley oak woodland consists of a carpet of introduced annual grasses and forbs, and the shrub layer, if present, contains bird-dispersed species such as poison oak, toyon, and coffeeberry. At lower elevations, valley oak woodlands merge with annual grasslands or border on agricultural land. In the foothills they intergrade with blue oak woodland or blue oak-foothill pine woodland.

Blue oak woodland. Blue oaks are relatively slow-growing, long-lived trees that can reach 80 feet in height. On shallower, well-drained upland soils, they form savanna-like stands on dry ridges and gentle slopes. Interior live oak and valley oak also may be present where the soils are deeper. The shrub layer in these communities is rarely extensive, often occurring only on rock outcrops. Shrubs include poison oak, coffeeberry, buckbrush, California buckeye, and several species of manzanita. The understory is typically composed of annual grassland species such as bromegrass, wild oats, foxtail, and fiddleneck. Blue oak woodland intergrades with annual grasslands or valley oak woodland at lower elevations and blue oak-foothill pine woodlands at higher elevations. Blue oaks are well adapted to dry, hilly terrain where the water table is usually unavailable, and they have an unusual tolerance for severe drought, shedding their leaves under extreme moisture stress.

Wildlife

Oak woodlands are one of the richest wildlife habitats in California, with over 300 vertebrate species relying on them for feeding, cover, or nesting sites during all or some part of the year.

Conservation Issues

Oak woodlands have decreased by over 1,000,000 acres during the last 50 years because of agricultural, residential, and industrial development. Moreover, in many places, blue and valley oaks have reproduced poorly during this time period. Even when germination occurs, seedling survival usually fails.

Valley oak regeneration. The failure of valley oak regeneration seems to be related to competition for soil nutrients and moisture between oak seedlings and introduced annuals, consumption of acorns and seedlings by wild and domestic animals, [ungulate browsing of seedlings and saplings], and flood control projects. Valley oaks are tolerant of flooding while other components of the community that are potential predators or competitors are not.

Blue oak regeneration. Poor blue oak regeneration also is related to competition for soil moisture from introduced annual grasses and the consumption of acorns and seedlings by insects, domestic livestock, and wildlife. Blue oak is somewhat shade-intolerant, and disturbances producing openings in the canopy may be necessary for seedling growth and survival.

Livestock and wildlife relationships. Some ecologists think that the lack of regeneration in oak woodlands can be explained by the consumption of acorns and seedlings by cattle. However, the cessation of livestock grazing does not generally result in oak regeneration because wildlife and insects also cause heavy damage to acorns, and seedlings and saplings. Populations of deer and many other species of mammals and birds that eat acorns and young oaks are probably more abundant now than in the past because of land use changes and predator control. However, some of these species have positive effects on oak regeneration; acorns buried by scrub jays, yellow-billed magpies, western gray squirrels, and California ground squirrels are more likely to germinate because they root better and are less likely to be eaten.

Fire. Frequent fires historically occurred in oak woodlands, and fire control has affected regeneration negatively in both valley and blue oaks. Young trees of both species will sprout when fire damaged, but older trees will not. Thus, frequent fires tend to maintain oak stands of younger age classes, but a century of fire control has resulted in the predominance of older trees. When these stands eventually burn, they do not regenerate themselves. Furthermore, the absence of frequent, non-catastrophic ground fires encourages the invasion of evergreen oaks, and their seedlings seem to be more browse resistant than those of deciduous oaks.

Conservation Management—Rangelands

Management goals for grazed oak woodlands in Placer County should include; (1) r egeneration of dominant oak species throughout their ecological and geographic ranges, (2) trends toward increasing or stable cover and extent by native understory plant species, (3) trends toward decreasing or stable cover and extent by invasive, non-native plant species, and (4) maintenance of associated species of concern and small-patch ecosystem types.

To attain these goals, Placer County will need to work with private and public landowners to disseminate and encourage the widespread implementation of best management practices (BMPs) relevant to grazed oak woodlands. The following BMPs have been shown to counteract the four major problems facing oak woodland conservation (Pavlik et al. 1991, McCreary 2001, CalPIF 2002); overgrazing, fire suppression, and the deleterious effects of non-native plants and animals.

Seedling and Sprout Shelters. Natural and outplanted seedlings must be protected from livestock and native grazing animals in order to survive and grow enough to support regeneration. In recent years many techniques and protective devices have been developed that can enhance regeneration on small spatial scales (summarized in McCreary 2001). Careful selection of critical areas for this kind of "intensive care" management (Pavlik et al. 1998, 2000, 2001) is necessary to be cost-effective and ecologically meaningful. Protection of stump-sprouts after stands have been thinned for wood harvest is also critical (Standiford and Tinnin 1996, McCreary 2001). See also: Costello et al. (1996), McCreary and Tecklin (1997), Weitkamp et al. (2001).

Artificial Regeneration Techniques. Directly outplanting container-grown native oaks in their appropriate habitat and geographic ranges can jump-start the process of regeneration (McCreary 2001), especially in edge habitats, areas with previous damage from overgrazing and agricultural development, isolated stands, and potential corridor areas near riparian zones. Selection of sites for this kind of restoration is critical because the costs are relatively high, as is the risk of failure if technical, logistic and environmental factors conspire against the project. McCreary (2001) presents a site-specific decision key (his Figure 3) to help determine if artificial regeneration techniques are appropriate. See also: Adams et al. (1997), Alpert and Peterson (1999), Bernhardt and Swiecki (1997), Brooks and Merenlender (2001), Griggs and Peterson (1997), Holmes (1996a, b).

Progressive Livestock Management. Progressive systems of grazing are those that maintain the economic use of oak woodlands for livestock production while maintaining or enhancing oak-related habitat features. Short-duration and deferred-rotation systems provide landowners with cost-effective, large-scale options that can encourage oak regeneration and control invasive plant species (George 1991, Johnson 1992, Jansen et al. 1997). On smaller scales, winter grazing is probably less damaging to seedlings than spring or summer grazing (Hall et al. 1992, Jackson et al. 1998). It should be emphasized, however, that there is still much to be learned about oak-compatible grazing systems in California that a program of adaptive management can elucidate and document (CalPIF 2002).

Prescribed Fire. Low-intensity ground fires may promote regeneration in some oaks by improving soil conditions, reducing acorn and seedling predation and removing a closed, competitive understory while at the same time lowering the probability of destructive canopy burns (Standiford and Tinnin 1996, CalPIF 2002). The benefits are neither universal nor reliable, however (especially at low elevation grassland-oak woodland boundaries), and the optimal fire frequency for many woodland types has yet to be determined (McCreary 2001). Efforts to conduct prescribed fires in Placer County should do so within an adaptive management framework so that science-structured learning and implementation can take place. See also: Biswell (1989), Schwan et al. (1997), Swiecki and Bernhardt (1998).

Weed and Feral Animal Control. Invasive, non-native plants ("weeds") should be controlled on a large scale with prescribed grazing and fire regimes and disking and on a small scale with mowing, mulching, hoeing, or judicious use of herbicides (McCreary 2001, Tu et al. 2001). Similarly, non-native animals (e.g. feral pigs, wild turkey) that severely impact oak woodlands should be controlled (McCreary 2001, Sweitzer and Van Vuren 1998). The techniques and timing of weed and feral animal control not only determine effectiveness, they also can determine the extent of unintended damage to sensitive resources (CalPIF 2002). For these reasons, such control practices should be part of an adaptive management program that can monitor benefits and costs to major resource elements. See also: Adams et al. (1997), McCreary and Tecklin (1997).

Habitat-Sensitive Wood Harvest. Downed and standing dead trees are essential habitat components for many important and often rare animal species. Constant removal of these materials can lead to soil depletion, reduction in beneficial insect populations, and reduction in the numbers of small vertebrates (Tietje and Vreeland 1997). Wood harvesting should be habitat-sensitive by leaving dead trees and wood (at least 1 snag per acre; Standiford and Tinnin 1996), as well as a variety of sizes or ages of living trees to maximize the structural diversity of the overstory canopy. Large, old trees capable of high acorn production are especially important for promoting regeneration and providing food and other essential resources for wildlife. Thinning, rather than clearing, stands is thought to have less negative impact on regeneration and habitat quality. Thinned stands should be small in size (< 3 ha), and left with (1) >75% of their original basal area, (2) large, old, and standing dead trees intact, and (3) spaced brush or trimmings piles as an artificial, temporary understory (Aigner et al. 1998, CalPIF 2002). No harvesting should be conducted adjacent to riparian zones (Standiford and Tinnin 1996).

Conservation Management—Suburban Interface

Management goals for suburbanized oak woodlands in Placer County should include; (1) maintenance of patches of oak overstory, (2) maintenance of patches of native understory plant species, (3) avoidance of accidental or intentional introductions of invasive, non-native plant species, including trees with flammable canopies, and (4) avoidance of practices that spread or encourage oak diseases.

To attain these goals, Placer County will need to work with private and public landowners to disseminate and encourage the widespread implementation of BMPs relevant to suburbanized oak woodlands. The following BMPs have been shown to encourage oak woodland conservation where human population growth creates special concerns or limits management options (Pavlik et al. 1991, Johnson 1991, McCreary 2001, CalPIF 2002).

Minimize Rootzone/Dripzone Alterations. Avoid rootzone/dripzone soil compaction, paving, grade and drainage changes, trenching, fertilizing, sprinkling and irrigation, lawn installation, construction, and animal grazing or penning. Firewood, especially if brought from other areas, should never be stored beneath oaks because it may release insect pests and diseases (www.suddenoakdeath.org). Guidelines for maintaining oaks in gardens, near buildings, or around domesticated animals are found in Johnson (1991, 1992).

Artificial Regeneration. Directly outplanting container-grown native oaks in their approp riate habitat and geographic ranges can jump-start the process of regeneration (McCreary 2001), especially where suburban development has removed mature trees. Special attention should be paid to filling canopy gaps between isolated groups of trees or maintaining continuity with riparian zones (CalPIF 2002). Guidelines for planting oaks are found in Johnson (1991, 1992) and McCreary (2001).

Encourage Native Plants in Native Soil. Where previous land uses (e.g. intense grazing) or current patterns of development have removed the native understory of shrubs, grasses. or herbs, landowners might allow these species to reclaim outlying portions of their properties. Remnant patches of chaparral, grassland, and riparian communities also should be left as unaltered as possible to maintain diversity in the overall landscape (CalPIF 2002). If gardens, planting beds, and lawns are installed, on-site native soil should be used instead of soil imported from nurseries or other foreign sources (including potted plants) that could be contaminated with oak disease organisms (CalPIF 2002, www.suddenoakdeath.org).

Aquatic and Wetland Ecosystems

Introduction

Aquatic and wetland ecosystems in Placer County include riverine (rivers and streams), lacustrine (lakes and ponds), fresh emergent wetlands (marshes), and springs. These are distinguished from terrestrial systems by the presence of water (permanent or seasonal), hydric soils, and hydrophilic vegetation. The boundary between wetland and upland ecosystems is generally delineated by the boundary between hydric and non-hydric soils. The boundary between wetlands and lacustrine or riverine ecosystems is identified by the deep-water edge of emergent vegetation, about 6.6. feet in depth.
All wetlands in Placer County are within the Sacramento-San Joaquin drainage that dominates California's Central Valley. During very wet years, these rivers historically connected with the Kern, Kings, Tule, and Kaweah Rivers of the southern Central Valley.

Riverine, or lotic, systems flow westward from the Sierra Nevada and its woodland foothills before entering the large rivers on the Central Valley floor. Rivers flowing through foothill woodlands are supported by many small streams that originate along the Sierra Nevada crest as well as by small foothill streams.

Rivers and high elevation streams support permanent aquatic habitats, contrasting with many foothill streams whose flow is seasonal and limited to periods of high precipitation or runoff. Many foothill streams are dry during summer and early autumn. Historically, rivers throughout Placer County experienced wide seasonal variations in discharge; high flows occurred in winter and during spring snow melt, and lowest flows occurred during summer. During high runoff, water typically rose to levels that that inundated expansive floodplains and often created freshwater emergent wetlands.

Most of the large streams and rivers in Placer County have been modified from natural conditions by channelization, loss of riparian vegetation, and alterations in discharge. Reservoir management has homogenized the hydrograph by decreasing the magnitude of floods and increasing discharge during summertime low flow periods. The discharge in small streams is elevated from historic conditions by seepage and runoff from agriculture lands. This suite of alterations has resulted in a drastic reduction of anadromous salmonids in Placer County rivers and streams.

Lacustrine systems in Placer County include natural lakes and ponds and reservoirs. Lakes are larger systems with littoral zones (areas where light is adequate to support plant growth) and limnetic zones (deep areas where light is inadequate for plant growth). Ponds are shallow and support only littoral habitats. A number of large reservoirs have been built along rivers in the County to control floods and store water for agriculture and urban uses. These impoundments have effectively altered natural lotic ecosystems and created new, artificial lacustrine ecosystems. A number of additional small reservoirs impound small streams and springs, mostly to store water for agriculture or recreation. Vernal pools are technically a type of lacustrine ecosystem, but because of their conservation importance in Placer County, they are treated separately.

Fresh emergent wetlands (FEWs) may occur in association with various terrestrial ecosystems or with riverine and lacustrine ecosystems. They range in size from small patches to areas covering several square miles. FEWs historically covered thousands of acres in Placer County and the Sacramento Valley, but most of this was drained and converted to agriculture. They are now small and usually limited to areas supported by seepage or agricultural runoff.

Springs occur throughout Placer County. They are most abundant in the foothills and higher elevations and scarce on the Central Valley floor. Some springs flow continuously and provide permanent aquatic habitat while others are intermittent and flow either seasonally or only during years with high precipitation. Permanent springs may support distinctive communities of aquatic species, including fishes and macroinvertebrates. The importance of springs recently has been demonstrated by recent surveys throughout large portions of the western U.S. that have documented an amazing diversity of aquatic macroinvertebrates (including mollusks, insects, and crustaceans) with limited distributions. Many newly described species are endemic to a small number of springs.

Vegetation

Riverine ecosystems can be subdivided into open water (depth greater than 6.6 feet) and submerged zones, which are between open water and the shore. Streams are smaller, and they rarely have open water zones. If the current is sufficiently slow, rooted vegetation may occur in the submerged zone. If vegetation on the shore has a canopy cover greater than 10% (and therefore creates significant shade), it is considered to be riparian habitat.

Lacustrine ecosystems also show zonation that is organized according to water depth. The limnetic or open water zone extends from the deepest water up to the depth of effective light penetration. The littoral zone is in shallow water along shorelines and above the limnetic zone, and it is distinguished by sufficient light to support plant growth. Rooted plants occur in this zone. The shoreline zone borders the water; if it has more than 2% vegetative cover it is classified as riparian.

Freshwater Emergent Wetlands are characterized by saturated or periodically flooded hydric soils that support some combination of rushes, sedges, nutgrass, saltgrass, cattail, bulrush, and arrowhead. Vegetation may be distributed as concentric zones, which follow basin contours and reflect the relative water depth during flooding, or if the bottom of the wetland is uneven, the vegetation zones may be patchy rather than concentric.

Springs are smaller aquatic systems that occur where ground water flows onto the land surface through natural processes. Under natural conditions, persistent springs generally support woody riparian vegetation that is similar to what is found along small streams. Where woody vegetation is sparse, rushes, sedges, bulrush, and cattail may be found. At ephemeral springs, vegetation includes species that tolerate more xeric conditions.

Fish and Wildlife

Freshwater Emergent Wetlands are among the most productive wildlife habitats in California. They provide food, cover, and water for more than 160 species of birds and numerous mammals, reptiles, amphibians, and fish. Many species rely on this ecosystem for their entire life cycle. Lacustrine systems are used by 18 species of mammals, 101 birds, 9 reptiles, and 22 amphibians for reproduction, food, cover, and water. This represents about 23% of the terrestrial vertebrates in California. The open water zone of large rivers provides resting and escape cover for many species of waterfowl and many fish-eating and insectivorous birds and mammals.

Several Phase 1 species, the Central Valley steelhead, chinook salmon, Sacramento splittail, and foothill yellow-legged frog, are completely dependent on healthy riverine ecosystems. The giant garter snake and California Black Rail use FEWs almost exclusively. The Bald Eagle uses both riverine and lacustrine ecosystems, and the California red-legged frog and Peregrine Falcon use those ecosystems plus FEWs.

Due to the large size, variety of habitats, and ancient age of Central Valley aquatic systems, they support a distinctive native fish fauna that includes seven endemic genera and 28 native species. The compounding influences of competition and predation from non-native fishes, reservoir construction and management (including water diversion and changes in water temperature and flow regime), channel alteration, pollution, and decreased watershed stability resulting from logging, excessive livestock grazing, and mining, have resulted in extinction of three native fish species. Populations of an additional eight species have undergone substantial declines and are at risk of extinction. Most native species have little economic importance, with the exception of trout and salmon, sturgeon, and Sacramento perch. Forty non-native species of fish also occur in this system. Most non-native fishes have been introduced from other North American habitats, although some are native to Europe and Asia. A number of invertebrate species. most notably crayfish and mollusks, also have been introduced into Central Valley aquatic ecosystems.

Spring ecosystems either may be isolated or tributary to other aquatic systems, and their biotic importance is generally a function of size and permanence. Large springs that flow continuously usually support a canopy of riparian vegetation and diverse aquatic communities that may include crenobiontic species (species that occur only in springs). Smaller springs and seeps may dry periodically, and their aquatic biota will consist of vagile species that also colonize ephemeral streams. Woody riparian vegetation is usually sparse at these types of springs. Few surveys have been conducted to assess biotic and abiotic characteristics of spring ecosystems in Placer County.

In California, where a large and growing human population competes with aquatic organisms for limited supplies of fresh water, amphibian populations are declining precipitously, and 77 of the 115 native fish species are either extinct or in danger of extinction within the next 50 years. The situation with other aquatic organisms is presumably just as bad or worse, but their status is poorly known. The acreage of FEWs in California has decreased dramatically since the turn of the century due to drainage and conversion to other uses, primarily agriculture. Virtually all aquatic and wetland systems in the state are in need of major conservation actions.

Necessary management actions for aquatic and wetland conservation include (1) restoring natural hydrologic regimes, including low and high flow events; (2) reconnecting rivers to their floodplains by de-channelization and other means; (3) restoring and managing riparian areas properly; (4) reducing or eliminating populations of non-native fishes, amphibians, invertebrates, and plants; (5) controlling water quality by decreasing nutrient and toxin loading and sedimentation; (6) providing for fish passage around diversion structures; and (7) educating people on the economic, aesthetic, and other values of properly functioning aquatic ecosystems These activities can be most effectively implement by organizing management by watershed boundaries, not by administrative units or political borders.

Best Management Practices

Best management practices (BMPs) are designed to reduce adverse environmental impacts that result from human activities in and near aquatic ecosystems. Many BMPs for aquatic ecosystems are similar to those for riparian ecosystems.

1. Restore rivers and streams to natural conditions wherever possible. A number actions will be required to accomplish this, including, but not limited to, removing channelization features (e.g., riprap, gabions, dikes, levees etc.), reestablishing historic meander patterns, enhancing riparian vegetation, modifying ditch networks, and reestablishing the natural hydrograph as much as possible. Restoration must be

conducted using an integrated plan that reconnects streams and rivers in a pattern where salmon may again migrate around urban and agricultural lands to their spawning areas.

2. Implement programs that decrease the amount of stormwater entering aquatic ecosystems to minimize its adverse affects on water quality and the hydrograph. This may be accomplished by reducing impervious surfaces, detaining runoff, disallowing construction along stream and river banks, and protecting riparian corridors.

3. Control runoff to maintain water quality and prevent introduction of nutrients and suspended material from reaching streams and rivers from non-point sources such as highways, construction sites, farms, and urban areas.

4. Wherever possible, enhance native fish and aquatic macroinvertebrate populations by restoring habitat, eliminating deleterious non-native aquatic species, and discouraging the introduction of additional aliens.

5. Maintain water quality standards in all streams and rivers.

6. Springs and a portion of their springbrooks should be protected from activities that result in functional changes in aquatic and riparian communities. Modifications resulting from diversion, recreation, and ungulate use should not impact the natural character of a spring source and at least 50 meters of its uppermost springbrook. Greater lengths of large springbrooks should be protected, possibly extending downstream for several hundred meters. For these springs, the length of springbrook needing protection should be determined by surveys to identify areas with highest biotic value. If diversion is necessary, all structures should be placed at least 50 meters downstream from the spring. Spring sources should be maintained in natural condition. Environmental damage by springbox construction and operation can be minimized by collecting water from a dry well placed in the springbrook bed at least 50 m downstream from the source. Diversions also should be limited to only the amount of water needed for the intended use, and at least 25% of a spring's total discharge always should remain in the springbrook. Unnecessary diversion should not occur, and diversions should be limited to periods when water is needed at a specified destination and should not continue when water is unnecessary. All water should remain in a springbrook when not being used for other purposes.

7. Adequately protect riparian areas to maintain watershed processes and functions. Because of the intensity of disturbance in surrounding uplands, riparian protections are critical in urban and in rural areas.

8. Manage vehicle use within riparian habitats by minimizing stream crossings that can harm watershed processes by disrupting fish passage, creating sedimentation, modifying channels, and changing drainage patterns. Vehicle use should be limited to specified locations where impacts can be minimized by using bridges instead of culverts, sizing bridges to a minimum width, designing culverts to pass at least the 100-year flood event, and ensuring regular and long-term monitoring and maintenance. Vehicles should not enter or cross streams except in cases where no alternative exists. Where stream crossings are required, minimize the number of crossings, and cross streams at right angles to the main channel whenever possible.

9. Control erosion and minimize suspended and deposited sediments that can suffocate eggs incubating in stream gravels, adversely affect fish respiration, and disrupt aquatic macroinvertebrate community structure. By covering or in-filling cobble, gravel, and boulder substrates, sedimentation also will decrease habitat heterogeneity and species

richness of the macroinvertebrate community. This will decrease the amount and quality of food available for fish and the ability of aquatic systems to process nutrients effectively. Minimize to the extent practicable, the use of heavy equipment and techniques that will result in soil disturbance or compaction of soils, especially on steep or unstable slopes. Implement sedimentation and erosion controls on all project sites where activities have the potential to deposit sediment into a stream or water body. Control structures must be placed and/or anchored appropriately to prevent adverse impacts to down slope habitats. Structures/techniques for erosion control may include, but are not limited to, silt fences, straw bale structures, seeding by hand and hydro-seeding, jute mats, and coconut logs. Grading and shaping should maintain or restore natural topography and hydrology.

10. Use of heavy equipment near streams should be permitted only when safeguards are implemented to prevent contamin ation of any water body.

11. Application of herbicides, pesticides, and fertilizer must follow label instructions to protect public health and avoid fish and macroinvertebrate mortality.

12. Minimize the adverse effects of excessive livestock use within riparian corridors. Site livestock watering facilities away from stream channels in areas where compaction and/or damage will not affect sensitive soils, slopes, or vegetation due to congregating livestock. Livestock fords across streams should be rocked to stabilize soils/slopes and prevent erosion. Place fords on bedrock or stable substrates whenever possible.

13. Fence habitats where necessary to regulate deleterious use. Replace and install new culverts following National Marine Fisheries Service guidelines to facilitate fish passage and minimize instream and bank erosion.

14. Develop programs to encourage careful landscaping that can help conserve water and reduce demands for flow that compete with aquatic ecosystem needs. These programs also should reduce the use of fertilizers, pesticides, and herbicides that may contribute to water pollution.

15. Develop mechanisms to implement programs that fund monitoring, maintenance, enforcement, and reporting that are necessary to assure that development will comply with approved policies, ordinances, and permitting procedures that protect and enhance aquatic ecosystems.

Valley-Foothill Riparian Ecosystems

Introduction

Riparian zones are dynamic areas of transition between riverine and upland environmen ts that are not only the most productive environments of Placer County but also are critically important habitat for many wildlife species. Delineated as the area between the low water line in the stream zone and the upper edge of upland areas influenced by flooding or high water tables (Naiman and Decamps 1997), riparian areas perform vital ecological services such as dissipating floodwaters, capturing nutrient-rich sediments, enhancing groundwater recharge, bank stabilization, providing organic matter and woody debris to aquatic food webs, and providing shade and cooler microclimates in streams and rivers. California riparian ecosystems are among the most productive in the world (Warner and Hendrix 1984).

Valley Foothill Riparian communities (VFR) in Placer County extend from the Great Valley to roughly 3,000 ft in the Sierra Nevada. These communities are generally associated with low velocity flows, flood plains, and gentle topography. In Placer County, VFR borders perennial streams such as the Bear River, Dry Creek, Coon Creek, Pleasant Grove Creek, and Auburn Ravine.

VFR has suffered more degradation and reduction than any other environment in Placer County and the Sierra Nevada in general. This community has been particularly impacted by human activities including industrial, agricultural, and residential development; historical hydraulic mining; gravel mining; altered flow regimes from water diversions and dams; floodplain drainage; road and railroad construction; and livestock grazing (Kondolf et al. 1996).

Vegetation

A healthy, mature VRI forest has a canopy layer of cottonwood, California sycamore, valley oak, or some combination of the three, a subcanopy tree layer, an understory shrub layer, and an herbaceous layer consisting of sedges, rushes, grasses, and some forbs. Generally the understory is impenetrable and includes considerable down wood. Transition to non-riparian vegetation is usually abrupt, especially near agriculture.
Fremont cottonwood type. Fremont cottonwood is the most important tree in the canopy. Black willow, box elder, California Sycamore, narrowleaf willow, Oregon ash, Pacific willow, red willow, walnuts, and/or yellow willow may be present. Trees are less than 25 m tall; the canopy can be continuous or open. Shrubs and grape lianas are infrequent to common; the herbaceous layer is variable. Most cottonwood dominated stands have been altered by grazing.

California sycamore type. California sycamore is the most important tree in the canopy, distributed as widely spaced trees. Arroyo willow, black willow, California bay, Fremont cottonwood, red willow, valley oak, white alder, and/or yellow willow may be present. Trees are less than 35 m tall; the canopy is open; shrubs are common to infrequent. The ground layer is grassy. Grazing reduces tree regeneration in this type.

Valley oak type. Valley oak is the most important tree in the canopy. Black oak, blue oak, California sycamore, and/or Oregon ash may be present. Trees are less than 30 m tall; the canopy can be continuous, intermittent, or open. Shrubs are occasional, and lianas are common. The ground layer is grassy.

Under natural flow regimes VRI communities are periodically disturbed by severe floods and undergo succession over many decades from herbaceous species and shrubs to multi-layered forests. In all three types succession usually begins with shrubby willow thickets. After a variable number of years these are overtopped and shaded out by trees. Cottonwood-dominated VRI ecosystems may reach climax in 25-30 years; valley oak dominated riparian systems take much longer to mature.

Fish and Wildlife

Research has repeatedly demonstrated causal linkages between riparian condition and fish habitat quality. Recent research is revealing the important role of Valley foothill riparian habitats during high water periods for native fish species such as juvenile Chinook salmon. Particularly important functions of riparian forests are their ability to provide shade and a source of wood to streams and to regulate inputs of nutrients and other materials. It is also well known that maintaining the physical connection between riparian forests along fish bearing streams and the rest of the stream network is a necessary prerequisite for high quality stream ecosystem.

VRI ecosystems also provide food; water; migration and dispersal corridors; and escape, nesting, and thermal cover for a number of wildlife species. Fifty-five species of mammals and 147 species of birds use VRI ecosystems as habitat in the Central Valley region. This represents 30% of the mammals and 27% of the birds in the entire state. In the planning area species of special concern that are strongly associated with VRI habitat include Chinook salmon, California red-legged frog, Foothill yellow-legged frog, Yellow-billed cuckoo, Swainson's thrush, and Willow flycatcher.

Assessment

Riparian conditions vary dynamically depending on flooding, drought, and land and water management and can recover quickly under appropriate management regimes. Systematic assessment of current riparian conditions (ongoing in Placer County) is an important first step in identifying management needs and prioritizing areas for conservation and restoration [see National Research Coucil (2002) for a review of assessment approaches].

The ecological health of Valley riparian habitats depends on (Moyle et al. 1996)

- good water quality and flow regime,
- periodic flooding,
- habitat connectivity along the long profile of the stream,
- vegetation productivity,
- vegetation structural diversity and connectivity within a variable-width buffer zone connecting aquatic and upland environments.

The assessment of riparian condition involves both structural and functional characteristics and some measure of species presence. Healthy riparian systems should have floodplains that are inundated fairly frequently, channels that have sinuosity and width/depth ratios in balance with the landscape setting, and point bars that are revegetating. Erosion or deposition should not be excessive for the landscape, and upland areas should not be contributing to riparian degradation. Vegetation should be diverse in both species composition and age structure, and individual plants should be vigorous. Understories should not be dominated by exotic species. Finally, the stream should support a diverse community of native fishes, and the terrestrial community should have a good complement of native, riparian-dependent species.

To obtain data on riparian condition it will be necessary to use aerial photographs or videography to visualize the gross structure of riparian vegetation, the continuity of riparian corridors, and surrounding land uses. It also will be necessary to survey riparian areas on the ground to obtain data on channel morphology, vegetation, and riparian-dependent species. Ideally, this would be done by sampling stream reaches at random, but that may not be possible.

Conservation and Restoration

Given the current degraded condition of most riparian areas in western Placer County, management and conservation strategies will need to focus on four related issues:

- Restoration of flow regimes in impounded and diverted streams
- Restoration of degraded channels, embankments and environments immediately adjacent to stream channels
- Conservation and restoration of the broader riparian zone that is infrequently flooded and that contributes energy and materials to the aquatic system
- Watershed management to control point and non-point sources of nutrients to riparian and aquatic systems.

Restoration of flow regimes. Riparian vegetation and ecosystem processes are inextricably tied to the stream flow regime (Poff et al. 1997) that can be defined by flow magnitude, frequency, duration, timing, and rate of change. Land use, water withdrawals, impoundments, and channel modifications such as levees and floodwalls all affect the flow regime and associated riparian processes.

Conserving and restoring flow regimes will require a multi-pronged strategy that will be somewhat reach-specific and dependent on the watershed context. Best management practices include water conservation and groundwater replenishment (e.g. stormwater recharge), changes in the timing and magnitude of dam releases to more closely mimic historical flows, and channel and bank restoration. Many of these management options are highly constrained by current patterns of land use and water demands and will need to be exercised through careful planning and adaptive management at the watershed scale in cooperation with the appropriate private landowners and public agencies. A number of such local and regional initiatives are already underway in Placer County [e.g., CALFED, Dry Creek Coordinated Resource Management Plan (CRMP) group].

Examples of best management practices to promote ecologically desirable flow regime and associate riparian conditions include:

1. Water conservation and groundwater replenishment
2. Water releases from dams to produce overbank flows at times when peak flows occurred historically
3. Channel and bank restoration
   a. Protect relatively undisturbed reaches that still have intact banks and channels.
   b. Manage and control upstream sediment sources.
   c. Remove or re-engineer roads and road stream crossings to reduce sediment yield.
   d. Modify or replace culverts to improve in-channel hydrological connectivity
   e. Remove in-channel barriers
   f. De-channelize to restore the connection between the channel and the floodplain
   g. Inject root wads and other large organic debris in areas where sources for such debris have been removed.

Additional detail on restoration channel and floodplain restoration for salmonids is provided in the California Salmonid Stream Habitat Restoration Manual (Flosi et al. 1998).

Floodplain Restoration and Management. The goals of floodplain restoration and management include protecting best existing intact areas and, to the extent possible, restoring desired ecological structure and function to degraded floodplains. Possible management actions include:

1. Creation of riparian management zones (Kondolf et al 1996). These are areas (sometimes referred to as buffers or setbacks) where vegetation cannot be disturbed and ground compaction is avoided in order to minimize bank erosion and promote native floodplain vegetation and its associated ecological benefits. The minimum width of the riparian management zone should be from 50-300 ft depending on stream size and local topography. Riparian areas on public and private lands are already under various strictures (summarized for the Sierra Nevada by Moyle et al. 1996). In Placer County local and County Ordinances already limit some activities on the 100-year floodplain or within specified riparian setback areas. Expanding floodplain protection may entail additional restrictions on industrial and residential development as well as agricultural setbacks, fencing to exclude livestock and provision of alternative water sources for livestock, etc.
2. Grading and filling to restore floodplain topography modified by past mining and other development activities
3. Reforestation through planting of desirable and appropriate tree and shrub species
4. Exotic plant species removal
5. Limiting application of pesticides and other potential pollutants

Watershed Management. Management of non-point sources of sediments, nutrients and other pollutants is critical to restoring and maintaining riparian areas. There are many guides for best management practices to reduce erosion and sediment yield and to improve stormwater quality. For a discussion of methods for assessing cumulative watershed effects, see Dunne et al. (2001). Many agencies (eg. CalTrans, USDA Forest Service, Tahoe Regional Planning Authority) have produced manuals detailing best management practices for minimizing cumulative watershed effects of construction, grazing and timber harvest activities in California (*www.dot.ca.gov/hq/oppd/stormwtr*).

Valley Grassland/Vernal Pool Ecosystems

Introduction

Valley Grassland occurs as a ring around the Central Valley from sea level to about 3900 feet and was the predominant ecosystem of the Phase I area. Prior to European settlement, the Valley Grassland ecosystem was most likely a bunchgrass-dominated prairie with native annual grasses and forbs filling the interspaces between the bunchgrasses. Unfortunately, no detailed descriptions of the presettlement community, other than "excellent pasture," (from early Mission Period accounts) exist. However, botanists are fairly certain that the prairie was dominated by perennials in the genera *Stipa (Nasella), Poa,* and *Aristida*, particularly purple needle-grass *Nasella pulchra*.

Permanent alterations to the original ecosystem began when Europeans first reached the Americas. First, seeds of alien plant species, including scores of annual grasses, arrived in packing material, hay, and debris from Spain, and once these species became locally established, they were widely distributed throughout California by birds, mammals, and human activity. Second, domestic livestock shifted the natural timing and extent of grazing. Although the original bunchgrass prairie supported large numbers of native grazing ungulates, they tended to be seasonal and migratory herds. Livestock were maintained in the grasslands throughout the year and in increasingly large numbers during the gold rush period and afterward. Yearlong, heavy grazing favored the introduced annual grasses and forbs at the expense of the native grassland ecosystem. Third, large-scale cultivation that began in the Valley Grassland ecosystem during the latter half of the 19th century also has contributed to the replacement of the original prairie. Abandoned farmland came back as introduced annual grassland rather than as the original community. Fourth, changes in the fire regime also may have favored the new annual grasslands.

Vernal pools or "hogwallows" are seasonal wetlands that form in shallow depressions of various sizes at sites where soils contain an impermeable layer such as claypan, hardpan, or some other material that produces a perched water table. The depressions fill during winter rains and dry out completely by spring or summer. In Placer County, vernal pools are most common in the Valley Grassland ecosystem, but they also occur in Blue Oak Woodland and on top of volcanic tables. Pools tend to be clustered in archipelagos in localities where the proper conditions for their formation occur. Vernal pools have been a part of the California landscape for thousands of years judging from the number of endemic species restricted to this ecosystem and from soil studies indicating their old age.

There are two types of vernal pools in Placer County. Northern volcanic mudflow vernal pools occur on Tertiary volcanic mudflows called lahars. These are usually small pools, forming in irregular depressions in gently sloping surfaces. In the foothills of the Sierra Nevada this type of pool is found primarily on the Merhten Formation. A second type, northern hardpan vernal pools occurs on acidic soils on old alluvial fans ringing the Central Valley.

Vegetation

The Valley Grassland ecosystem now consists of a wide mixture of species, mostly introduced, annuals. Grasses include wild oats, soft chess, ripgut brome, red brome, wild barley, and foxtail fescue, and forbs including numerous species of filaree, mullein, clovers, and many others. The boundaries of this ecosystem are probably little different from the original perennial prairie. A few small remnants of the original ecosystem still exist, and most of the original perennial species can still be found as scattered individuals throughout the ecosystem. This ecosystem is now commonly named the California Annual Grassland since less than 1% of the original Valley Grassland community still exists in the Great Valley.

The annual plants begin to germinate in the fall with the first good rains, grow slowly through the winter, grow rapidly in the spring, and mature between late April and June. A few warm-season annuals may reach their peak growth in summer. Since soil water deficits characterize this ecosystem for 4-8 months every year, most of the vegetation lives through the dry season in the seed stage. While species composition, distribution, and densities have changed radically since settlement, grasslands are still highly productive and support a broad diversity of native fauna. A Jones and Stokes study

California vernal pool vegetation is characterized by a high proportion of plants that are endemic or regionally restricted to that habitat, and many species are of conservation concern. Studies have identified 56 genera and 200 species of vascular plants known to grow within vernal pools (Holland 1976); more than 70% are native annuals. Nearly 70% are endemic, and 1/3 (73 taxa) are considered endangered. Introduced species comprise less than 7% of this flora.

The vegetation in vernal pools is arranged concentrically. The first zone corresponds to the pool bottom, the second occurs around the pool margin, and a third zone is on higher ground and supports typical California Annual Grassland species. Because of winter flooding there is a sharp boundary between the grassland and the pool zones. Few other ecosystems are delineated as discretely. Plant cover in the grassland zone may exceed 100%, while most pools have a characteristically low total cover, frequently less than 15-30%. Species richness is highest in the pools' marginal zone, slightly lower in the grassland zone, and considerably lower in the pool zone.

The number of plant species within an individual pool (alpha diversity) is usually low and is related to pool area, pool depth, and the amount of bare ground. However, the number of species among pools in an archipelago (beta diversity) is quite high. Thus, typical vernal pool plants are characterized by highly subdivided populations, probably with low genetically effective sizes and low dispersability.

Sensitive vernal pool plant species known in Placer County include the Bogg's Lake hedge-hyssop *Gratiola heterosepala* (State Endangered), dwarf downingia *Downingia pusilla* (CNPS list 2), Ahart's dwarf rush *Juncus leiospermus* var. *aharti* (Federal SC, CNPS list 1B), legenere *Legenere limosa* (Federal SC, CNPS list 1B), and Red Bluff dwarf rush *Juncus leiospermus* var. *leiospermus* (CNPS list 1B).

Fauna

The original Valley Grassland ecosystem supported large numbers of pronghorn, deer, tule elk, rabbits, hares, squirrels, voles, gophers, mice, and other rodents. Coyote, fox, and even wolf roamed with grizzly bears. As European humans and their domestic animals rapidly increased in numbers in the 1850s, the larger wild animals diminished, but the smaller ones remained numerous. The California Annual Grassland ecosystem is still high-quality habitat for numerous native reptiles, birds, and mammals. A few vertebrates such as California tiger salamander *Ambystoma californiense* (Federal Candidate, State SC), and western spadefoot *Scaphiopus hammondii* (Federal and State SC) may use vernal pools for breeding in Placer County, but the vast majority of the pool fauna consists of invertebrates.

The invertebrate fauna of conservation concern in Placer County's vernal pools consists of two fairy shrimp, *Linderiella occidentalis* and *Branchynecta lynchi* (Federal Threatened) and the vernal pool tadpole shrimp *Lepidurus packardii*, (Federal Endangered). Although both species of fairy shrimps occasionally co-occur in the same pool, *Linderiella occidentalis* is typically found in pools that are moderately predictable (fill regularly) and long-lived (remain filled more than three weeks). In contrast, *Branchinecta lynchi* is most commonly found in less predictable and shorter-lived pools.

Lepidurus take longer to develop to maturity than the fairy shrimps, so they are effectively restricted to longer-lived pools.

Most vernal pool plants are pollinated by native, ground-nesting, solitary bees in the family Andrenidae. Many of these bees are quite specialized and take pollen from only a single genus of plants.

Many typical grassland bird species are still found in this fast-dwindling habitat. Swainson's Hawks *Buteo swainsonii* (State Threatened) and Burrowing Owls *Athene cunicularia* (Federal and State SC) often are associated with vernal pools since they often utilize the surrounding grasslands for foraging. Nesting Northern Harriers *Circus cyaneus* (State SC) and wintering Ferruginous Hawks *Buteo regalis* (Federal and State SC) and Rough-legged Hawks *Buteo lagopus* (no legal or protected status) overlap in habitat use with Swainson's Hawks.

Conservation and Management

California Annual Grassland ecosystems continue to disappear under agricultural, residential, and industrial development, so their conservation is an important goal for Placer County. This dovetails well with open space conservation for agriculture, since these grasslands thrive under grazing disturbance and need to be managed as grazing systems. In the absence of livestock, annual grasslands often become dominated by tall, dense stands of grasses such as ripgut brome and wild oats that are not used by many wildlife species. Many annual grasslands can withstand fairly heavy livestock use with little soil erosion, high productivity, and little change in floristic composition. The introduced grasses are now permanent members of the ecosystem; and their elimination, except perhaps in small, restored areas, is highly unlikely. Thus, they should be thought of as naturalized species rather than as invaders characteristic of rangeland in poor condition. Certain exceptionally troublesome species such as goat-grass, Medusa-head, and yellow star-thistle present a different situation and should be reduced or eliminated whenever possible.

In Placer County, urbanization, industrial development, and infrastructure construction have resulted in substantial losses of vernal pool ecosystems. To date, most conservation efforts have focused on fencing off single pools or tightly confined small pool complexes and surrounding them by various types of development. The majority of these conserved pools reside in an urban or suburban landscape. In addition to vernal pools being protected through this onsite avoidance strategy, offsite conservation has occurred on a 600-acre vernal pool conservation bank in the Orchard Creek watershed near Lincoln. The conservation effort has been coupled with an offsite mitigation strategy that has resulted in the 1:1 creation of new vernal pools, although little or no new Mehrten habitat has been created. The creation of new vernal pools in mitigation banks is of marginal long-term conservation value at best. Rather, effective conservation must focus on the protection of archipelagos of pools containing a number of pools and pool types plus a substantial portion of the surrounding catchment area.

Pool number. Because of the complexity of vernal pool habitats and the life history requirements of their associated species, a conservation area must contain many pools of different types.

- The diversity of plant species is low at single pools but each pool tends to have a different complement of species.

- Vernal pool invertebrates require different pool types in terms of longevity and predictability.
- Since tadpole shrimps and larvae of salamanders and spadefoots are predators of fairy shrimps, long-term survival of fairy shrimps requires that some of their populations are in pools free of tadpole shrimps and vertebrates.

Catchment area. A vernal pool conservation area must include a significant amount of the surrounding drainage basin or sub-watershed. The following points suggest that reserves of less than several thousand acres will be ineffective in conserving all the components of the vernal pool ecosystem.

1. A large catchment area helps ensure sufficient runoff to fill the pools with regularity and to resupply the bicarbonates, carbonates, and hydroxides needed for adequate buffering capacity.
2. Vernal pool plants are pollinated by specialized bees, and it is quite likely that a number of bee species are required in a pool archipelago to pollinate the plants. Species richness of bees is almost certainly dependent on area.
3. Spadefoots migrate at least several hundred meters from non-breeding to breeding habitats, and California salamanders are known to migrate at least one mile from their non-breeding habitat to a breeding pool. This suggests that the amphibians breeding in a single pool may have come from an area encompassing over 3 square miles or more than 2000 acres.
4. Burrowing Owls have been observed at densities of 8 pairs per 640 acres in California. Thus, a minimally viable population of Burrowing Owls (ca. 50 individuals) requires at least 2000 acres of suitable habitat.
5. Swainson's Hawks apparently need between 1400 and 10,000 acres to support a single nesting pair.
6. The watershed surrounding the pools must be large enough to contain viable populations of several species of mammals since they are important in the ecology of several grassland and vernal pool species. Both the California tiger salamander and western spadefoot live in mammal burrows during the non-breeding season. The Burrowing Owl depends on fossorial mammals such as the California ground squirrel to excavate nest sites, and it feeds on small mammals such as deer mice and meadow voles in addition to insects.

Management. Management strategies must include fencing for the protection of pool archipelagos from off-highway vehicle use, trash dumping, unauthorized hunting, and watershed alteration.

1. Off-highway vehicles can alter hydrology, damage vegetation, and kill or injure small animals, especially when they are migrating to breeding areas.
2. Ground squirrels and other rodents must not be shot or poisoned because of their importance to the vernal pool community.
3. Pool complexes must be sufficiently free from disturbance so that ducks and other aquatic birds are able to move freely from pool to pool. Fairy shrimps are an important part of the diet of many birds, and the resistant cysts of the shrimps are dispersed from pool to pool in the guts of these birds or in the mud adhering to their feet.

4. Artificial drainages that alter pool hydrology must be eliminated, and the natural drainage pattern must be restored.

5. Vernal pools and their associated Valley Grassland habitats could be managed as grazing systems. In the absence of grazing, annual grasslands often become dominated by tall, dense stands of grasses such as ripgut brome and wild oats that are not used by many wildlife species. Fall grazing is also necessary to keep the vernal pools free of invasive vegetation.

6. Prescribed fire also may be considered as a management tool to mimic natural conditions and maintain the natural vegetative community.

7. Many other human uses including hiking, horseback riding, and other types of "soft" (less invasive) recreation are compatible with vernal pool conservation.

8. In the absence of protected areas, large areas of ranchland managed for both conservation and livestock production, provided that the grazing regime is consistent with vernal pool conservation, may be the best conservation prescription for vernal pools and their associated species. The latter strategy fits in well with Placer Legacy's agricultural conservation goals.

Restoration and Creation of Vernal Pools

The results of vernal pool restoration are mixed, ranging from qualified successes to dismal failures. The lack of detailed knowledge of the physical and biological attributes of natural reference pools makes the evaluation of restoration success quite difficult, and much further study is necessary. Avoidance of disruption is clearly the preferred option for remaining vernal pools.

While the creation of new pools may be useful in the short term for the conservation of some species of vernal pool plants, its long-term effectiveness for those species is doubtful unless the right species of pollinating bees also have been established near the pool complex. Unless the created pools mimic the heterogeneity in predictability and duration of a natural pool complex, it seems unlikely that they will be very effective for the conservation of pool invertebrates either. It is also very hard to see how a created pool complex can provide the appropriate habitat for the vernal pool-associated vertebrates discussed above. In any event, it should be the responsibility of those creating the pools to demonstrate their long-term effectiveness for any species before relying on created pools as a major conservation tool. Until that has been done, the conservation of existing pools and their associated catchments is a far better strategy.

Management Goals and Practices

1. Biodiversity
   - Minimum preserve size should be approximately 200 acres.
   - Reduce or remove non-native plant species, especially weedy/invasive ones.
   - Restore native perennial bunchgrass and native plant associations.
   - Maintain and increase native species diversity.
   - Reduce and remove non-native animal species such as feral dogs and cats, beaver, bullfrogs, mosquito fish.

2. Water/hydrology
   - Provide a range of hydrological conditions to buffer against climate change.

- Reduce/remove augmented water from storm drains, irrigation, outfalls, etc.
- Control agents of hydrologic change (beaver dams, water table alterations, etc.).

3. Management (general)
   - Focus on ecosystems, not single species.
   - Follow best management practices; monitor results. Change management practices if they are not achieving goals (adaptive management).
   - Focus management trials on small sections of reserves only.

4. Grazing management
   - Disturbance is important in grassland and vernal pool ecosystems, and the complete removal of grazing will most likely lead to the collapse of the natural ecosystem.
   - Grazing should be conducted both on grassland and in vernal pools
   - Cows are best for grass management; sheep will work for some forbs but won't enter pools when wet; goats are quite problematic; horses have little success (but few research trials yet).
   - Moderate to intense grazing should mimic natural migratory regimes by moving grazers from pasture to pasture at regularly scheduled intervals.
   - Do not remove existing grazing regime until a grazing management plan is in place.

5. Fire management
   - Careful and strategic use of fire along with grazing has been shown to reduce alien weed populations, increase biodiversity, and encourage perennial bunchgrass and native annual species expansions.
   - Mowing, baling, mulching, and various other biomass reduction techniques have provided small to moderate successes toward these goals.
   - Preserves should be large enough so that burning and grazing can continue regularly on a rotational basis.

6. Access and exclusion
   - Access to reserves should be restricted to a well-designed system of entry and exit points; visitors should be restricted to trails and boardwalks.
   - All intensive and/or invasive recreational activities (i.e., any activities that would disrupt natural ecosystem functioning) must be prohibited.

7. Research and Monitoring
   - Conduct baseline research on biological resources and current management practices.
   - Monitor the effects of human access on ecosystem structure, composition, and processes.
   - Monitor for contaminants.

Agricultural Ecosystems

Introduction

Agricultural ecosystems include pasture, cropland, orchard-vineyard, agricultural riparian, and eucalyptus; other classification systems differentiate between flooded agriculture, seasonally flooded agriculture, and non-flooded agriculture. Agricultural ecosystems generally have been planted on deep, fertile soils that once supported productive natural ecosystems and an abundance of wildlife. This conversion, while resulting in tremendous economic gain, has impacted California's biological diversity significantly.

Pasture, cropland, and orchard-vineyard ecosystems are found throughout the Phase 1 area in the Central Valley and lower foothills. Many orchards have been abandoned in Placer County since the 1950s. These have been invaded by native or naturalized vegetation, and some are now reverting to oak woodlands.

Vegetation

Pasture vegetation is a mix of perennial grasses and legumes that normally provide 100% canopy closure. Vegetation height varies according to season and livestock stocking levels, and the mix of grasses and legumes depends on management practices. Pastures are often established on soils not suitable for other crops where an ample water supply is available. They are a fairly permanent agricultural vegetation type; with proper management, pastures will remain productive for 30 years.

Cropland is almost always grown as monocultures, using tillage or herbicides to eliminate unwanted species. Most crops are rotated between annuals and perennials on a five to seven year rotation. Hay crops are grown on more acreage than any other crop in California.

Orchards are typically single-species, open-canopied, tree dominated ecosystems planted in a linear pattern with uniform spacing between trees. Vineyards are also single-species plantations arranged in rows, with the crop often supported on trellises. In both vegetation types the understory usually consists of bare soil (controlled by tillage or herbicides) or a cover crop of herbaceous plants. In California, orchards are generally planted in citrus, nuts, and other fruits; vineyards are primarily grapes with berries and kiwi fruit making up the remainder.

Agricultural riparian ecosystems are found along irrigation ditches, canals, and stock ponds. These ecosystems have some of the species found in natural riparian zones, particularly willows and cottonwoods, but the vegetation is often cut, sprayed with herbicides, or burned periodically to reduce water loss through transpiration. Water-saving practices such as lining canals or replacing ditches with pipes results in the elimination of this ecosystem--with poorly understood consequences on riparian-dependent species.

Eucalyptus has been extensively planted throughout California since its introduction from Australia in 1856. Most eucalyptus have been planted into rows for wind protection or into groves for hardwood production in agricultural landscapes, but eucalyptus also can be a significant vegetation type in urbanized areas.

Wildlife

Although agricultural ecosystems are used periodically by a number of species, they are not major reservoirs of biodiversity. Ground nesting birds, including waterfowl, nest in pastures if adequate vegetation is present at the onset of nesting season, and flood irrigation of pastures provides feeding and roosting sites for many shorebirds, wading birds, and waterfowl. Some species of waterfowl feed on waste rice and corn that remain in the fields after harvesting. Croplands flooded for weed control, leaching, irrigation, or waterfowl hunting also serve as temporary habitat for a variety of wetland wildlife, including the giant garter snake, a Placer County species of particular interest. Swainson's hawks use pasture and cropland ecosystems for foraging. Eucalyptus can be important as roosts, perches, and nest sites for a number of bird species, especially raptors.

Fleishman et al. (1999) and Simpkin (1999) have shown that agricultural ecosystems support a fairly large subset of the native riparian-dependent butterflies and dragonflies and in the western Great Basin, and there is no reason to think that these findings would not apply to California as well.

Conservation and Management

Agricultural ecosystems can be both beneficial and detrimental to biodiversity. On the one hand, since these lands are managed primarily for crop production, pest species need to be controlled to prevent excessive crop losses. If these actions are not carried out with some care, many non-target species are killed as well. Agricultural operations also can be major sources of pollution. Fertilizers, pesticides, and herbicides all can find their way into rivers and streams with highly deleterious impacts on native biodiversity. Environmentally friendly practices such as no-till and organic farming can help reduce these impacts considerably.

On the other hand, agricultural lands can provide habitat for many species, and small changes in management sometimes result in substantial benefits to biodiversity. For example, in the Sacramento Valley rice fields and irrigation ditches have become the giant garter snake's last retreat. During the summer the rice fields are flooded, providing good foraging habitat, and during the winter the snakes hibernate in the ditch banks. Until recently, the fields were drained in the fall so the stubble could be burned; however, if the water were let out too fast, some of the snakes became stranded in the fields and became easy prey for raptors. Because of recent air quality legislation that prohibits burning, rice farmers are now letting the water remain in their fields, and this wintertime flooding reduces stranding and helps confine the snakes to the drier levees when springtime planting begins. Over the winter, the rice stubble is broken down by bacteria in the water, and the invertebrates that feed on the bacteria provide food for overwintering birds. This provides a win-win situation for both the grower and wildlife. Unfortunately, rice fields are not stable habitat for the giant garter snake since the amount of acreage in rice production is highly variable and depends on market conditions and water availability.

Biodiversity provides many services to agriculture that are not always recognized by the agricultural community. Many wildlife species act as biological control agents by feeding on weed seeds and deleterious insects, and wild bees now pollinate many crops such as alfalfa, fruits, and nuts. These crops once were pollinated by domestic honeybees, but now that honeybee populations are drastically reduced by low honey prices and parasites, growers are becoming more and more dependent on wild bees. Thus, the melding of conservation and production interests in rural landscapes makes good sense. The best hope for conserving biodiversity in western Placer County is a mosaic of agricultural, natural, and semi-natural areas. Such a landscape will not only serve conservation objectives but also will improve economic returns for agriculture through the restoration of ecosystem functions at a landscape level and by helping to minimize inputs and costs (Recher 2003). The following guidelines suggest some ways in which farming and ranching practices can be integrated with biodiversity conservation (Doley 2003, Hobbs 2003, Lambeck 2003, Lefroy 2003, Lloyd and Butterworth 2003).

• Work with the natural system rather than against it. California's climate and water availability are different from other areas; practices designed for the Midwest are not optimal here.

• Maintain diversity and keep options open. Build resilience into the system so that it is less susceptible to extreme events and conditions (e.g., droughts, floods, insect outbreaks). A farming system that combines raising a diversity of livestock and crops is good insurance against economic and environmental disasters. Monocultures and low diversity systems can survive only with high inputs and are inherently susceptible to environmental variability, pests, disease, and market fluctuations.

• Manage according to natural boundaries. Farming to soil type increases yields and makes efficient use of fertilizers and pesticides if they are needed. Careful identification of where most of the yield comes from can release low productivity areas for other uses such as revegetation.

• Preserve or restore representative patches of the original vegetation. This not only helps preserve biodiversity, but remnant vegetation also provides habitat for many species of birds and predaceous insects that help control insect pests. Patches of native vegetation also retain many important functional attributes beneficial to agriculture. There is evidence that mixtures of native vegetation and production areas result in less energy use and fertilizer demand, are more efficient in water use, are more productive, and degrade the soil less than conventional agricultural systems (Melvin 2003).

• Maintain permanent strips of native trees and shrubs to connect the patches.

• Be cautious in the use of herbicides and insecticides. Reduce production of weed seeds by cultivating instead of using herbicides. Rely more on natural enemies to control pests; use chemicals only as a last resort and not as routine insurance. All weeds and insect pests eventually develop some degree of resistance to chemical control measures.

• Manage nutrient cycles by maintaining a low input system that utilizes nitrogen from legumes or animal waste rather than chemical fertilizers. Minimize nutrient losses by decreasing runoff and wind erosion. Contour plowing, retaining stubble, and creating shelter belts of native vegetation can help accomplish this.

• Use water entering the system effectively.

• Get to know the species in and around your land. Survey the birds, mammals, amphibians, reptiles, and common insects on your land at least once a year; keep records. Get out of the truck on off of the 4-wheeler whenever possible to increase observation time.

• Provide roosting perches and nestboxes for birds and bats.

• Leave winter crop stubble and brush piles through the winter to provide ground cover; plant cover crops to provide food and cover for native birds.

• Control feral cats, foxes, bullfrogs, weeds, and other non-native species. Feral cats kill an estimated 4 million birds per day.

Urban Ecosystems

Introduction

Urban ecosystems are created by the construction of buildings, roads, and other infrastructure accompanied by the replacement of native vegetation with exotic species. They are found throughout the Phase 1 area. There is usually no abrupt boundary between urban and non-urban ecosystems; rather, a gradient of increasing urbanization can be identified. An example of such a gradient might be: natural ecosystem, low-density suburban, golf course, city park, higher-density suburban, urban residential, and city center.

Urbanization results in the loss and fragmentation of native vegetation and wildlife habitat and modifies many environmental parameters to favor introduced species. For example, wind velocities tend to be reduced in highly urbanized areas (except where there is high-rise construction), and temperatures tend to be 3o to 5o C higher than in the undeveloped landscape. The latter is the "urban heat island" effect, largely due to intensive energy use and changed albedo (surface reflectivity).

Vegetation

The structure of urban vegetation varies, and five types of vegetative cover have been defined. Tree groves have a continuous canopy and are found in city parks, green belts, and cemeteries. Street tree strips can have either continuous or discontinuous canopies. Both types are often monocultures of non-native species. Shade tree/lawns are typical of residential areas; they tend to have more diversity of tree species than the first two. Lawns tend to be structurally uniform. Although a variety of grass species may be planted, lawns are usually maintained at a uniform height and as continuous ground cover. The fifth type, shrub cover, is more limited in distribution than the others, and the kinds of species, planting design, and maintenance schedule determine its structural characteristics. All these cover types, along with areas lacking significant vegetative cover, intergrade and form a complex mosaic within cities and towns and along urbanization gradients. The characteristics of the matrix as a whole may be more important in determining the value of urban ecosystems for biodiversity conservation than the characteristics of any particular cover type.

The richness of native plant species tends to decline along the urbanization gradient, and the richness of non-native species, particularly trees, tends to peak in suburban and urban residential areas. Weedy exotics and a few hardy exotic trees and shrubs dominate city centers--if any vegetation grows there at all.

Wildlife

Recent studies by Blair (1996, 1998) and Blair and Launer (1997) in oak woodlands in the San Francisco Bay Area using birds and butterflies as biodiversity indicators have shown that any development at all is detrimental to some species, but that others can tolerate varying degrees of urbanization. Species intolerant of any urbanization in this area were Steller's jay, wrentit, western wood-pewee, Hutton's vireo; grass skipper, and western checkerspot butterfly. The 57 other native species in the study dropped out at different places along the urbanization gradient. Only four native species of birds--white-throated swift, Anna's hummingbird, Brewer's blackbird, Scrub jay, and mourning dove--and two native but highly migratory butterflies, the fiery skipper and painted lady, were present at the most urbanized part of the gradient.

More recently Niell (2001) examined the relationships among parcel size, landscape-level vegetation characteristics, and butterfly community composition in rural residential development in Placer County oak woodlands. She sampled butterflies on twenty-six 8-hectare sites that spanned a range in development intensity from sites with small 0.4 hectare (1 acre) parcels and highly modified vegetation to large parcels greater than 81 hectares (200 acre) in size that were characterized by substantial amounts of undeveloped oak woodland. She found that parcel size was negatively correlated with diversity of vegetation types and positively related to the percent area of native vegetation across the range of parcel sizes observed. Butterfly species richness was negatively related to parcel size, positively related to vegetation diversity, and peaked where intermediate levels of area of native vegetation exist. The loss of native vegetation associated with smaller parcel sizes, however, resulted in the loss of butterfly species that are closely associated with native vegetation. These trends represent a shift in butterfly species composition from specialist to generalist with increasing urbanization. This suggests that zoning for larger parcel sizes may be useful for conserving native oak woodland vegetation types and its associated biotic diversity; however, her data also showed that maintaining patches of oak woodland, even on small parcels, helps retain specialist species at a landscape scale.

In general, low-density suburban areas support many species of native wildlife, but few of these species are of conservation concern. A few native species such as scrub jays, house finches, monarch butterflies, raccoons, and striped skunks, have adapted well to fairly heavy urbanization, and these species can become quite common in residential neighborhoods. In commercial and industrial districts most native species have been replaced by a handful of invasive, exotic species. One study found that rock doves (feral domestic pigeons), house sparrows, and starlings comprised over 90% of city center birds. The cabbage white, an exotic species, is often the only species of butterfly that can be found in city centers.

Curiously, the Peregrine Falcon *Falco peregrinus*, a Phase 1 covered species, has been known to colonize high-rise buildings in city centers where it preys primarily on rock doves. Burrowing owls, another Phase 1 covered species, occasionally use vacant lots in urban areas.

Conservation and Management

Urban ecosystems generally require substantial management such as irrigation, pruning, fertilizing, and pesticide spraying to maintain their structure and species composition. When management stops, these ecosystems are invaded by both native and exotic species, and unmanaged urban ecosystems eventually may revert to communities of largely native vegetation.

Since a goal of the HCP/NCCP is to maintain current levels of biodiversity, development must be spatially concentrated, and the amount of undeveloped land must be maximized. Golf courses, city parks, and other recreational areas support relatively little native biodiversity, and even though many species can adapt to lightly urbanized environments such as low-density suburban, completely undeveloped reserve areas must be established to maintain the highly specialized species found only in undisturbed natural ecosystems.

There are two design elements for new developments that are directly under the control of developers and planners: the size and shape of green spaces and the intensity and design of development on adjacent lands. Green spaces should be large with internal fragmentation minimized, close together, interconnected (preferably with multiple linkages), and contain heterogeneous vegetation, soils, and topography whenever possible. Vegetation should be kept natural, and exotic species should be removed; shrubs and small trees should not be removed to achieve a park-like effect. Wide, maintained paths and landscaped areas within green spaces should be avoided; rather, walking and biking trails should be sited along edges.

Developers should not design residential areas with straight lines of grassy lawns and hedges planted with non-native species. Instead, neighborhoods should be designed with as much natural cover as possible and should be landscaped with shrubs and native grasses rather than lawns. Native trees should not be replaced with exotic ones, and dead trees should be left in places where they pose no threat to humans.

Individual homeowners need to minimize intrusions into the green spaces. Homeowners associations should encourage residents to keep their cats inside at all times, keep dogs in fenced yards and on leashes when outside of the yards, and not to dump lawn trimmings or other debris in green spaces.

Waters near urban and suburban areas are often adversely affected by urban storm water runoff. Impacts of this runoff are manifested in a variety of ways, including:

• Altering hydraulic characteristics of receiving streams by increasing peak discharge, increasing flooding and the duration and frequency of elevated discharge, and reducing base discharge.

• Changing stream morphology by increasing shoreline erosion, stream bed scouring, channel widening, sediment transport, and stream bed scouring.

• Altering fish and macroinvertebrate communities, and decreasing populations of sensitive species.

• Increasing risks to public health by increasing human contact with contaminated water, and by contaminating drinking water supplies, and fish and shellfish used for recreation and by the food industry.

The goal of urban BMPs is to minimize affects of these impacts. In existing urban areas, BMPs should address a range of water quantity and water quality issues. In new developments, BMPs should be designed so that post-development peak discharge rates, volume, and pollutant loadings are no greater than pre-development conditions. Within context of these goals, it is usually inappropriate to identify specific BMPs that can resolve a wide range of problems because BMPs must be designed to address the specific challenges and issues at each particular site. Therefore, BMPs shown below provide general design guidance to resolve a wide variety of issues. Assessment and implementation of individual BMPs should be an integral part of the Placer County planning and permitting process, and programs should be periodically reviewed to ensure their effectiveness. More detailed information about the variety of designs that may be utilized for urban BMPs is available in a number of reports by the U.S. Environmental Protection Agency, American Society of Civil Engineers, and the Water Environment Federation that should be consulted to maximize the efficacy of individual projects. A selection of these reports is shown in the References section.

Urban Development BMPs

There are two basic types urban development of BMPs. *Stru ctural BMPs* are designed to treat storm water at either the point of generation or at the storm water or sewage treatment point of discharge. *Non-structural BMPs* include educational, pollution prevention, and runoff management programs to prevent pollutants from entering runoff. It may be necessary to use a suite of structural and non-structural BMPs to minimize entrance of storm waters into stream and lake systems and their adverse impacts.

Structural BMPs include:

• *Infiltration systems* to capture runo ff and allow it to infiltrate into the ground. These systems include porous pavement, trenches, and wells.

• *Detention and retention systems* to temporarily capture runoff and retain it for a short period of time before it is slowly released. Detention systems are usually dry between runoff events and retention systems usually maintain a pool of water.

• *Constructed wetland systems* are similar to detention and retention systems but wetland vegetation is maintained in the system to allow biological uptake of pollutants.

• *Filtration systems* use granular material such as sand, organic material, carbon or other membranes to remove suspended material from the runoff. These systems may be constructed on the surface or underground.

• *Conveyance and delivery systems* that minimize connections between impervious surfaces and storm water drainage. Such conveyance and delivery systems direct storm water away from impervious surfaces (e.g., include rooftops, driveways, parking lots, streets, and highways) to areas where it may be detained or infiltrated.

Non-Structural BMPs

• Establish county and/or city *recycling programs* to minimize the amount of waste material that is released into the environment.

• *Public education* is necessary to inform the community about the affects of their activities on surface water pollution. Education should emphasize non-point source pollutants such as fertilizers, pesticides, automotive products, household chemicals, and animal (e.g., pets) and plant (e.g., lawn clippings) waste. These programs also should inform the public about city and county programs that allow the proper disposal of pollutants (e.g., recycling, hazardous waste).

• *Maintenance practices* can be implemented by cities and counties to minimize runoff from the urban landscape. These practices generally ensure that existing systems are operating properly and efficiently and include sweeping parking lots and streets to remove organic and inorganic debris, cleaning catchment basins, maintaining streets and ditches to prevent deteriorating pavement and accumulated materials from entering the storm water system, collecting floatable material (e.g., styrofoam), enforcing laws to prohibit unlawful discharge of chemicals, and maintaining sewer facilities to minimize leakage.

Adaptive Management and Associated Monitoring

Introduction

Current levels of information are inadequate to identify minimum ecosystem units that will stay healthy through time, to identify minimum viable population sizes for target species, or to describe an effective system of habitat linkages that will facilitate ecological interaction and gene flow among these species. The combination of these factors reduces the probability that the network will support some of the target species over the long term without active management.

Since this process will provide only a best-guess about the ecological and conservation requirements of most of the covered species, the HCP/NCCP will rely heavily on the process of adaptive management for its execution. Unlike the usual prescriptive approaches that rely on rigid standards and guidelines, adaptive management acknowledges the various sources of uncertainty inherent in resource stewardship, takes an experimental approach, and is self-correcting if the management actions are failing to achieve the conservation goals.

For these reasons the NCCP will require the establishment of a monitoring and adaptive management program. Monitoring will evaluate population levels of sensitive species in conservation areas, patterns of use of landscape linkages, and the responses of species to disturbance. Adaptive management incorporates newly acquired information from monitoring and allows response to unforeseen circumstances.

Principles

Adaptive management is an iterative process that evaluates management actions or program elements through carefully designed monitoring and proposes subsequent modifications (Mulder et al. 2000). The modifications are in turn tested with an appropriate, perhaps redesigned, monitoring. Even though adaptive management is logical, can deal with uncertainty and data gaps, is similar to the scientific process of hypothesis testing, there are few examples of its successful implementation in the existing literature [but see Wisconsin DNR (1999) and Pavlik et al. (2002) for operating examples]. There appear to be three main reasons for its limited success: (1) failure to have clear ecological and social goals that are endorsed by all parties, (2) reluctance of planners or resource managers to rely on monitoring data for decision-making, and (3) monitoring programs that are not specifically-focused on the management actions or that lack the statistical power to provide the necessary level of certainty. These problems are discussed at length in a recent NRC report on Adaptive Management of the Everglades: http://books.nap.edu/catalog/10663.html.

Implementing an effective program for adaptive management and monitoring in Placer County requires understanding the following principles:

Policy-makers, resource managers and scientists must collaborate on the design of the adaptive management program from DAY ONE.

Initial "buy-in" as to how adaptive management works is absolutely essential so that policy makers and resource managers know how the monitoring program should be used and how it cannot be used. They must specify which management actions most urgently require evaluation, provide focus on specific issues to be included in the monitoring, and understand how the monitoring will provide the necessary data for modifying the existing action or proposing a new action. Similarly, the scientists must understand the policy and management needs, explain the design and limits of the proposed monitoring (e.g. error and power analyses), and provide useful distillations of the monitoring data for decision-making.

Different types of monitoring programs provide distinctively different services.

"Monitoring" is too vague a term to convey the kinds of designs and information feedbacks that will be required for implementing an adaptive management program for all of eastern Placer County. Therefore, effective implementation of the NCCP/HCP will require these three types:

1. *Compliance Monitoring*: This is a simple information feedback on fulfillment of permit conditions, mitigations, rates of land conversion, spatial patterns of development, preservation, or other forms of land use, and other non-biological measures are recorded and analyzed. In essence, it will track whether the most basic objectives of the NCCP/HCP are being met. Placer County, through its planning department, is probably the organization that can provide compliance monitoring for the NCCP/HCP.

2. *Status and Trend Monitoring*: Biological data on the population sizes, numbers of populations, areal extent, or quality of critical biological resources are subjected to trend analysis to determine how they are performing under the existing conditions imposed by the NCCP/HCP or under specific management regimes. Although agencies will probably require some kind of status assessment on all listed or CEQA species, the selection of indicator species or habitat types (see questions 3 and 4 of Species Addressed section, below) may provide a reasonable subsample of different organisms or community types for more detailed trend analysis. It should be noted the Status and Trend Monitoring does not establish cause and effect, but simply gives an evaluation of resource condition though time. Consequently, its statistical power must be appropriately evaluated to give managers clear indications of its limitations and levels of uncertainties. Resource agencies (CDFG, USFWS) have the appropriate expertise and databases for performing this kind of monitoring in cooperation with the eastern Placer County NCCP/HCP. The principles and techniques of trend analysis are given in Pavlik (1994), Willoughby et al. (1997), and Thompson et al. (1998).

3. *Cause and Effect Monitoring*: This is the most scientific of all three types of monitoring because it tests management hypotheses with field experiments. It attempts to fill very specific data gaps by testing the effects of relevant variables (e.g. controlled burns, grazing regimes, reintroductions of rare species) on resources of concern (see Management and Monitoring section, question 2, below). A well-designed experiment with appropriate controls, replications and statistical power can provide the best management guidance, but is very specialized, time-consuming and relatively expensive.

Consequently, this type of research-oriented monitoring is most likely to be performed by qualified consultants or university scientists supplied with adequate levels of funding. The principles and techniques of cause and effect monitoring are given in Taylor and Gerrodette (1993), Pavlik (1994), Willoughby et al. (1997), Thompson et al. (1998) and Feinsinger (2001).

Oversight committees must facilitate communication among government, scientists, and the private sector.

Information flows between decision-making bodies and constituencies must be facilitated to promote the synergy necessary for successful adaptive management. Various structures can be proposed (Pavlik et al. 2002), but efficient and timely exchange of information between policy, research, and management must be of primary concern.

Implementation

Adaptive management can accommodate much of the uncertainty inherent in the planning and implementation processes. However, it is one thing to design and adaptive management program and quite another to implement it. Leadership, decision-making authority, and scientific expertise are all needed to make adaptive management work. Public agencies generally do not have these capacities, nor do consulting firms. Optimally, adaptive management and the administration of conservation lands should reside with an independent, adequately funded organization with broad representation (agencies, university officials, local government, development and agricultural interest) and the power to redirect or modify development or conservation activities. This HCP/NCCP oversight organization would coordinate monitoring activities, track progress toward county-wide conservation goals, and have the ability to change management practices if the goals are not being met. An independent technical advisory group (TAG), consisting of policy, resource management, and scientific representatives also should be created. Data from the various monitoring programs would flow to the TAG, who would then recommend management alternatives or modifications to the oversight organization.

The oversight organization and the TAG need to be created by the County, participating agencies, and stakeholders in the earliest stages of HCP/NCCP implementation and provided with adequate funding to do their jobs. The source of the funding stream for this organization must be identified explicitly in the HCP/NCCP. Until such an organization can be created, the County needs to hire staff with the proper expertise to ensure that conservation lands are acquired expeditiously and managed intelligently.

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