Ecological Planning and Urban Village Design

ECOLOGICAL PLANNING AND URBAN VILLAGE DESIGN

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BACKGROUND

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ECOLOGICAL PLANNING AND URBAN VILLAGE DESIGN

1.0 Introduction

BACKGROUND

The cities of California's Central Valley are growing rapidly and are likely to more than double in population by the year 2040, according to California State Department of Finance projections. The way we plan and design our cities to accommodate this growth will have a great impact on the region's environment, ecology, agriculture and quality of life. To achieve positive environmental outcomes, ensure ecological health, and to create better places for people to live, our communities will need to integrate complex issues and use systems that deliver multiple benefits; including those that:

- mitigate air and water quality impacts,
- reduce the need for fossil fuel consuming vehicular trips,
- conserve Central Valley natural habitats and wildlife corridors,
- preserve farmland and productive agricultural systems,
- improve urban livability and social/economic opportunity.

PURPOSE OF THE STUDY

This document investigates how urban development can (or can not) address biological issues and contribute to the Central Valley's ecological well being. We focus on urban development and regional ecosystems that are affected by urban growth. We apply ecological principles and available scientific studies to develop urban village planning and design criteria. We often focus on the needs of birds, as there is more information on this group of animals and they are visible to city dwellers. The study presents positive opportunities and realistic limitations in the context of what is known about Central Valley biology.

Information in this study is intended for use by land use decision makers, including officials, land owners, professionals, and community members. The data has direct application to policy and master planning level issues.

URBAN VILLAGES

In 1998, Community Design & Planning Services (CDPS) at the University of California at Davis, began the Urban Village Initiative. With major funding from the US Environmental Protection Agency, this program is focusing on smart growth in California's Central Valley. The initiative is addressing two complementary scales, local urban development patterns as well as local impacts on regional systems. It's mission is to collaborate with regional partners, conduct applied research, disseminate information and tools throughout the region, and help communities implement urban village projects.

Urban Villages Defined
We use the term urban villages to mean urban neighborhoods that provide satisfying community living in very humanistic settings. An urban village is a discreet component of an urban system that features concentrated amenities, services and population. Villages are human scaled, both in dimensions and details. Walking to destinations is both efficient and pleasing. The accessibility and scale requires that neighborhood services, recreation, open space, jobs, and other components of daily living are located nearby. Many villages are also within walking distances of the heart of their urban systems, and the ease of access to the best of urban amenities and services is part of village life.

Several features separate villages from conventional development. Villages provide significant public living opportunities and extend personal living space beyond the private residence. Parks and plazas are community scaled outdoor living rooms. Coffee houses are the front porches, places to sit, watch, and interact. Villages are more socially complex than single use zoned development. Ideally there are different types of places to live for different incomes, ages, and lifestyles. Villages strive for positive compatible diversity. When walking on the village sidewalk, everyone; young and old, rich or poor; are on common ground.

Villages are not for everybody, nor are they intended to replace other urban forms. Often urban villages near metropolitan cores have less children, and more young and senior adults than suburban neighborhoods. Yet the potential market within these groups is significant. In the Sacramento region, 45% of the population falls into the age groups that are attracted to urban village living.

Village examples
Villages occur in various degrees in most metropolitan areas. They vary in size, urban structure, open space systems, and land use efficiency. (To measure land use efficiency, we divide the total land area of the village by the number of people living in the village, and generate a people per gross urban acre figure). The following villages have been analyzed as part of this study:

Core Area of Davis has preserved and expanded its traditional downtown. The grid commercial area with pedestrian friendly streets provides a high level of access to services, amenities, and housing. Central Park, the town's outdoor gathering place at the edge of the downtown, links the commercial area with the UC Davis campus. The 200 acre core area has about 12 people per acre in the system.

Midtown in Sacramento has more of a main street structure along J, K, and L Streets. While the area features many well landscaped streets and several neighborhood parks, a major open space or natural feature is not part of the system. The heart of Midtown, I to L and 23rd to 27th, has about 24 people per acre, one of the more efficient areas in the 460 acre village.

North Beach in San Francisco combines a main street styled commercial street along Columbus Avenue with more civic and community uses surrounding Washington Square, the major community gathering space. View corridors to the San Francisco Bay, Marin hills, and urban landmarks add to the urban experience. About 53 people per acre live in the 512 acre North Beach/Chinatown zone.

West End district in Vancouver, BC has a main street spine that runs in a U-shaped loop through the 480 acre district. The West End straddles a narrow peninsula that juts into the Vancouver harbor. The neighborhood has access to over 20 miles of water edge walks and an adjacent 1,000 acre forest/park. This is the most land efficient village studied in this project, with 85 people per acre.

Urban Villages and Environmental Relationships
Urban villages are good places to be, and properly designed, attract high numbers of people to small geographic areas. By being land efficient, a village can generate numerous benefits. Private automobile use drops the closer villages are located to major urban amenities. Less miles traveled reduces polluting emissions and saves energy. Clustering buildings reduces heating and cooling loads. More people per acre make

public transit more cost effective. Villages put more construction on less land, hence generate more property tax revenue with less infrastructure and service costs per acre of land.

An Urban Village may also be the only community form that has a true symbiotic relationship to local ecosystems. By requiring less land, more open space and essential ecosystem features in or near the urban zone can be preserved. In turn, access to open space and natural features enriches village life.

DOCUMENT ORGANIZATION

- In Section 2 we look at some of the basic landscape ecology and conservation biology principles and what they tell us about designing effective habitat areas in urban settings.
- In Section 3 we examine some broader biological issues of the Central Valley that affect consideration of the values of urban habitat, as well as the crucial issue of human access to habitat areas.
- Section 4 provides some basic principles for designing different urban habitat areas.
- Section 5 combines these principles with our thinking on urban village design to give suggestions on how to lay out and design an urban landscape that includes developed and natural areas.

2.0 Landscape and Conservation Essentials

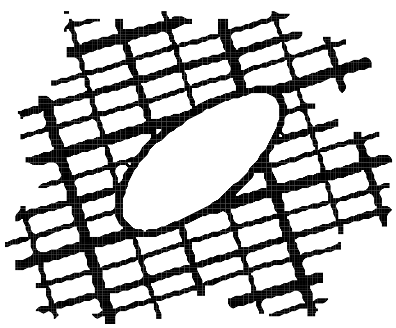
2.1 Patches, Corridors, Matrices and Networks
2.2 Ecotones, Edge Effects and Buffers
2.3 Habitat Planning for Species Needs
2.4 Some Factors Affecting Biological Usefulness of Habitat Areas
2.5 Significance of Our Knowledge Limits
2.6 To What Extent Can Urban Habitat Provide for Wildlife?
2.7 Notes

Urban habitat areas form a series of patches and corridors in a matrix of urban development. This section explains the basic scientific concepts that show how these habitat areas can be valuable to native species, and examines key constraints and opportunities that are important to consider when planning urban habitat areas and their surrounding development. In planning for urban wildlife areas it is important to keep the limits to our knowledge in mind, and to understand that these habitat patches and corridors, while very valuable, are not a substitute for conservation of large expanses of rural lands.

2.1 PATCHES, CORRIDORS , MATRICES AND NETWORKS

Landscape ecologists describe the components of a landscape as a system of patches that are linked by corridors and embedded in a matrix.[1] This model is particularly suited to consideration of urban wildlife habitat. The natural areas and other greenspaces form a system of patches. Streams and other linear features form corridors that link many of the patches. The surrounding urban development area is the matrix.

HABITAT PATCHES



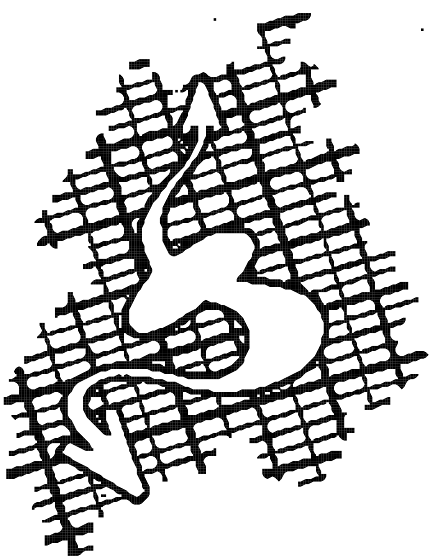
An isolated patch within an urban matrix

A habitat patch is a discrete land area or water body with suitable vegetation to support plant and animal species which is surrounded by a different landscape called a matrix.[1] In this case the surrounding landscape is urban development, but habitat in rural areas also exists in patches. Habitat patches can be of any size, from a small clump of trees to a large natural area.

Habitat patches can be isolated or connected. Connected patches have a corridor of habitat joining them to other habitat areas or to the rural lands beyond the urban area. Isolated patches are completely surrounded by the matrix.

Examples of habitat patches

A woodlot surrounded by buildings and the vernal pool preserve at Sacramento's Phoenix Park are isolated patches. The young oak woodland on the east of the Sacramento Regional Sanitation plant is a connected patch because it joins the Laguna Creek corridor. The west Davis wildlife pond is an isolated patch near agricultural lands that also provides flood control. The 8,600 acre Graylodge Wildlife Management Area and the Sutter Buttes in the Central Sacramento Valley are both examples of large rural habitat patches surrounded by a matrix of agricultural fields.



A patch connected by a corridor within an urban matrix

The importance of patch size and shape

A large number of factors influence the biological quality of urban habitat areas. We discuss many of these in Section 2.4, *Some Factors Affecting the Biological Usefulness of Habitat Areas*. Size, shape and connectivity all determine habitat patch's health and diversity (see *Habitat Corridors* below for the latter issue).

The biological value of a patch increases as its size increases. Firstly, more species can utilize the area. Most resident species or summer (breeding) visitor species have minimum area requirements that can be quite large, although data are only available for some species. Secondly, any given species in a patch needs a number of individuals present in order to survive over the long term. This requires a large enough area and the presence of suitable feeding breeding and cover habitat. Thus a five acre woodlot with suitable vegetation will support breeding pairs of some native vertebrates, while a 25 acre woodlot will support additional species. Smaller isolated patches lose key species over time - see for example loss of native bird and plant species in San Diego canyons.[2] Populations in separate patches may function as metapopulations, disappearing from some patches and then being reestablished by recolonization, or existing only in certain conditions such as very wet years.[2]

Some species require very large areas, and so are most unlikely to occur in urban habitat areas. An example is the ferruginous hawk, a winter visitor than needs large open grassland landscapes. The yellow-billed cuckoo nests in extensive and very wide tracts of riparian forest and so will not occur in urban situations.

The shape of a patch determines what percentage of its area is close to the surrounding matrix, land that is less suitable for some key species (see *Edge Effects* in Section 2.2) even though it may be preferred habitat for some common species that also utilize the surrounding matrix.

Biological benefits and constraints
The biological benefit of a patch increases with patch size, as we discussed above. A very small patch (for example one acre) is of very limited biological usefulness. Isolated patches, unless very close to the urban fringe, will also have less biological benefit.

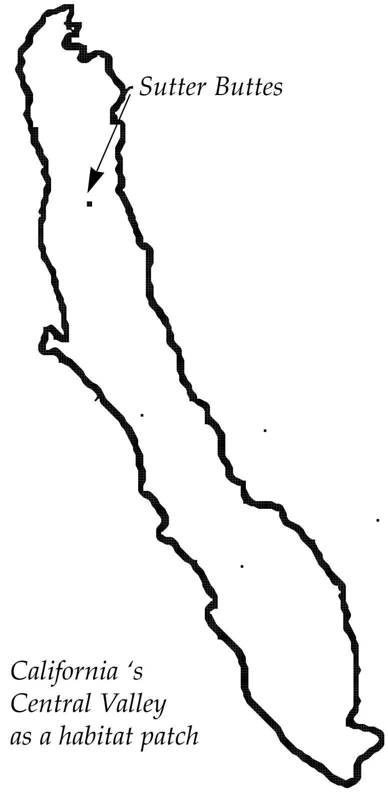
Patches with newly restored or created habitat will take time to develop their full benefits, depending on the type of vegetation. A new planted woodland patch, for example, will not have the tall trees required by some species for 50 years or more.

HABITAT CORRIDORS

A habitat corridor is a linear stretch which connects patches to each other or to the larger rural landscape.[1] A corridor may provide for movement and dispersal of species between two urban habitat patches or between an urban patch and the distant rural landscape.[3] For many species, the vegetation in the connector needs to be the same as in the patches. For example the burrowing owl, which lives in grassy areas, will use a grass connector but not a woodland connector. In some cases a series of habitat patches may function as stepping stones and provide the function of a corridor for mobile species.

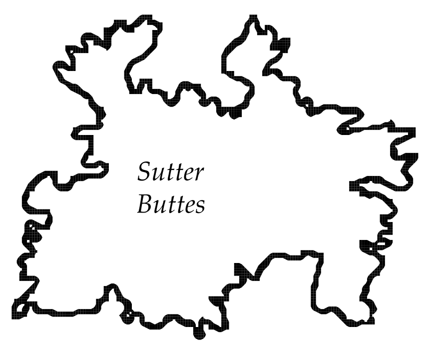
A corridor may be a significant habitat area in its own right, as is the case for riparian corridors along streams and rivers.

Examples of habitat corridors
The American River Parkway, over 3/4 mile wide in places, is the premier example of an urban river corridor in the Central Valley. The parkway includes extensive floodplain lands with large tracts of riparian woodland and some grass or shrub areas. Lower Laguna Creek in the southern part of the Sacramento metropolitan area is a good example of a stream corridor. This urban creek has a variety of wetland,

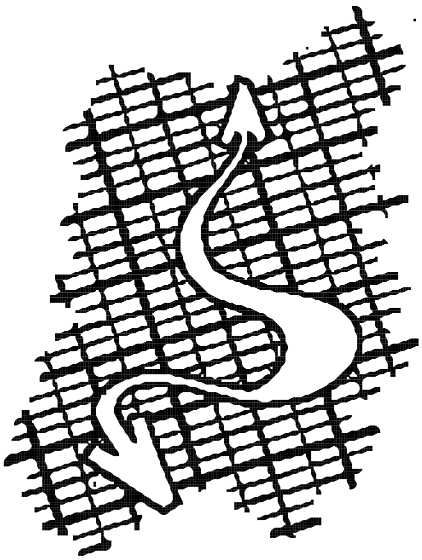


California 's Central Valley as a habitat patch

Patches can exist across infinite scales. The Central Valley is a habitat patch within California and is composed of sub-patches of habitat such as the Sutter Buttes or Delta region



Sutter Buttes as a habitat patch within the Valley matrix.
(different scale than valley diagram above)



Corridor as linear habitat patch with an urban matrix

woodland and grassland habitats along its length.

Rivers flowing through cities may function mainly as a corridor for fish and some water birds, while having little or no adjacent natural land habitat. The Sacramento River between downtown Sacramento and West Sacramento is an example.

Power lines and railroad rights of way that have natural vegetation may function as upland habitat corridors for some species. Sacramento examples are the Union Pacific Railroad corridor stretching south from Curtis Park railyard site (a habitat patch, albeit significantly degraded at present) and the power line right-of-way stretching north east from the Sunrise Douglas vernal pool mitigation bank. The railroad corridor includes grassy stretches and some flanking woodlands. The power line corridor consists of vernal pool grasslands and while at present it is part of a larger vernal pool landscape, in the future it will be a corridor flanked by suburban development.

Improving habitat quality

Corridor width is a key variable. Very narrow corridors have little biological value, except for movement of species that are adapted to the flanking matrix areas. For example, a 50 or 100 foot wide stream corridor with a strip of trees on one or both sides of the stream will be suitable for some species if it is passing through a developed area that has many large trees (see [4] for caution on widths). A narrow corridor, such as a 100 foot grassland strip with a narrow stream along one side, will function as a non-point source pollution barrier [5] and may also allow for movement of some animals that utilize that habitat type.

In general, a longer corridor should be wider, particularly to benefit the smaller animals found in urban habitat areas. Many animals do not travel long distances, so individuals will not travel between two patches by a very lengthy corridor. However if that corridor is suitable habitat for a species occupying the patches, there may be a population of the species living in the corridor. This will result in individuals moving across the patch/corridor boundaries, and help ensure long term maintenance of the species in the patches.[5] It is also important to recognize that a corridor leading to a small patch can be a death trap for species that cannot survive in a small urban habitat patch.

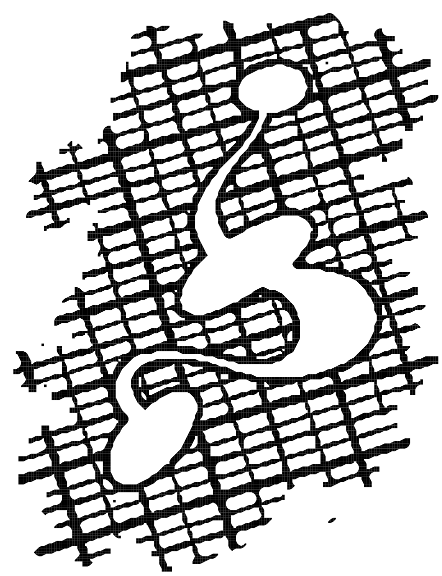
Wider corridors that include good quality habitat have very high value. Urban stream and river corridors, in particular, can have great habitat value. Riparian areas are extremely important as the Central Valley has over 90 percent of its riparian woodland since 1850 (See *Riparian Corridor Biological Characteristics* in Section 4.2 and[6]).

The American River Parkway is over 3/4 of a mile wide in several stretches and provides the very best example of a high-value corridor, although it is not ideal and has areas of non-native vegetation set aside for recreation, such as a golf course. A 600 to 1,000 foot urban stream corridor with riparian woodland, patches of wetlands, and some grass and wooded areas above the 100 year floodplain, has high value, providing habitat in its own right and aiding movement of a variety of species (see endnote [4] for caution on widths).

Biological constraints
Very narrow corridors, or corridors that are extremely long, especially relative to their width, will be less effective for movement of animals.

Very narrow corridors will also be less effective as habitat.

Corridors with more detrimental human activities beside them will be less suitable habitat unless they are very wide. This includes recreational activities.

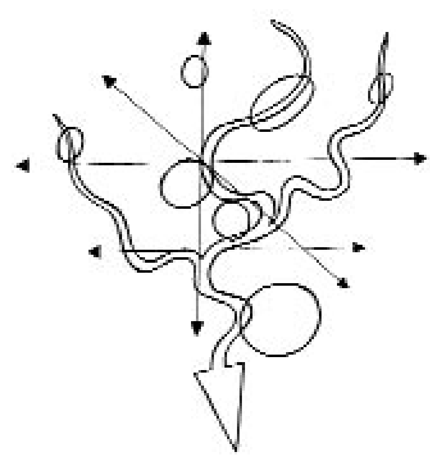


Corridor as a connection between patches with an urban matrix

MATRICES

The matrix is the land surrounding a patch or corridor, in this case the urbanized region including urban villages and other developed areas.[1] Since patches and matrices occur at multiple scales, any given area can be both a patch and a matrix. For example, a Central Valley city is a matrix to its urban habitat patches. But it is also an urban patch in a larger matrix of farmland.

Biological impacts of the matrix
Throughout this document we provide examples of the biological impacts of the matrix on habitat patches and corridors, including pets, noise, air, water pollution and stormwater runoff. [7-9] The nature of the matrix adjacent to a natural area affects the magnitude of these impacts, while buffers (see *Ecotones, Edge Effects and Buffers* below) reduce impacts. In general, business areas have less impact, residential areas and busy streets a greater impact. Public parks and golf courses, or streets with little traffic, can buffer many of these impacts.



Patches, stream corridors, and right-of-way linear corridors can be integrated into an ecologically functioning network

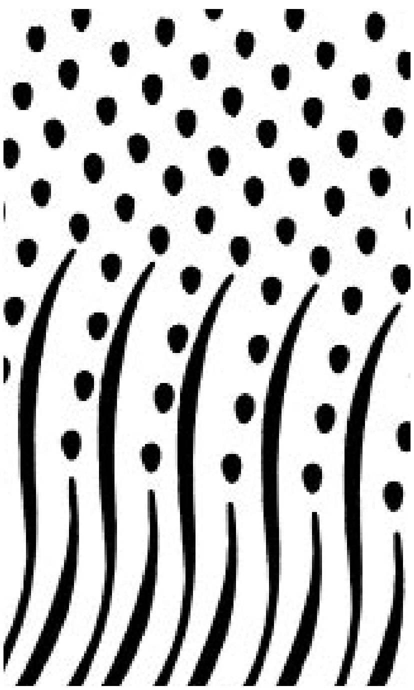
HABITAT NETWORKS

The system of habitat corridors and patches forms a habitat network.[1] In most Central Valley metropolitan areas, stream corridors are the foundation of this network and their riparian habitat provides a key biological function that is not found elsewhere in urban areas. Patches may be larger areas along the corridors, separate habitat areas adjacent to the stream corridors, or areas at a distance from the streams. They include fragments of the historic natural landscape, agricultural fields left behind as development spread out, and areas restored to provide habitat value.

Upland connections are another part of the network. Uplands are any land above the floodplain. Many of these connections can have a significant human use. Examples are a power line corridor, a greenbelt and possibly even a tree-lined street where the tree canopy provides a connection for some bird species.

The overall network should minimize isolation of habitat patches and include multiple examples of each habitat type indigenous to the area. Connectivity - joining patches with corridors and linking the habitat pattern to the rural landscape beyond the urban fringe - will greatly increase habitat values.

2.2 ECOTONES, EDGE EFFECTS AND BUFFERS



An ecotone represents a transitional area where two distinct communities interact.

ECOTONES

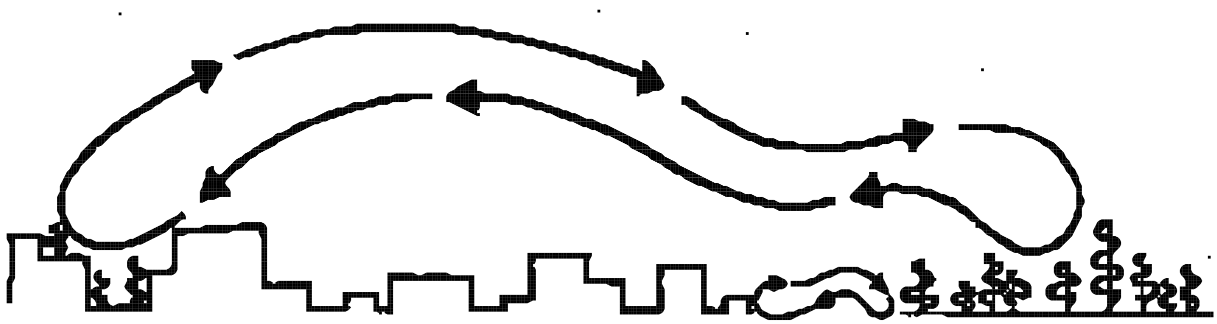
An Ecotone is the junction between two adjacent habitats or between a habitat area and the surrounding matrix. The ecotone is the site of flows of energy and materials between the two adjacent area.[1] It is more than the actual boundary line and includes some of the area on each side of the boundary - how much depends what activity or attribute you are considering. Ecotones have both positive and negative impacts on habitat areas.

EDGE EFFECTS

The condition of a habitat area is affected by various aspects of the adjacent urban matrix. These effects are called edge effects.[7] They are greatest right at the ecotone boundary line and diminish with distance away from this boundary. The distance that edge effects impact a habitat area depends on the vegetation type (e.g. narrower in dense woodland, wider in grassland) and the factor being measured (e.g. a particular bird species, pollution runoff, changes in the natural hydrology). There is relatively little quantitative data available regarding the impacts of edge effects. Narrow habitat areas, such as many stream corridors, are entirely edge. A habitat area will also impact the surrounding urban matrix, so edge effects occur in both directions. Edge effects can occur over significant distances.[7-9] Thus while previous research suggested that edge effects on forests did not extend for more than 150 meters, some recent studies show it is possible to find human-induced impacts extending for several kilometers .[7]

BUFFERS

The area next to the boundary acts as a buffer protecting the rest of the habitat area from edge effects. The optimal buffer width is different for different edge effects, and is often unknown.[10] And while buffers are



often part of the habitat area, ideally they are additional land just outside the habitat area, so as not to reduce the effective area of the natural habitat.

Edge effects can vary in scale and intensity. The above diagram depicts the possible ecotonal relationship between a cat (small arrows) and an urban-adaptable bird (large arrows)

EXAMPLES OF ECOTONES, EDGE EFFECTS, AND BUFFERS

The boundary between a wooded stream corridor and an adjacent urban village is an ecotone. Domestic cats present in the urban village will wander into the woods along the stream and kill birds and small mammals, and can have a major negative edge effect on the biological state of the stream corridor. Pollen from the trees along the stream will drift into the urban village and impact people with allergies. A region of dense blackberry bushes placed between the streamside woods and the urban village will block movement of cats and so act as a buffer.

Another example is stormwater runoff from streets and parking areas into an adjacent grassland patch, bringing pollution into the habitat area and possibly altering its hydrology. The presence of a drainage channel or a strip of vegetation placed outside the habitat patch and designed to catch this runoff is an effective pollution and hydrology buffer.

An ecotone is beneficial to species that utilize the habitat on both sides of the boundary. For example, red-shouldered hawks may nest in very tall trees in the urban matrix, and forage in a patch of grassland. Some bird species like to forage in the trees right at the edge of a woodland and so preferentially use the ecotone portion of a habitat area.

Ecotones occur at various scales. In this guide we are concerned with a small scale, the junction between habitat patches or corridors and the surrounding urban matrix. The larger junction between a metropolitan area and the surrounding rural land is also an ecotone, as is the junction between two major biological regions, such as a desert and wooded mountains.

IMPROVING ECOTONE QUALITY AND MINIMIZING ADVERSE EDGE EFFECTS

Edges can be hard or soft.[1] A hard edge is a sudden change between two habitat types (for example a road alongside a dense woodland). A soft edge is less abrupt (e.g. a belt of shrubs or an area with fewer trees between the road and the woodland). In general, soft edges reduce the negative impacts on edge affected species.

The negative impacts of the urban matrix vary with the particular situation, so planning suitable adjacent uses will reduce negative edge effects. For example, the level of cat predation in a woodland habitat will be lower if it is surrounded by business parks than if it surrounded by houses and gardens. Tree lined streets often provide a good buffer, as do agricultural lands.

In general, wider areas provide greater buffering. But this depends on the factor under consideration. For example, non-erosive vegetated buffers of 100 feet, or even less, will buffer a stream from most non-point source water pollution runoff.[5] Buffers to protect a wooded area from cats need greater width, while buffers to protect bird nests from cow-bird parasitism must be extremely wide. Our biological knowledge is usually too limited to determine buffer widths that will be most effective for a given situation. In the absence of specific knowledge a conservative approach, with wider rather than narrower buffers, is biologically preferable.

BIOLOGY AND SOCIO-POLITICAL CONSTRAINTS

Many corridors and linear habitat areas (for example a narrow stream corridor) are entirely edge for many species and ecological processes. In many ecosystems, edges are used by habitat generalists which are more adaptable to human presence. Rare and endangered species are often habitat specialists, less adapted to human presence and using edges less.

There are often severe socio-political constraints on the creation of effective buffers. Local land use conditions and general plans will restrict dimensions of habitat areas. For example, local plans and other land use needs may restrict the width of an urban stream corridor to 600' or even less. Also, there is often an unwillingness to provide buffer areas in addition to the natural areas.

2.3 HABITAT PLANNING FOR SPECIES NEEDS

Planning and design of urban natural areas usually proceeds from a habitat or ecosystem viewpoint. This approach is used partly because biologists lack specific information on the precise habitat requirements of many species and because the suitability for any particular species varies from area to area.

In some cases, however, it is both possible and desirable to plan an urban natural area for the needs of one or more species. This is usually the case when a rare or endangered species is either present in an area, or very likely to use it after habitat restoration, and there is sufficient information about that species' needs.

Planners need to consider a set of key points when planning a habitat area for a particular species. And it is critical that they involve local species experts in the planning process, since they are the individuals most likely to know what works for a particular species under particular local conditions.

UNDERSTANDING BASIC HABITAT AREA NEEDS

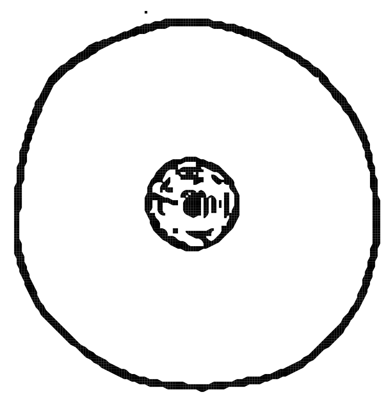
Any animal species has particular requirements for foraging, cover and breeding. There are also minimal requirements for supporting a population with long-term viability, although in almost all cases that is based on professional judgement rather than precise knowledge.

- Foraging habitat	Understand the type and structure of needed habitat, whether the species requires access to water, how far individuals move, how much habitat a likely population of individuals requires.
- Breeding habitat	Know of any particular habitat type, structure, condition or size required for nesting or denning.
- Cover	Understand whether the particular species has any cover needs that are different from foraging habitat.
- Seasonality	Know whether the species is a permanent resident or a visitor at a particular season.
-Competition	Knowledge of other species likely to use or share habitat and impact planning species.

UNDERSTANDING ECOLOGICAL AND HUMAN IMPACTS

Different species are impacted in different ways by particular ecological conditions or human activities. When designing a natural area for specific species, it is important to utilize known information about how habitat conditions, management practices and human activities affect the species. Discussions with both species experts and community ecologists will be very helpful.

- Human disturbance	Impacts of different types of human activity.
- Edge effects impacts	Impacts from various matrix conditions and extent of buffering needed.
- Biological issues	Impacts of, or interactions with, other species.
- Physical issues	Impacts of changing physical conditions such as hydrology on the species.



A twenty-five acre grassland patch will provide habitat for a burrowing owl colony with numbers no greater than six

DESIGNING FOR SPECIES - THE BURROWING OWL AS A CASE EXAMPLE

The burrowing owl provides a good example of designing for an individual species. It is a ground-dwelling bird found in grasslands, fallow field corners, and some weedy areas.[11] It is adaptable to disturbed land and to the proximity of human activity.[12] However it is also in severe decline across its California range with scientists concerned that the bird could be extirpated from California within 40 years.[13] In 1992, there was “a moderate but rapidly declining population of perhaps 770 pairs in the Central Valley.”[13] It is very feasible that the California burrowing owl will be listed under endangered species laws in the future. Because agricultural practices may be contributing to the bird’s Central Valley decline,[13] and because this species tolerates partially disturbed habitats in partially developed areas, conservation of burrowing owls in urbanizing areas is particularly important.

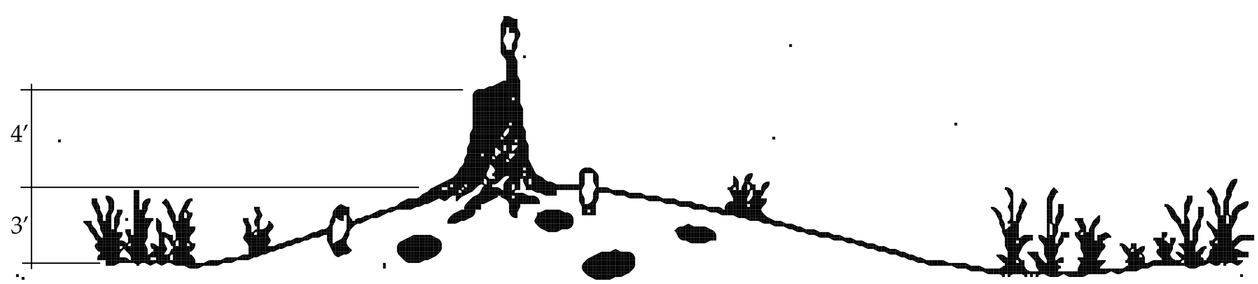
Providing foraging habitat

Burrowing owls forage for arthropods (insects and related invertebrates) and small mammals in grassy areas including pasture lands and fallow patches,[11] but not manicured turf such as lawns or golf courses. In the plains states, the nesting area around a burrow ranges from 7 to 14 acres, while the foraging area averages 500 acres.[11] The California Department of Fish and Game estimates a minimum of 6.3 acres for a pair of owls. But this assumes very high quality foraging habitat. Also, burrowing owls are colonial. We recommend a minimum of 25 acres for an urban grassland patch providing for burrowing owls, based on our best judgement. This should provide for at least two, possibly three, pairs of owls, as well as their young. Larger areas will provide for more substantial owl colonies, which will have a much better chance of long-term survival.

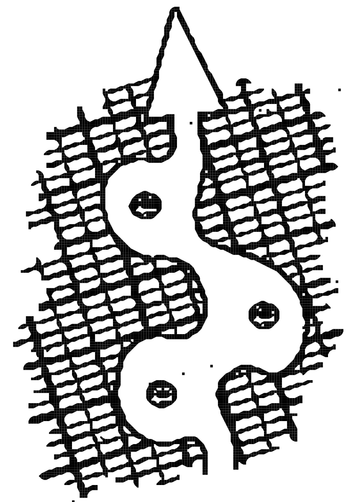
Providing cover and breeding area

The owls utilize abandoned ground squirrel holes for cover and breeding. They often stand at the entrance during the day. A small ground squirrel colony, which will have a number of interconnected burrows, will provide underground habitat for the two to three pairs of owls in a 25 acre habitat patch. In the plains states, burrowing owls stop breeding in sites where the ground squirrels (prairie dogs) are eliminated. Owls will also use artificial holes made with suitable piping. The Department of Fish and Game recommends five artificial holes per pair of owls.

A burrowing owl preserve should provide several nesting areas of about twenty feet in diameter that have abandoned ground squirrel holes and little or no vegetation. A post or tree stump allows a sentry owl to watch for predators



The burrows must not be flooded in the winter and many flat grassy areas do suffer occasional inundation. A small earth mound will raise the burrows above flood waters. An earthen berm can also provide this function. The ground needs to be fairly clear around the burrow entrances. A dead tree stump, post, or berm allows good visibility for a sentry owl.



Burrowing owls' grassland habitat patch should also be connected with an adequate sized corridor (approximately one-hundred feet wide) , or stepping stones of habitat patches, to enable genetic variability and sustainability with other populations

Reducing matrix impacts on owl habitat

The breeding success of burrowing owls in fragmented landscapes is often severely impacted by predation.[11] The urban matrix surrounding the grassy patch will impact the owls. It is best to avoid a residential neighborhood abutting the owl habitat, since pets will prey on the owls and people can be a disturbance. Commercial areas, college campuses and other public buildings make a very suitable land uses adjacent to the habitat patch.

Providing connectivity

Burrowing owls are unlikely to survive over the long term in habitat patches that become isolated by a large expanse of urban development. A habitat corridor, or at least stepping stones of habitat patches, extending to the large rural area beyond the city will increase the likelihood that young owls can disperse and there is occasional entry of owls from elsewhere, to maintain genetic viability and provide recolonization after local extinction (see *Corridors* in Section 2.1). A 100 foot wide grassy strip will provide a short corridor, while grassy areas along a railroad right of way make a suitable long (perhaps even several miles) corridor, especially if there are occasional habitat patches. There is not sound scientific information on burrowing owl corridor widths and lengths in urban areas, or how effective they will be for owl movement - this is our best judgement. Shorter corridors are always better.

2.4 SOME FACTORS AFFECTING THE BIOLOGICAL USEFULNESS OF HABITAT AREAS

A wide range of factors determine whether a natural area is suitable for a particular species. Here are some of the basic situations and ecological concepts regarding habitat conditions, size and context (see also *Corridors and Edge Effects* in Section 1).

PLANT COMMUNITIES AND FUNCTIONAL WILDLIFE HABITAT

In pre-European settlement times, the Central Valley possessed a number of different plant communities. Examples are blue oak woodland, cottonwood riparian forest, freshwater marsh and vernal pool grasslands. Many of these plant communities have been severely reduced in area and in habitat quality over the past 150 years (see end note [14] and Section 3.1).

Each plant community provides habitat for particular animal species. Animals use their habitat for foraging, breeding and for cover. An individual species may have different habitat needs for these different activities. For example, a robin nests in shrubs, but forages in grassy areas. Some species use multiple habitat types for foraging. Different species use different habitat types (for example, a chickadee forages and nests in shrubs and trees, while a grasshopper sparrow uses grasslands).

Plant communities constructed by humans, such as suburban gardens or golf courses, are very different to any of the original plant communities. These non-native communities do not provide the same wildlife habitat as the original native communities, and will not support many native species.[15] Even urban natural areas are often changed in species composition (loss of native species and appearance of exotic or non-native species).[16] Provision of plant communities that consist, as much as possible, of the native species originally found in that community type is important to providing for native wildlife species.

HABITAT CONDITIONS

Habitat conditions are also important. For example, simply providing woodland habitat will not guarantee that most woodland species will be present. Some species require tall trees that form a closed canopy, others require shrubs that form an understory below the trees. There are species that need significant amounts of dead branches and standing trees, and others which utilize the dead logs lying on the ground.

The species that utilize other habitat areas, such as wetlands and grasslands, also have a variety of requirements. As a rule of thumb, habitat areas with complex biological structures and varying physical conditions will provide for more species than areas with very simple and uniform structures. Plants also have specific needs, including soil type, moisture, and level of shading. Some plants have specific conditions for germination and development. For example, seeds of the cottonwood tree need clear fresh soil for germination, which is why they sprout up after a flood has cleared ground and deposited fresh sediment.[17] Shade loving under-story shrubs will not succeed in a woodland until the trees have developed a good canopy layer.

These above habitat structure needs underscore the importance of ongoing management of urban natural areas. Management is needed to maintain and improve habitat condition over time, and also to avoid deterioration caused by invading exotic plants and animals, vandalism and other impacts.

HABITAT CONTEXT

The landscape context of a protected area plays a critical role in determining its biological usefulness and the long-term viability of its native species and ecological processes. A thousand-acre grassland preserve surrounded by a much more extensive grassland landscape is part of a very large ecosystem. The preserve can provide for species requiring extensive areas of grassland habitat. Also, if preserve populations of animals with smaller area requirements are connected to additional populations beyond the preserve, they are unlikely to become extinct because of isolation effects. Habitat quality improves if there are no edge effects between the preserve and the surrounding landscape.

A thousand acre grassland preserve surrounded by extensive housing subdivisions and other types of urban development is in a completely different landscape context. It will be little used by species with large area requirements, or species that move through large grassland landscapes. Terrestrial species that will not travel across the urban matrix are now isolated from the larger grassland landscape and may become locally extinct over time. The historic assemblages of native species that once surrounded the natural area are now largely replaced by gardens and parks with non-native species and different three-dimensional structures. Domestic cats from the neighboring urban matrix roam through the natural areas and eat many small birds and rodents making it difficult to maintain populations of the native prey species.

PERSISTENCE OF NATIVE SPECIES OVER TIME

Even if an urban habitat patch possesses native species which are not adapted to the urban matrix, these species may not persist over time. Small populations that are separated from other populations of the same species can easily go extinct. For example, small isolated canyons in San Diego progressively lose chaparral dependent bird species over time.[18] If local extinction occurs, the habitat patch needs recolonizing. This will only occur if the habitat patch receives periodic individuals from other areas. Habitat corridors can provide that critical function.[19]

Larger urban habitat areas are more likely to retain their particular native species. Some species need a sufficient amount of habitat that is free of negative impacts from the neighboring urban matrix (see *Edge Effects* in Section 2.2). How far negative edge effects extend in the habitat area depends on the habitat type and the species under consideration.

Plants are also affected by the urban context. Patches of natural vegetation that have been in or close to urban environments for a long time tend to lose many of their historic native species and to gain many exotic (non-native) species. Two-well studied examples are vegetation patches on New York City's Staten Island and the Middlesex Fells forest reserve on the edge of the Boston, Massachusetts metro area .[16] This loss of native plant species over time also occurs in San Diego coastal sage scrub fragments.[20] But while the overall flora may change, individual native plant species, including some very rare plants, can continue to survive in urban habitat areas for long periods.[21]

Because of factors such as these, the biological benefits of urban habitat areas are usually somewhat limited. However, they can still play important roles for a number of species (see Section 3.1, *Central Valley Biological Issues*). And they have some very important secondary functions, and provide multiple benefits to society. For example, providing nearby nature for urban dwellers improves people's quality of life, increases their appreciation of nature and so helps to build support for

2.5 SIGNIFICANCE OF OUR KNOWLEDGE LIMITS

Our scientific knowledge about the needs of species and habitats and the functioning of ecosystems, and especially the impacts of adjacent urbanization, in the Central Valley is quite limited. Most of the research on crucial issues has been carried out in situations that are very different from Central Valley urban areas. Typical biological research sites are in large natural landscapes, far from urbanization. Any analysis that considers impacts of human caused landscape changes usually focuses on logging, creation of habitat islands in intensive agricultural areas, and similar natural resource issues.

Those studies that have examined urban or suburban habitat look at very different habitats and suites of species in the eastern and northwest US and the coastal sage scrub of southern California. Results are not necessarily applicable in another region, quite apart from changes in habitat type and the urban-rural divide. Thus red shouldered hawks avoid developed areas in New Jersey but use them in Southern California.[15]

And most of the existing studies have not examined the long-term effects of complete habitat alteration. Creation of clear-cut forest openings where trees grow back over a period of decades is a world apart from formation of urban habitat islands that will remain islands for many centuries.

Ideally, urban planners would like quantitative guidelines for natural areas and their surrounding landscapes, telling them what sizes and widths to use for patches, corridors and buffers, and what species they might expect to use these areas on a regular basis. That type of precise information is simply not available. In this work we provide some suggested minimum sizes and widths, but stress that these are very much rules of thumb and often based on what is doable in the current sociopolitical context.[4] Guidelines based on rigorous science, allowing delineation of urban habitat areas that have a high likelihood of providing for particular species, do not exist and we cannot create them from the current knowledge. And even if there was a body of relevant research, many factors are site specific and individual species dependent and generic rules of thumb would never be more than a rough guide.

2.6 TO WHAT EXTENT CAN URBAN HABITAT PROVIDE FOR WILDLIFE?

While our scientific knowledge is lacking, we can make some generalized statements about the likely value of some urban habitat areas in the Central Valley. The most significant biological role of urban village areas is that they can provide a great benefit to wildlife by reducing the footprint of urban and metropolitan development, so reducing the conversion of rural lands that are the most important wildlife habitat.

THE BIOLOGICAL NEED FOR LARGE AREAS OF AGRICULTURE AND NATURAL LANDS

It is easy but erroneous for urban dwellers to consider that a city provides for particular wildlife species because they have seen them in the city. The best comparison is a freeway rest area. Because we see people in a rest area, it does not follow that the rest area provides all the needs to sustain a population of people.

Urban habitat areas can never provide all the habitat needs for a species except for some species that have become completely urbanized (and are usually non-native) such as European house sparrows and starlings or are considered a nuisance such as crows. Our array of native species in California is primarily dependent on suitable habitat in the rural landscape. (At best, urban habitat areas will be a minor component of Valley-wide habitat, while providing very significant added value as they provide wildlife for nearby city-dwellers). Many of the statements in Section 2 and elsewhere lay out the arguments that urban habitat areas, which by definition are divorced from their historic rural context and are almost always small and relatively fragmented, provide some habitat value but only a small fraction of that found in the rural landscape. Section 2.4 explains some basic biological issues that limit the usefulness of urban natural areas. In addition, the acreage of habitat is far less in an urban area than in a similar sized rural area. So even if the value per acre were the same, the numbers of individuals that can be supported drops dramatically.

Exceptions to this general rule occur when a species is reduced to a very few populations and these are all in cities or developing areas. In that case there is no alternative to urban habitat patches. Existing examples in California include a manzanita species in the city of San Francisco and the El Segundo Blue butterfly next to Los Angeles International Airport. There is one species in the Central Valley which could suffer almost the same fate - the Sacramento Orcutt grass. Currently we only know of a few populations, almost all of them within the Sacramento County urban services boundary.

Two suites of species, and two individual species, can illustrate the need for very large rural landscapes.

The wintering waterfowl of the Pacific Flyway use very extensive wetlands, including natural marshes, managed wetlands such as duck clubs, and winter-flooded rice fields. In addition, the geese forage in dry fields. Finally the waterfowl utilize vernal pools in late winter, obtaining high protein food before the flight north.[22] Also, there are several hundred thousand shorebirds that winter in the Central Valley and use shallow waters and mudflats in similar habitats. Very extensive rural landscapes are necessary for provision of adequate habitat.

As discussed earlier, the Central Valley has over 90 percent of its riparian woodlands. This loss has resulted in the total disappearance of several once-common birds, like the least Bell's vireo, and the virtual elimination of several other species like the yellow-billed cuckoo. Currently biologists are devising a valley-wide recovery plan for riparian woodland, focused on 15 of these bird species. It involves restoration of extensive riparian woodland areas in rural settings, as is occurring in the Cosumnes River Preserve and along parts of the upper Sacramento River.

One individual species that demonstrates the need for large rural areas is the Swainson's hawk. Once common across much of California, it is now restricted to a few counties in the Central Valley, where it nests in large trees and forages in fields with row crops such as alfalfa. While a very few hawks nest in urban settings in Davis and north Stockton, the vast majority of hawks use scattered trees in the agricultural landscape and large trees along streams and sloughs.[23] Maintenance of the current population will require conservation of several hundred thousand acres of cropland with scattered large trees and riparian woodland along streams and sloughs. Recovery of the species will require a much larger area.

A second example is the tricolored blackbird, a California endemic whose population is declining rapidly (see Section 7.2 *Bird Lists*).[24] This bird nests in dense colonies in various sites up and down the Central Valley, foraging in pasture and other fields up to two miles from the nest. The important sites vary from year to year. Conservation of this species requires protection of large agricultural areas.

VALUES OF URBAN WILDLIFE AREAS

Natural history information tells us that a very large natural area in an urban setting, such as the American River corridor, provides for a wide variety of plants and animals. Much of this particular river corridor has been urbanized for a few decades (see Section 7.2 *Bird Lists*). So we may predict that species which are still present in such a large, heavily wooded river corridor have a good chance of persisting over a period of decades, and quite possibly centuries.

The usefulness of a smaller habitat patch, such as a 25 acre woodlot next to an urban village, or a 600 foot wide riparian corridor in a heavily developed setting, is debatable. As we discussed in section 2.4, a habitat area surrounded by more habitat or by farmland is in a completely different context to an area surrounded by urban development. In the latter case we may reasonably expect a much lower biological value.

Another complexity here is distance from the urban fringe (see *Habitat Context* in Section 2.4). And since Central Valley cities are growing rapidly, urban habitat areas' geographical context is changing over time. A wildlife pond at the urban fringe will attract a variety of bird species that use the nearby farmland landscape (see Section 7.2 *Bird Lists*). As the city grows, the distance from the pond to farmland increases. If, in fifty years time, there is a 3 mile width of urban development between the pond and continuous farmland, then it is highly likely that many of those initial bird species will no longer visit the pond.

One significant benefit that urban habitat areas, and also mature naturescaping, provide is stop-over habitat for migrating songbirds like the yellow rumped warbler. They stay a day or two, eating insects, and then fly on.

As we state on various pages, a system of wooded riparian corridors could have greater value than many other forms of urban habitat. This couples the fact that riparian areas are unusually species-rich with water quality improvements that stem from providing natural vegetation along streams. But as we state above, while urban riparian habitat is valuable, it in no way replaces the much greater need for large riparian woodland areas in rural settings. In addition, development of narrow riparian strips along the fields and sloughs of the rural valley would provide a very considerable biological benefit.

SACRAMENTO COUNTY THREATENED AND ENDANGERED SPECIES

Consideration of the 11 endangered, threatened animal species or animals of concern in Sacramento County demonstrates the relative values of urban and rural habitat. While several of these animals will make some use of urban habitat reserves, the vast majority of their conservation is, and will be, in rural areas. The two exceptions, for whom urban areas probably play a more important role, are the Cooper's hawk and the burrowing owl.

Vernal pool species ((1) Vernal pool fairy shrimp, (2) vernal pool tadpole shrimp, (3) California tiger salamander, (4) western spadefoot). Large urban preserves will provide some of the conservation requirements, but over 90 percent of the overall conservation will be in the rural landscape, especially in large preserves sized 5,000 to 15,000 acres or more. Tiger salamanders for example, are assumed to be only in the rural landscape.

(5) Valley elderberry longhorn beetle
Some conservation in urban riparian corridors, most in rural areas.

(6) Pond turtle
Stone Lakes National Wildlife Refuge and the Cosumnes River Preserve are the most likely sites for pond turtles.

(7) Giant garter snake
An urbanized creek may provide some habitat for juvenile giant garter snakes. But the important areas are rural slough systems, creeks, and rice fields.

(8) Cooper's hawk
This bird does use urban areas, including some established residential neighborhoods with large trees and many bushes.

(9) Tricolored blackbird
Pasture and other lands in the agricultural landscape. Some colonies in the urbanizing area will continue to be used for a while. However, the conservation goal is to not try and maintain these over the long term but rather to establish new colony sites in farmland areas.

(10)Burrowing owl
This is one of the few declining birds that will use disturbed developed landscapes. It is not clear, however, if urban burrowing owl patches will be viable over the very long term (that is hundreds of years).

(11) Salt marsh harvest mouse
A tidal marsh species from the Delta that is not found in developed areas.

2.7 NOTES

(1) See Forman T (1995) Land Mosaics: the Ecology of Landscapes and Regions, Cambridge University Press, for a thorough explanation of Landscape Ecology principles.

(2) Our understanding of the role of habitat patch size is based on analysis of various habitats in different locations. Much of the work focuses on the impacts of habitat fragmentation in deciduous forest in the eastern U.S., a variety of mid-west habitats, and European landscapes. See Andren H (1994) “Effects of Habitat Fragmentation on Birds and Mammals in Landscapes with Different Proportions of Suitable Habitat: a Review.” Oikos. 71:355-366, and Robinson SK, Brown JD and Hoover JP. (1997) “Effectiveness of Small Nature Preserves for Breeding Birds.” In: Conservation in Highly Fragmented Landscapes, Ed. Schwartz, MW . Chapman and Hall; and Wilcove DS, McLelland CH and Dobson AP (1986) “Habitat Fragmentation in the Temperate Zone.” In Conservation Biology: the Science of Scarcity and Diversity. Ed. Soule ME. Sinauer Associates Inc.
For California, there is an analysis of loss of bird species in fragmented coastal sage scrub patches in San Diego County. See Soule ME et.al. (1988) “Reconstructed Dynamics of Rapid Extinctions of Chaparral-requiring Birds in Urban Habitat Islands.” Conservation Biology. 2:75-92. For an analysis of plant species in San Diego County fragments, see Alberts, A.C. et.al. (1993) “Effects of Habitat Fragmentation on Native and Exotic Plants in Southern California Coastal Scrub.” In Keeley, JE (ed). Interface Between Ecology and Land Development in California. Southern California Academy of Sciences. A study of riparian birds in Santa Clara County shows that the richness of bird species increases with distance to buildings and bridges and width of riparian habitat. See Rottenborn SC. (1999). “Predicting the Impacts of Urbanization on Riparian Bird Communities.” Biological Conservation. 88:289-299.
For a thorough explanation of metapopulations, see McCollough, DR (ed) (1996) Metapopulations and Wildlife Conservation. Island Press

(3) For a discussion of connectivity and corridor issues, see pp 150-156 in Noss, RF and Cooperrider AY (1994) Saving Nature’s Legacy: Protecting and Restoring Biodiversity. Island Press; and Shafer, CL (1997) “Terrestrial Nature Reserve Design at the Urban/Rural Interface.” In: Conservation in Highly Fragmented Landscapes, Ed. Schwartz, MW. Chapman and Hall.

(4) There is little scientific data demonstrating the minimum sizes and widths needed for various Central Valley habitats to provide for different animal species, especially in an urban setting. This lack of knowledge covers both habitat patches and corridors. We have chosen minimum corridor widths for various situations based on our best judgement coupled with cases of local planning limitations. In the absence of specific knowledge, a conservative approach is essential, with the provision of the greatest width and size feasible.

There are many studies of this issue in other North American locations and in Europe, addressing both agricultural and urban habitats. For discussion, see Shafer, CL (1997) "Terrestrial Nature Reserve Design at the Urban/Rural Interface." In Conservation in Highly Fragmented Landscapes, Ed. MW Schwartz. Chapman and Hall. For discussion of the roles of small reserves , see Schwartz, MW and van Mantgem, PJ (1997) "The Value of Small Preserves in Chronically Fragmented Landscapes" in the same volume.

(5) The effectiveness of riparian buffer strips to protect water quality from run-off pollutants and trap sediments depends on the structure of the buffer and local conditions. For example, see Hill, AR (1996) "Nitrate Removal in Stream Riparian Zones." Journal of Environmental Quality. 25: 743-755; Schultz RC et.al. (1995). "Design and Placement of a Multi-species Riparian Buffer Strip System." Agroforestry Systems. 29:201-226; and Wirka J. (1998) "Natives and Nonpoint Source Pollution." Grasslands. 8:1-9.

The Natural Resource Conservation Service of the U.S. Department of Agriculture published riparian forest guidelines based on studies of eastern forest riparian areas. These studies recommend a buffer of at least 90 feet, with forested and grass components to protect water quality, see Welsch J. (1991) Riparian Forest Buffers: Function and Design for Protection and Enhancement of Water Resources. NA-PR-07-91. U.S. Forest Service, Radnor, PA.

(6) For information on historic and current riparian woodland in the Central Valley see Sands, A , ed. (1980) Riparian Forests in California : their Ecology and Conservation. Pub 4101.Agricultural Sciences Publications, University of California, Berkeley. CA.

(7) There is extensive research on edge effects on habitat areas, most of it relating to forests. See pp 197-203 of Noss, RF and Cooperrider, AY (1994) Saving Nature's Legacy: Protecting and Restoring Biodiversity. Island Press. For California situations and methodology for considering buffer widths, see Kelly PA and Rotenberry JT (1993) "Buffer Zones for Ecological Reserves in California: Replacing Guesswork with Science." In Keeley JE (ed). Interface Between Ecology and Land Development in California. Southern California Academy of Sciences. Recent research shows that certain edge effects can extend 10 kilometers into a forest. See Laurance, WF (2000) "Do edge effects occur over large spatial scales?" Trends in Ecology and Evolution 15:134-136.

(8) Cat predation on birds and small mammals is a special problem in urban and suburban areas. See for example, Crooks KR and Soule ME. (1999) " Mesopredator release and avifaunal extinctions in a fragmented system." Nature 400:563-566.

(9) Studies in the Netherlands show that busy highways have a significant negative impact on breeding bird populations, extending up to 800 meters in the case of grasslands. For roads with 50,000 to 60,000 vehi-

cles per day, densities of the most sensitive grassland birds are only 35 percent of the undisturbed level 500 meters from the road. For the most sensitive forest bird species, bird densities are 55 percent of the undisturbed level at 500 meters. See Reijnen, R. et. al. (1995) "The effects of car traffic on breeding bird populations in woodland. III. Reductions in density in proximity to main roads." Journal of Applied Ecology 32:187-202. And Reijnen, R, Foppen, R and Meeuwsen, H. (1996) "The effects of car traffic on breeding birds in Dutch agricultural grasslands. Biological Conservation. 75:255-260.

(10) Buffer zones are considered in discussions of edges effects and habitat fragmentation. See in particular Kelly, PA and Rotenberry, JT (1993) “Buffer Zones for Ecological Reserves in California: Replacing Guesswork with Science.” In Keeley, JE (ed). Interface Between Ecology and Land Development in California. Southern California Academy of Sciences.

(11) For a description of burrowing owl ecology in the Plains states, see Dechant, JA et.al. (1999) Effects of Management Practices on Grassland Birds: Burrowing Owl. Northern Prairie Wildlife Research Center, Jamestown, ND. Available on the Internet at *http://www.npwrc.usgs.gov/resource/literatr/grasbird/buow/buow.html*

(12) For an example of burrowing owls in an urbanized area, see Holmes B (1998) “City Planning for Owls.” National Wildlife October/November 1998 issue. For use of artificial burrows and problems of owl relocation, see Trulio, LA (1995) “Passive Relocation: a Method to Preserve Burrowing Owls on Disturbed Sites.” Journal of Field Ornithology. 66:99-106.

(13) DeSante, DF et.al. (1992) The First Annual Report from a Census of Burrowing Owls of California. Institute for Bird Populations. This contains both two years of surveys and discussion of longer-term trends and their implications.

(14) For general descriptions on Central Valley biological changes since 1850 see various chapters in Barbour, M.G and Major J, eds (1988) Terrestrial Vegetation of California. California Native Plant Society; Barbour M et.al. (1992) California’s Changing Landscapes: Diversity and Conservation of California Vegetation. California Native Plant Society; and pp 13-20 of Jensen, DB, Torn, MS and Hart J (1993) In our own Hands: a Strategy for Conserving California’s Biological Diversity. University of California Press. Note the notion that the grasslands which ring the Valley and extend into the foothills are comprised of perennial bunchgrass is dated. Now some botanists view the original (pre-Spanish period) grasslands as being perennial bunchgrasses only on damper sites, and native annual grasslands in many drier sites. See for example Blumer MA (1992) “Some Myths About California Grasslands and Grazers.” Fremontia 20:22-27. For changes in riparian woodlands, see several papers in Sands A , ed. (1980) Riparian Forests in California : their Ecology and Conservation. Pub 4101. Agricultural Sciences Publications, University of California, Berkeley. CA. For wet-

land losses, see Dahl TE (1990) Wetland Losses in the United States 1780's to 1980's U.S. Fish and Wildlife Service, U.S. Department of the Interior. For rivers, see Argent G, Ed. (1993) California Rivers, a Public Trust Report. California State Lands Commission.

(15) There are examples from other regions of how standard urban and suburban plant communities do not provide habitat for many of a region's animal species. For example, see Beissinger, SR and Osborne, DR (1982) "Effects of Urbanization on Avian Community Organization." Condor 84:75-83. Extrapolation of results from other regions, such as deciduous forests of the north-east does not hold in all cases. For example, the red-shouldered hawk is the raptor most sensitive to human disturbance in New Jersey (Bosakowski T and Smith DG (1997) "Distribution and Species Richness of a Forest Raptor Community in Relation to Urbanization." Journal of Raptor Research. 31: 26-33). In California, on the other hand, the red shouldered hawk now nests in heavily urbanized areas (Rottenborn SC (2000) "Nest-site Selection and Reproductive Success of Urban Red-shouldered hawks in Central California." Journal of Raptor Research 34:18-25). Analysis of bird species along an urbanizing gradient in Santa Clara County, historically an oak woodland area, shows that increasing urbanization leads to loss of increasing species of native birds. See Blair, RB (1996) "Land Use and Avian Species Diversity Along an Urban Gradient." Ecological Applications. 6: 506-519.

(16) Non-native species rarely provide the same biological functions as native species. In addition, many non-native plant species are very invasive because they lack the predators present in their original home. This is also the case with some animals, such as the Chinese mitten crab. See Cox GW (1999) Alien Species in North America and Hawaii. Island Press. For loss of native plant species over time, see reference [21].

(17) Scott, MJ, Auble, GT and Friedman, JM (1997) "Flood Dependency of Cottonwood Establishment Along the Missouri River, Montana, USA." Ecological Applications 7: 677-0690.

(18) See Soule, ME et.al. (1988) "Reconstructed Dynamics of Rapid Extinctions of Chaparral-requiring Birds in Urban Habitat Islands." Conservation Biology. 2:75- 92. For further discussion on this issue, see additional references in note (2).

(19) For discussion of this issue, see Shafer, CL (1997) "Terrestrial Nature Reserve Design at the Urban/Rural Interface." In: Conservation in Highly Fragmented Landscapes, Ed. Schwartz, MW. Chapman and Hall.

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(24) Beedy, T and Hamilton, B (1997) Tricolored Blackbird Status and Management Guidelines. California Department of Fish and Game.

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Ecological Planning and Urban Village Design

3.0 Urban Ecology in the Central Valley

3.1 Some Central Valley Biological Issues
3.2 Urban Form and Habitat in the Central Valley
3.3 Roles of Conservation at Different Scales
3.4 Public Access and Habitat Protection
3.5 Notes

The Central Valley has changed drastically since the beginning of European settlement in 1850, and will undergo much more change in the 21st Century. The historic changes make some urban habitat areas, particularly riparian corridors, especially valuable. At the same time, urban habitat planners must bear in mind issues of urban form and future change, since the geographic context of each urban wildlife area affects its biological usefulness. Habitat areas in the urban landscape can also provide for a variety of human needs, and improve the livability of urban areas.

3.1 SOME CENTRAL VALLEY BIOLOGICAL ISSUES

THE HISTORICAL VALLEY

The Central Valley looked completely different 150 years ago.[1,2] The Delta was a vast tule marsh, interlaced with a network of meandering rivers. Tulare Lake in the southern San Joaquin Valley was the largest lake west of the Mississippi.[3] Tule marsh surrounded this lake, occupied various basins, and bordered rivers in the southern Central Valley. In the winter, skies were blackened by millions of waterfowl.

Away from the Delta, wide riparian forests lined many major rivers. These dense forests, with cottonwoods, sycamores, vines and other plants, harbored a tremendous variety of birds and other animals.[2] Valley oak woodland stretched away from the riparian forest and slowly gave way to grasslands. A large valley oak savanna area extended across the eastern side of the Valley in Tulare and southern Fresno counties.

The grasslands formed vast expanses and included large areas dotted with vernal pools, whose seasonal water provided habitat for dozens of unique plant and animal species and high protein food for waterfowl and shorebirds. Elk, pronghorn antelope and grizzly bears abounded. In the foothills bordering the Valley, grasslands gave way to blue oak savanna and woodland.[2]

The very low rainfall of the southern San Joaquin Valley created desert conditions away from the rivers and lakes. Here large areas of alkali soils shaped the San Joaquin saltbush community in much of the Kern County valley floor, as well as smaller areas further north.

THE VALLEY TODAY

The Central Valley underwent a succession of changes after 1850. The riparian woodlands quickly succumbed to the ax to provide firewood as well as rich bottom-land for agriculture. Grazing, then dryland farming, utilized millions of acres. Levees built along rivers allowed conversion of rich bottom-lands to farming, while drainage projects obliterated many wetlands.[2,5]

Additional changes occurred in the twentieth century. Rivers were channelized and several flood bypasses constructed, producing artificial conditions and abolishing historic flood regimes that had nurtured riparian woodlands and marshes for thousands of years. Dry land farming gave way to irrigated agriculture in many areas. Construction of the Central Valley Project and the State water project, with their massive reservoirs and systems of canals, allowed great expansion of irrigated agriculture, including conversion of many vernal pool grassland areas.[2] Today the Valley is the most productive agricultural region on the planet.

THE VALLEY TOMORROW

The Valley continues to undergo rapid change. As the population grows, we are seeing the rapid development of large cities. Government forecasts (a doubling and even tripling of the Central Valley population[6] by 2040), coupled with continued reliance on low density development, suggest formation of vast metropolitan areas and obliteration of rural land unless we change overall development patterns.

There is a strong focus on conservation of irrigated farmland in the face of these urbanization pressures. However, this single issue focus often leads to the view that rangeland and remaining wildlife habitat are the best places for future urbanization. We need a truly integrated approach to growth, one that recognizes a variety of values and needs and which places strong emphasis on protection and restoration of ecosystem health and ecosystem functions, as well as conservation of the full variety of habitat types and native species.

BIOLOGICAL CONSEQUENCES OF POST SETTLEMENT CHANGE

The biological consequences of the past 150 years of changing land use are very severe. Over ninety percent of the riparian woodland and ninety five percent of historic marshlands are gone.[4] Tulare Lake has completely disappeared,[3] as have smaller lakes like American Lake in northern Sacramento County. Large areas of vernal pool grasslands, especially those of the low terraces, have disappeared.[5] Most rivers and streams are channelized shadows of their former selves.

The herds of elk and pronghorn antelope and the grizzly bear are gone, while waterfowl and shorebird populations are diminished. A suite of bird species that utilize riparian woodland has disappeared, except for tiny remnant populations of a few of the species. Grassland species are in decline. Even animals that can adapt to intensive agriculture have restricted ranges and severely reduced populations.[5]

ROLES OF NATURE IN URBAN AREAS

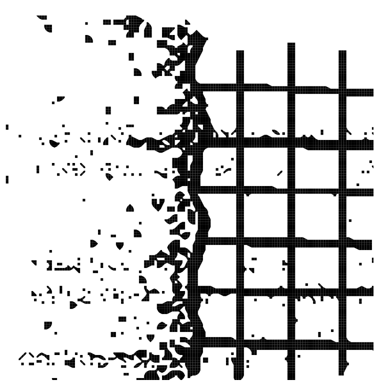
In Section 2.6 we explored the extent to which urban habitat areas can provide for wildlife in the Central Valley. We know that urban habitat areas can still provide for a variety of native plant communities, a number of animal species that require native habitats, and some ecosystem functions and processes, at least in the short to medium term.[7]

Riparian corridors along streams and rivers are especially valuable and should form the backbone of any urban natural system. Restoration of riparian vegetation can be successful, but native riparian vegetation depends on periodic flooding[8] and is limited to areas within levees for Central Valley urban areas. Patches of wetlands, grasslands and woodlands all provide useful habitat values.

In addition to habitat areas, Naturescaping of public green spaces and individual gardens can provide habitat for some wildlife. Naturescaping utilizes vegetation like tall trees, shrubs and large perennials to attract native birds, butterflies and other animals. It is especially helpful to migrating songbirds, which make brief stops to eat insects on trees and shrubs before flying on to their summer or winter territories.

The impact of urban natural areas on human populations is tremendously important. Natural habitat patches and corridors in urban areas ("nearby nature") improve quality of life, provide opportunities for education and nature appreciation and help build support for nature conservation at Valley-wide scales. Naturescaping makes urban village regions more attractive to people, and so reduces the pressure of urbanization on rural landscapes at the urban fringe. A recent survey in the Sacramento region suggests that many residents prefer "nearby nature" areas to urban parks.[9]

3.2 URBAN FORM AND HABITAT IN THE CENTRAL VALLEY



Minimize negative impacts by reducing indentation

There are many interactions between the form of urban areas and the usefulness of both natural areas and naturescaping as wildlife habitat. The issues include:

- the overall shape of a metro area;
- the pattern and connectivity of natural and greenspace areas across the developed landscape;
- the nature of development near the urban fringe;
- change over time as a city grows.

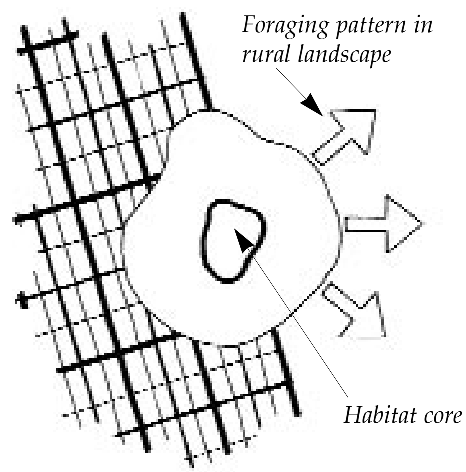
OVERALL SHAPE

The shape of urban areas varies from city to city and changes over time as metropolitan areas grow. The common feature of these shapes is that they do not involve much indentation, which would create fingers of rural lands extending into cities and fingers of urban land extending into the countryside. Indentations greatly increase the edge between rural habitat and the urban landscape, to the detriment of much wildlife that utilizes rural lands and not the urban areas[10] (and see Section 2.2). It is also noteworthy that minimizing indentation is helpful to agricultural operations, as it minimizes the zone of conflict between urban dwellers and farm operations.[11]

HABITAT PATTERN AND CONNECTIVITY

Habitat patches and corridors will be most beneficial to wildlife and native plants when they are fairly close to the urban edge. Once a habitat patch is highly isolated, with extensive urbanization between it and the rural edge, fewer species will use the patch and survive over the long term. The effect increases as the distance increases. Similarly, a narrow riparian corridor will be less beneficial to wildlife species when several miles into an urban area than close to the urban fringe. A very wide habitat corridor, such as the American River Parkway, has sufficient interior habitat protected from urban influences to provide major wildlife benefits for many miles into the urban region[12] (and see Section 2.1).

Establishing a connected pattern of habitat and naturescape areas throughout an urban area can provide significant biological value. In Central Valley cities, stream corridors usually trend in an east-west direction. The main exception is major rivers like the Feather at Marysville-Yuba City which flow along the Valley floor toward the Delta. Provision of wooded greenways that trend north-south will provide connections between wooded, east-west, stream corridors. These will aid dispersal of wildlife species that can utilize metropolitan areas that have significant naturescaping, whether in private gardens or public places.



Habitat patches that permit wildlife foraging in rural landscape near an urban area

DEVELOPMENT NEAR THE URBAN FRINGE

Development near the urban fringe will provide the most benefit to wildlife if it has extensive naturescaping, including large trees. It will then provide cover and nesting habitat for a number of bird species that utilize the surrounding rural landscapes for foraging.

URBAN FORM CHANGES OVER TIME

Central Valley cities are growing. Significant population growth is most likely for at least the next few decades. This creates a range of problems for wildlife.

Firstly, the growing metro areas are consuming valuable wildlife habitat utilized by species that cannot survive in an urban environment. Continuing this trend will cause major declines in a number of wildlife species. Actions that minimize the increase in the development footprint, such as creation of urban villages, will be immensely beneficial to natural systems.

Secondly, successful habitat patches and corridor segments which are currently close to the urban edge, will become more and more distant from the rural landscape as a city grows outward. So their wildlife value will diminish.

Thirdly, provision of nearby nature cityscapes near the rural fringe will be less beneficial if that fringe keeps moving outward. It takes several decades for shade trees to mature and reach a large size and even shrubby vegetation takes years to reach optimum size. The established naturescape areas are usually in older areas, such as the Land Park and Curtis Park neighborhoods in Sacramento. Urban fringe naturescaping is of less long-term value if, by the time the vegetation has matured, that neighborhood is now a long way from the urban fringe. In the absence of long-term urban boundaries, it may be possible to reduce the negative impacts of this changing relative position with an extensive network of riparian corridors and greenways.

3.3 ROLES OF CONSERVATION AT DIFFERENT SCALES

The conservation of land to protect biological diversity and ecological health occurs on a variety of scales, from the entire Central Valley, to large regions, to counties, to specific patches and corridors. It is important to consider the needs of all these scales and, for our purposes, the roles of urban habitat.

MULTI-SCALE ROLES OF URBAN CONSERVATION AREAS

Urban conservation areas have many important functions, despite their small size and surrounding developed matrix (see Section 4 for further details on specific habitats).

Riparian woodlands provide a critical habitat that has nearly vanished from the Central Valley.[4] Urban streamside woodlands, particularly when wide and nearer the urban fringe, provide for a wide variety of animals that are dependent on this habitat for all or part of their lifecycle.[3] As well as providing local conservation, they aid regional and Valley-wide conservation goals even though they have less biological value than a large riparian woodland in a rural area.

Streamside vegetation areas, whether woodland, grassland or wetland, improve water quality by reducing non-point source water pollution.[13]

Constructed wetlands and detention ponds doubling as wildlife areas provide ways to couple management of urban runoff with provision of useful wildlife habitat. Adoption of decentralized stormwater management systems will not only improve water quality, it will also provide a network of urban wetland/aquatic habitat patches that can add to the regional and Valley-wide benefits of rural wetlands.

Patches and corridors of native woodlands, and also naturescaping in gardens and public places, provide habitat for migrating songbirds and aid Valley-wide conservation needs.

Specialized vernal pool grassland preserves allow conservation of unique biological values present in some urbanizing Valley areas, and will be an important component of regional and Valley-wide vernal pool conservation.

REGIONAL SCALE AND THE ROLES OF RURAL LANDSCAPE

The conservation of thousands of acres of landscapes beyond developed metropolitan areas is essential for protecting biodiversity and ecological health. Conservation goals include long-term protection of functioning ecosystems, the full array of species and biological communities native to the region and also ecological processes and functions such as nutrient cycling and disturbance regimes.[14] This requires the conservation of large landscapes, such as now exist away from the metropolitan areas. While these large areas may include preserves, they will be mainly working landscapes, where various resource activities, such as grazing, continue on private lands protected from development.[15] Conserved landscapes with a matrix of habitat types, including grass, shrub, wood and farm lands, provide for the myriad interactions between species and habitats.

In the Central Valley, irrigated field crop lands provide a key part of the regional conservation mix. They have essential habitat of a variety of animal species.[16] Management of their network of streams and sloughs affects water quality and aquatic ecosystems at a Valley-wide scale. Wildlife-friendly farming techniques, including strips of riparian woodland alongside waterways, add tremendously to the wildlife value of cropland.

Regional conservation includes the protection of landscapes that are often undervalued by society. Wetlands, riparian woodlands and blue oak woodlands are all recognized for their biological importance. Society is now realizing the values of vernal pool grasslands. But other areas, including dry-looking grasslands, scrublands and areas of alkali soils, are undervalued even though very important and provide for their own array of species and ecological functions.[17] For example patches of alkali soils in the Central Valley provide habitat for unique plant species that require the high pH, while San Joaquin Valley grasslands and alkali scrub provide habitat for an array of endangered species.[18] Regional scale conservation must encompass any of these habitats that are present.

3.4 PUBLIC ACCESS AND HABITAT PROTECTION

Human access is a major issue with urban habitat areas. Biologists are concerned about the negative impacts of human access on species and the overall ecological condition. On the other hand, providing some access for people is very important. People need to be able to visit these areas in order to appreciate them and to obtain the quality of life benefits of nearby nature. Public familiarity with the urban habitats builds support for their protection and proper management, and also awareness of the importance of conserving wildlife areas across the Central Valley.

The solutions to this dilemma include designating portions of habitat areas for public access, creating viewing points and adjacent trails, and developing public education programs.

PUBLIC ACCESS AREAS

It is often possible to design a habitat area so humans have direct access to part of it without impacting other portions. For example, a vernal pool grassland preserve may have a public area at one edge, separated from the preserve by a fence. A riparian corridor may have foot trails going down to the stream at occasional points, chosen for their distance from particularly sensitive habitat areas. A few guided tours a year along a narrow trail that passes through a sensitive habitat area usually will have minimal negative impact on nature, while building support for conservation.

Viewing points and adjacent trails

Wetlands and detention basin wildlife areas are particularly suited to elevated viewing platforms, reached by a boardwalk that extends to the edge of the habitat patch. The viewing platform and boardwalk should be located at one side of the habitat area in order to reduce disturbance of wildlife by human visitors.

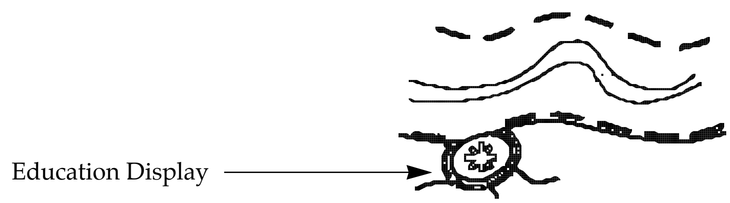
Foot trails may run along the edge of a riparian corridor or a habitat patch and provide opportunities for nature viewing. Wildlife near the trail might be disturbed by passing people so it is important to provide vegetative screening at any particular sensitive locations, such as nesting areas. Also levees and abandoned infrastructure rights of way also provide good trail opportunities.

Educational programs

There are several ways to couple urban habitat patches with educational programs. Educational displays at natural area viewing points and along trails provide explanations of likely wildlife and actions people should take to protect habitat and water quality. A few of the larger natural areas in a metropolitan region should have visitor centers, with displays and programs. The town center area of an urban village may also have a visitor center. Natural history programs at both the visitor centers and at meetings of various community groups provide many outreach opportunities. Guided walks, including walks organized by local Audubon Societies and other groups, are another important component.

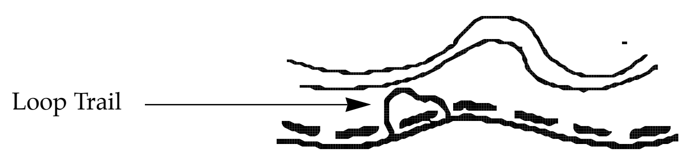
DEGREE OF PUBLIC ACCESS IMPACTS

Of the three illustrations, option 1 has the least habitat impact. The public trail is at the edge of the corridor and educational information is placed where trails intersect.



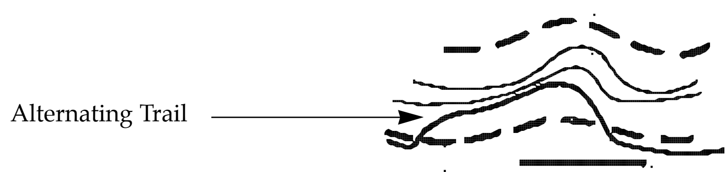
Minimum Impact on Riparian Corridor

Option 2 inserts a loop trail into the corridor. If the loop trail is located away from sensitive habitat areas, it should have minimum impacts.



Intermediate Impact on Riparian Corridor

In option 3, the trail alternates in and outside of the corridor. This system allows more human access, yet can impact habitat value.



Greater Impact on Riparian Corridor

3.5 NOTES

(1) Jose Maria Narvdez's 1830 map of California depicts much of the Central Valley floor, from near Sacramento to Bakersfield, as cienegas o tulares a vast seasonal wetland. See page 170 of Thelander, CG, ed. (1994) Life at the Edge: a Guide to California's Endangered Natural Resources. Biosystems Book.

(2) For an overview of the pre European settlement condition of the Central Valley, see pp 144-145 and 166-174 of Bakker, E. (1971) An Island Called California: an Ecological Introduction to its Natural Communities. University of California Press.

(3) Kirk "A Vanished Lake, Vanished Landscape." In: Thelander, CG, ed. (1994. Life at the Edge: a Guide to California's Endangered Natural Resources. Biosystems Book.

(4) "Based on historical accounts, it has been estimated that there were about 775,000 acres of riparian woodlands in 1848-1850. Dairies and filed notes written in the early 1800's describe the extent of the forests. They also describe the lush jungles of oak, sycamore, ash, willow, walnut, alder, poplar and wild grape which comprised almost impenetrable walls of vegetation of both sides of all the major valley rivers and their tributaries. Notes were made of giant sycamores 75 to 100 feet tall and of oaks 27 feet in circumference." Smith, F. (1980) "A Short Review of the Status of Riparian Forests in California." In: Sands A., ed. Riparian Forests of California: their Ecology and Conservation. Division of Agricultural Sciences, University of California. See also Roberts, WG, Howe, JG and Major, J. "A Survey of Riparian Forest Fauna and Flora in California" in the same volume.

(5) See articles in (2) above and also Sliding Toward Extinction: the State of California's Natural Heritage (1987) Jones the Stokes Associates for the California Senate Committee on Natural Resources and Wildlife; and Griggs T (1992) "The Remaining Biological Diversity of the San Joaquin Valley, California." In Williams, DF, Byrne S and Rado, TA, eds. Endangered and Sensitive Species of the San Joaquin Valley, California : Their Biology, Management and Conservation. California Energy Commission.

(6) M. Heim. (1998) State of California, Department of Finance, County Population Projections with Age, Sex and Race/Ethnic Detail. Demographic Research Unit, California Department of Finance.

(7) For example, see Germaine, SS, Rosenstock, SS, Schweinsburg, RE and Richardson, WS (1998) "Relationships Among Breeding Birds, Habitat and Residential Development in Greater Tucson, Arizona." Ecological Applications 8: 680-691. They stress the importance of protecting native vegetation in riparian areas. Other specific recommendations apply to bird species not present in the Central Valley. Gotfryd, A and Hansell, RIC (1986) [Prediction of Bird-Community Metrics in Urban Woodlots. In: Verner J. Morrison, ML and Ralph, CJ (1986) Wildlife 2000: Modeling Habitat Relationships of Terrestrial Vertebrates.

University of Wisconsin Press] provide specific recommendations for woodlots in Toronto, Canada. However, once again the species and habitat are different to those in the Central Valley. We do know that many Central California valley bird species are sensitive to proximity of human development - see Rottenborn, SC (1999) "Predicting the Impacts of Urbanization on Riparian Bird Communities." Biological Conservation. 88: 289-299. Some Central California species survive in developed areas, at least over a period of decades. See for example, Blair, RB (1996). "Land Use and Avian Species Diversity Along an Urban Gradient." Ecological Applications. 6:506-519.

(8) Friedman, JM, Scott, ML and Lewis, WM. (1995)" Restoration of Riparian Forest Using Irrigation, Artificial Disturbances, and Natural Seedfall." Environmental Management. 19: 547-557.

(9) Fleming, R and Weiss, C. Living in the Region : "Survey of Residents' Treasured Places" (1998). Sustainable Communities Consortium, University of California, Davis.

(10) See pp 197-203 of Noss, RF and Cooperrider, AY (1994). Saving Nature's Legacy: Protecting and Restoring Biodiversity, Island Press.

(11) Handel, ME (1999) "Conflict on the Urban Fringe" In Medvitz, AG , Sokolow, AD and Lemp, C (eds). California Farmland and Urban Pressures: Statewide and Regional Perspectives. Agricultural Issues Center, University of California.

(12) For issues of habitat fragmentation and small isolated patches, see Andren, H. (1994) "Effects of Habitat Fragmentation on Birds and Mammals in Landscapes with Different Proportions of Suitable Habitat : a Review." Oikos. 71:355-366. For a California example, see Soule ME et.al. (1988) "Reconstructed Dynamics of Rapid Extinctions of Chaparral-requiring Birds in Urban Habitat Islands." Conservation Biology. 2: 75-92.

(13) See, for example: Welsch, J. (1991) Riparian Forest Buffers: Function and Design for Protection and Enhancement of Water Resources. NA-PR-07-91. U.S. Forest Service, Radnor, PA.

(14) Costanza, R, Norton, BG and Haskell, BD (eds). (1992). Ecosystem Health : New Goals for Environmental Management. Island Press. Noss RF (1990) "Indicators for Monitoring Biodiversity : a Hierarchical Approach." Conservation Biology 4: 355-364.

(15) Hopkins, JD and Britting S (2000) "Conserving Wildlife Habitat in the Sierra Nevada Foothills: an Example of Conservation Strategies for Rural Landscapes." Linkages. 9 :8-10.

(16)Various breeding and wintering raptors forage in row crop fields. See for example, Estep, JA. (1989) Biology, Movement and Habitat Relationships of the Swainson's Hawk in the Central Valley of California, 1986-1987. California Department of Fish and Game,

Sacramento, CA. Rice fields provide most of the habitat for wintering shorebirds. Shuford, WD, GW Page and JE Kjelmyr (1998) "Patterns and Dynamics of Shorebird use of California's Central Valley" (1998) The Condor. 100: 227-244. They also provide key waterfowl habitat. See: Elpick, CS and LW Oring. 1998. "Winter Management of California Rice fields for Waterbirds." Journal of Applied Ecology. 35: 95-108. Certain agricultural practices can provide very signifcant habitat for certain animal species. See Clark, J and Rollins, G. (1996) Farming for Wildlife: Voluntary Practices for Attracting Wildlife to Your Farm. California Department of Fish and Game, Sacramento, CA.

(17) The California Department of Fish and Game's Wildlife Habitat Relations (WHR) System provides information about which species might occur in which habitat. A GIS system allows sorting of data by county and habitat type and provides additional information. A set of books provides information on the different habitat types and on the distribution of mammals, birds reptiles and amphibians. For further information see the WHR Web site, *www.dfg.ca.gov/whdab/cwhr/whrintro.html*

(18) For example, see U.S. Fish and Wildlife Service. (1998) Recovery Plan for Upland Species of the San Joaquin Valley, California.

Ecological Planning and Urban Village Design

4.0 Natural Systems and Urban Village Relationships

4.1 Riparian Corridors
4.2 Biological Benefits of Riparian Corridors
4.3 Stormwater Detention Basins as Wildlife Areas
4.4 Wetland Patches
4.5 Vernal Pool Grasslands
4.6 Woodland Patches
4.7 Notes

In this chapter we provide design guidelines for a variety of basic habitat types suited to Central Valley cities, while emphasizing that scientific uncertainties prevent the application of very specific and rigid prescriptions. Individual urban habitat area sizes are often determined by the amount of land that society is willing to set aside as a natural landscape. From a biological standpoint, more is better, especially in the light of the scientific uncertainties. The added benefits that the natural areas provide to society, including wildlife ponds doubling as detention basins and increased flood protection from conservation of riparian corridors, help to build the case for protecting more sizable urban habitat areas.

4.1 RIPARIAN CORRIDORS

DEFINITION OF RIPARIAN CORRIDORS

A riparian corridor is a stream or river corridor with natural vegetation on each side that passes close to an urban village. The vegetation is often riparian woodland, but there are grassland and wetland areas under certain circumstances (see Section 4.2). There are three levels of waterway: river, major stream and minor stream.

Examples of riparian corridors

The American River Parkway in Sacramento provides the premier Central Valley example of a major urban river corridor. It has extensive woodland vegetation and a wide corridor approaching a mile wide in places. The river's course is close to some areas with commercial and high-density residential development.

Two good examples of major urban stream corridors are Laguna Creek in Elk Grove, which flows through a rapidly urbanizing area and includes wetlands and riparian woodlands, and Big Chico Creek on the east side of the city of Chico which is bordered by valley oak woodland.

URBAN VILLAGE CONTEXT

Riparian corridors can co-exist with nearby urban villages under certain conditions. They bring a variety of benefits to the highly urbanized setting.

CDPS focus groups conducted in 1999 on urban village design demonstrated interest in having a nearby stream or river. Waterways with mature woodlands along their banks appear highly popular in the Central Valley. With some public access to the corridor, they provide a nearby nature element that improves the quality of life of an urban village. They also provide the educational benefits of access to rare Central Valley habitats, plant and animal species.

Use of a natural setting along a stream, with any levees set back, provides a more effective way to bring flood control to the urban village region than construction of a narrow channelized corridor.

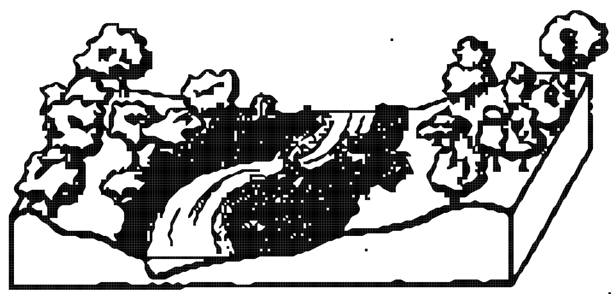
CORRIDOR WIDTH DESIGN GUIDELINES

The biological, flood control and aesthetic benefits require substantial corridors for streams and rivers flowing through urban areas. The ecological ideal for rivers is an extensive riparian corridor at least a half mile wide, and which includes some uplands that lie above the historic 100 year floodplain[1,2] and also upland areas that provide additional habitat types, as well as dryland refugia during flood events. This is only seen in a few instances, such as some sections of the American River Parkway. Here a wide riparian woodland provides habitat for a

Major river corridor
1500′ minimum

great variety of bird and terrestrial vertebrate species that require wide woodlands and distance from development. Nearly all of the corridor is a flood plain lying within set-back levees and so it assists with flood control. An extensive trail system, with multiple access points from the surrounding urban matrix, including river access points, provides many recreational opportunities. Because of the large scale of the Parkway, this public access only has limited negative biological impacts, except where artificial areas such as a golf course replace native habitat.

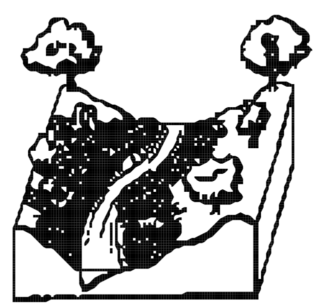
For major streams a corridor width of 600 to 1000 feet, with occasional wider natural areas, should provide for significant biological functions. This corridor width will allow riparian woodland width of at least 250 feet on each side of the stream. Such a width will provide for some animals that are not adapted to highly urbanized settings, providing these species can reach the area from the rural landscape[3] (see Section 2.1). It will also reduce the negative impacts of noise and lights on the stream side of the woodland. Inclusion of some upland areas above the 100 year flood in some locations, to a width of at least 200 feet, will provide additional benefits (see Sections 4.2 and 2.2 and also the Caution[4]).



Major stream corridor
600′ - 1000′ minimum

The corridor should include at least the entire 100 year floodplain whenever feasible, with any levees set back to the edge of the floodplain. An upland corridor adjacent to this riparian corridor provides a great increase in biological value, as well as a buffer for the riparian area.

The stream should follow its natural course, with both bottom and sides unmodified. Channelized streams,[5] which are common in Central Valley cities, suffer from severe loss of biological functions and are also aesthetically unappealing to people.[6]



Minor stream corridor
200′ minimum

Many minor streams flow only during the wet periods in the Central Valley, unless they receive the runoff from summer irrigation. In the past these streams were often converted into artificial drainage ditches. But it is often possible to provide at least a narrow buffer with a strip of natural habitat for these intermittent urban streams. A buffer of a 100 feet of vegetated land on each side of the waterway is usually sufficient to protect surface water quality from most non-point source water pollution.[7] This buffer zone can provide attractive vegetation that improves the quality of life for urban residents.

URBAN VILLAGE DESIGN GUIDELINES

Stream corridors may pass close to urban villages. Wherever possible they should not flow through such high density, intense use areas. There should be buffers between the corridor and urban village mixed use development or residential neighborhoods. These types of development result in decreased biological benefits because of bird and small mammal predation by cats and because of traffic noise impacts on the avian community.

It is important to avoid bordering the riparian corridor by streets with high traffic levels. The noise from these streets will have a negative impact on breeding birds, while the air pollution will have widespread negative ecological effects.

Placement of passive recreation park areas alongside the riparian corridor (including golf courses) will provide a buffer with many fewer negative impacts. Providing a significant canopy cover with large trees in the park areas will provide added habitat for some bird species using the riparian corridor. Business parks may also make a buffer along the riparian corridor, as they do not have high noise or pollution levels, pets, or intense human activity. An urban farm area utilizing organic agriculture is another example of a possible buffer.

INFRASTRUCTURE CORRIDORS

Roads, railroads, and pipelines repeatedly cross an urban stream but intrusiveness to habitat can be mitigated in various ways. All bridges should span the riparian vegetation areas and any adjacent natural uplands as well as the main flow channel. If bridges only span the stream or river they form a block to terrestrial animal movement, and also impede floodwater flows through the riparian area.

FLOOD CONTROL

Urban development of a stream's watershed greatly increases runoff during storms because of the large increase in the impervious surface.[5] In addition, tradition urban stormwater management focuses on removing storm water from developed areas as quickly as possible. Central Valley communities often use local streams to convey storm water run off, rather than building a stormwater sewer system.

As a result, the urban increase in flood flows is dramatic. A flood that might have occurred once during the year's rainy season will now occur several times. Flood waters can cause severe stream bank erosion and degrade the riparian woodlands. This is in contrast to flood events in rural areas, whose occasional destruction of riparian woodland segments is beneficial (see Section 4.2).

There are several remedies to minimize damage from urban runoff. Low impact development design strategies reduce the amount of runoff by lowering the extent of impervious surfaces, focus on maintaining the natural hydrologic regime, and provide decentralized filtering systems to improve water quality.[8] These techniques also remove pollutants from the runoff.

A second remedy is to built stormwater detention basins. Since these can double as wildlife areas they can have multiple benefits (see Section 4.3). However they do not remove pollutants from runoff. It is important that stormwater pass through decentralized filtering systems before entering streams and detention basins, or channel the first 1/2" of rain through a primary treatment system.

A less desirable approach, which is sometimes necessary, is to widen the stream, developing a summer low-flow channel with the riparian vegetation and a winter runoff channel for excess storm waters. Now those flood waters that do go through the riparian area will be less damaging. Banks can be reinforced where necessary. Even rip-rap, material placed along banks to prevent erosion, can be designed to include trees growing between boulders, as recently done for a segment of the American River Parkway.

Flood control design of the stream corridor should also avoid steep slopes within the natural areas. For example, any uplands with natural vegetation should be connected to the riparian area by gentle slopes (see Section 4.2).

COMMUNITY / HUMAN DESIGN NEEDS

Public access provides great community benefits. Urban village residents will be able to walk to a portion of the stream corridor that is a 1/2 mile from urban village mixed use development and high density residential areas, and bicycle in ten minutes if the distance is less than two miles. There should also be one or more transit lines connecting the urban village to access points along the riparian corridor.

The design for human access to the riparian corridor is important, since unrestricted access will have severe biological impacts. Indeed managers of urban natural areas routinely fence off people. The best compromise is to have foot and bike trails along the edge of the corridor, with occasional small trails that loop into the riparian woodland and access the stream itself (see Section 3.4). These small loop trails should be in less biologically sensitive areas.

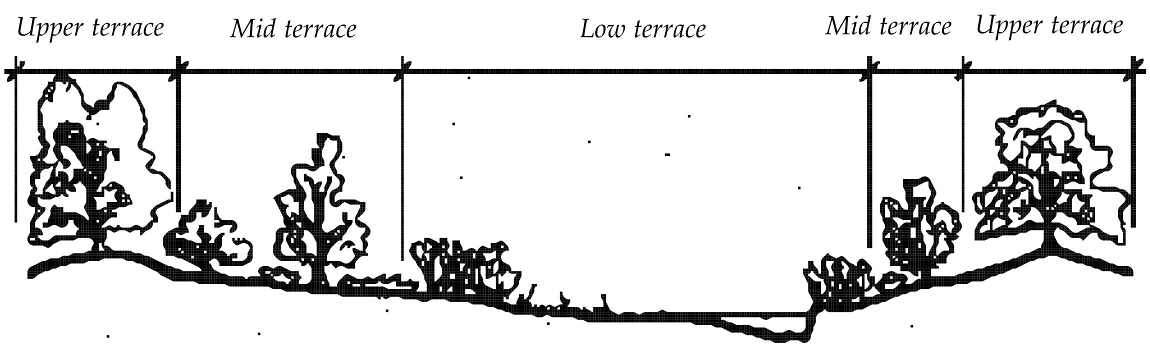
It is important to maximize the educational benefits of the riparian corridor. Actions include interpretive signs along the corridor trails and at corridor access points, one or more visitor centers, and an educational outreach program within the urban village.

A stewardship program for urban village residents will increase understanding and support of the corridor's natural landscape and provide assistance for clean up, tree planting, biological monitoring and some oversight of human use of the corridor.

Placement of a school beside or close to the riparian corridor will aid development of school science projects. These projects educate children about the natural history of the riparian areas and flood control issues. They can also provide an effective long term monitoring program for water quality and the ecological health of the waterway and the riparian community. Trails alongside riparian corridors provide bicycle and walking routes to and from school.

4.2 RIPARIAN CORRIDOR BIOLOGICAL CHARACTERISTICS

Riparian Corridor Sub-Sections



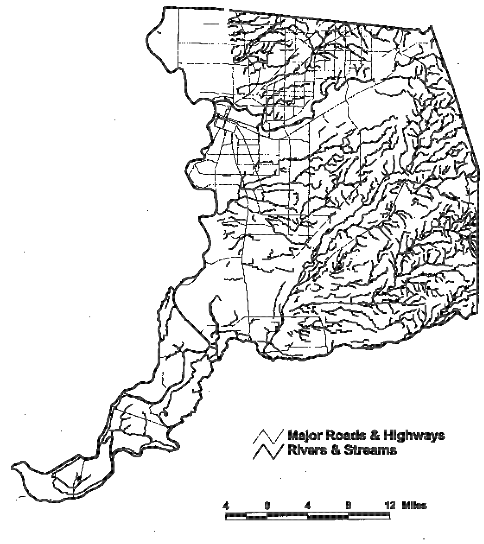
CRITICAL ELEMENTS

There are several key biological elements to a riparian corridor in an urban area. A natural stream or river is a highly productive aquatic ecosystem, with a wide variety of features as conditions change along the waterway's length (e.g. riffles, pools, areas with gravel bottom).[1] The impacts of urban stream segments extend great distances, including influencing water quality downstream to the ocean and the ability of streams to serve as corridors for salmonid fish.[6]

The area adjacent to the stream possesses riparian vegetation, which is dependent on a high water table.[1] Cottonwood-dominated riparian woodlands are particularly important, because the Central Valley has lost 90% of this rich ecosystem that provides habitat for a wide variety of plants and animals.[2] Valley oaks usually grow further from the stream, forming a more open woodland and grading into uplands (lands above the 100 year floodplain).

Seasonal (dry in summer) and perennial wetlands with tule reeds and similar vegetation along the stream corridor provide habitat for a different array of plants and animals. The historic loss of 95percent of Central Valley wetlands[9] increases the importance of wetland patches along urban stream corridors.

In some areas the historic natural streamside vegetation was grassland. This condition occurs where soil conditions are not suitable for trees, as with the hardpans of vernal pool grasslands, or where conditions were too arid, as in parts of the southern San Joaquin Valley.



Sacramento County rivers and streams

PLANNING FOR BIOLOGICAL BENEFITS

Woodlands are the preferred riparian vegetation along urban stream segments and should be maintained or restored wherever possible. The urban riparian corridor is especially valuable for those animal species which are averse to buildings, roads and intense human activity, and require native plants and natural vegetative structure. These are rarely found in the urban garden or small nearby nature areas. But because they are disturbed by human structures and activities, these species require wide riparian corridors.[3] A wooded corridor 600 feet in width should provide for a variety of animal species, although it will not be sufficient for all native species (see Caution in note 4 and Section 4.1 for width issues).

Various structural elements will increase the diversity of species and the health of the riparian ecosystem. The presence of dead trees (snags) or limbs will help cavity nesters, while dead wood, including downed logs, and leaf litter are essential to biological function and provide food and cover for more species. Understory plants such as shrubs will increase the biological complexity, providing habitat for yet more animal species.[6]

The California prairie grasslands, blue oak savanna or blue oak woodland make feasible adjacent uplands in some areas, as do valley oaks if there is a high water table. These uplands will provide for additional species.[10] They also provide a multi-habitat mosaic that is necessary for some species. For example, the giant garter snake hunts in dense wetland vegetation. It uses rodent holes and crevices in grassy upland areas as refuges from winter floods and from summer heat. Grassy areas grading away from wetlands, with no steep slopes and with holes or crevices, provide important refugia habitat for the giant garter snake.

Riparian corridors also provide for movement of animals through urbanized areas (see Section 2.1, Habitat Corridors). In order to do this they must provide a continuous ribbon of vegetation suitable for the particular species. Placement of bridges is critical, as they should not form a block across the riparian vegetation.

ROLE OF FLOODING

Retention of the natural 100 year floodplain, with set-back of any levees, provides great biological value. Periodic flooding provides vital ecological functions, providing it is not increased substantially above the pre-development levels of the watershed (see Section 4.1, *Riparian Corridors and Urban Villages and Habitat Conditions* in Section 2.4). This flooding is necessary for germination and establishment of some plant species. For example, cottonwood seeds germinate and establish themselves in clear areas of freshly deposited sediment.[11] This occurred in the Cosumnes River preserve after a levee break, creating a healthy young cottonwood forest. In addition, flooding provides fresh soil and nutrients and, by removing some plants, helps to create a diverse vegetative structure.

Restoration projects can mimic some of these elements. For example by planting groves of single tree species at intervals of time (such as 10 years) helps provide structural diversity.

4.3 STORMWATER DETENTION BASINS AS WILDLIFE AREAS

DEFINITION OF BASINS

Stormwater detention basins in urban areas may be specifically designed to double as wildlife areas, especially for a variety of riparian and wetland species. These may be free-standing ponds in a development that are linked to a local stream system by a ditch and whose flood control purpose is to hold stormwater runoff from a small area. Or they may be ponds located along a stream, to accommodate the increased runoff from an urbanizing watershed.

Examples

There are two excellent examples in the City of Davis: the west Davis and north Davis ponds. These have a wide variety of wildlife habitat features and year-round management of water levels to ensure optimum wildlife habitat while still retaining flood control capacity.[12]

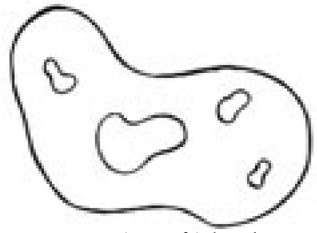
URBAN VILLAGE CONTEXT

Management of stormwater runoff is essential in the Central Valley. Urbanization usually increases runoff dramatically, because of an increase in the impervious surface.[5] The traditional detention basin is simply a large hole in the ground, with bare dirt for its bottom and sides. This is aesthetically most unappealing, has negative impacts on surrounding land use, and may decrease property values.

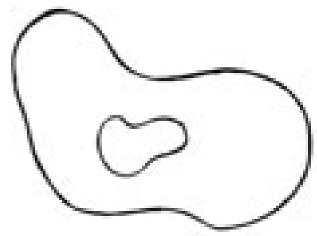
Design of detention basins to double as wildlife areas provides a dramatic change. The vegetation, small islands, and year round ponds are visually pleasing. The areas are usually rich in wildlife, especially when closer to the urban fringe or a wide wildlife corridor, and are likely to attract visits by a variety of ducks, shorebirds, songbirds and hawks (see Section 7.2 *Bird Lists*). Ponds that include viewing areas and trails provide many opportunities for urban village residents to view wildlife and pleasing habitat. They greatly increase local quality of life and provide a wealth of educational opportunities. They provide major benefits for surrounding land use. Also, as aesthetically pleasing open space, they may also increase adjacent property values.[13]

Mudflats and shallows water areas

DETENTION BASIN DESIGN GUIDELINES

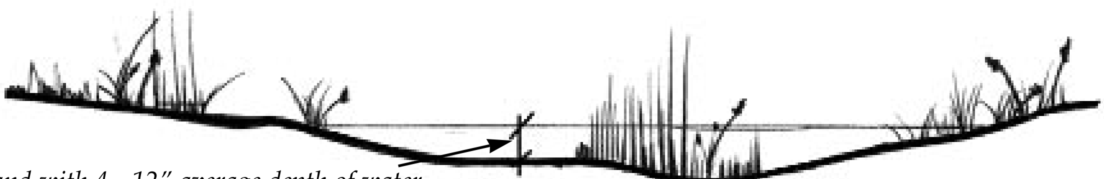


Top view of islands in summer



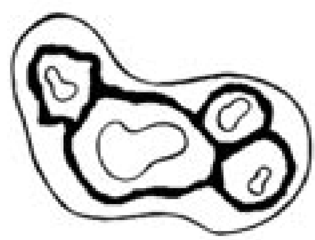
Top view of islands in winter

Design for wildlife habitat requires provision of a number of physical and vegetation features and provision of year-round water level control.[12] This is very different to the simple digging of a stormwater detention basin. It requires significant expertise in design of wetland habitats



Wetland with 4 - 12" average depth of water

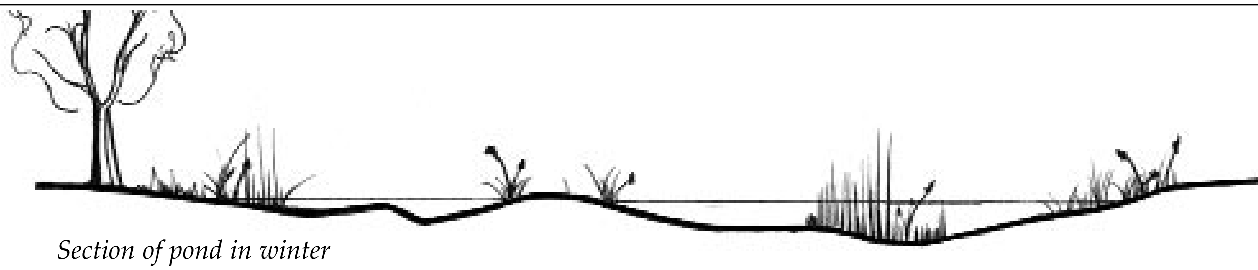
and attention to local physical, climatic and biological conditions. It is also more costly.[12] However there are so many benefits to people and the local community as well as to nature that these costs are well worth while. Here are the key design features, based on the experience of the 31 acre west Davis pond.[12]



Top view of islands with channel

- *Mudflats that are exposed during the spring water draw down*. They provide food for a variety of invertebrate-eating shorebirds, including colorful avocets and black-necked stilts.

Section of pond in summer



Section of pond in winter

- *Small islands that are surrounded by water in the summer and periodically flooded during the winter*. These include low islands that have grassy habitat and taller islands which have riparian trees, including cottonwoods, willow and box elder. The low islands will be inundated during much of the winter season, the taller islands only during exceptional flood periods.

- *Wetland habitat areas with* cattails, bulrushes and other plants provide habitat for a wide variety of wetland species.

- *Year round water areas.* These include channels between the islands which contain shallow (two to three foot depth) water during the summer. This water protects the islands from cats and other terrestrial predators and also provides habitat for aquatic invertebrates, fish and amphibians. In addition, pothole areas, which have summer water depths of three to five feet, help provide effective habitat for mosquito fish, other fish and a range of aquatic invertebrates from crayfish to insects.

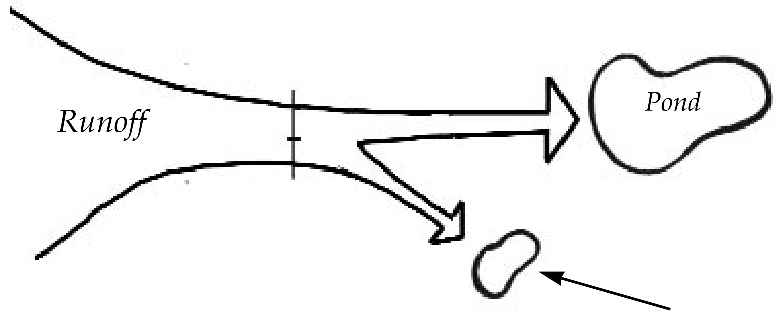
- *Larger winter ponds* that cover the mudflats and small islands. These provide habitat for wintering waterfowl and prevent growth of noxious weeds on the mudflats and low islands.

- *Grassy slopes away from the pond.* These areas lie above the standard winter water level and extend up to the edge of the detention basin area, above the 100 year flood level. Plantings of native perennial grasses and a scattering of native shrubs provide a rich variety of grassland habitat for birds and small terrestrial vertebrates.

- *Vegetation considerations*. Steeper banks pay an important role in limiting cattail invasion. To also help control cattail invasion, plant spike rush as it stays low in height, yet com petes effectively with cattails. Varying the landscape around the pond, such as providing open/low vegetation as well as dense/wooded vegetation provides for a variety of habitat and wildlife needs.

FLOOD CONTROL AND YEAR-ROUND WATER MANAGEMENT

The primary purpose of the pond is to detain stormwater runoff and prevent flooding of the surrounding urban area. The size of the catchment area, degree of runoff and local rainfall conditions dictate the number of acre feet that the pond must hold. The West Davis pond, located in the southern Sacramento Valley, captures runoff from a 736 acre residential area. The pond system covers 31 acres and can hold 257 acre feet (runoff from a 100 year storm event) with over 62 acre feet of additional capacity. The runoff is then pumped into a drainage ditch.



One option to treat most polluted runoff is to channel the first 1/2" of rain runoff to a primary treatment system

Water levels for optimal wildlife habitat vary during the year. Low levels in the summer fill the channels and pot holes, as above. Runoff from garden watering and other urban uses may provide some of this water, which should not contain high levels of pesticides, herbicides or nitrogen. Supplemental water, for example from a local shallow well, may be necessary to maintain summer water levels.

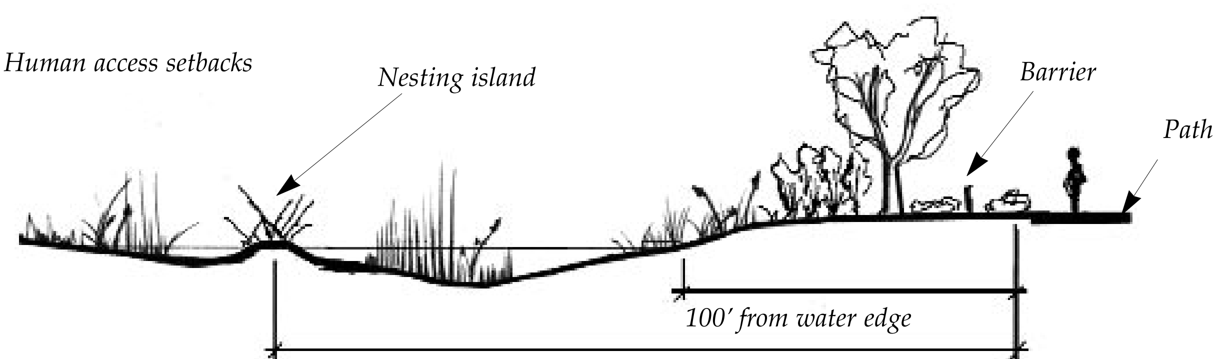
The first one or two winter rains will produce very polluted runoff, with oils, metals and other toxins from street surfaces. It is important to remove these chemicals before the runoff water enters the wildlife pond. This can be done by using a variety of modern low-impact design approaches, such as vegetated filter strips, grass swales, and infiltration trenches.[8] If runoff is entering the pond through culverts, then filters can remove oils. Also, when runoff enters the pond via culverts screens will block large debris.

During the winter, water levels should cover the mud flats and small islands, naturally rising higher after storms. In the spring, a gradual draw down exposes the low islands, mud flats and wetlands.

URBAN VILLAGE DESIGN GUIDELINES AND HUMAN NEEDS

Various human uses can take place around the detention pond, providing there are appropriate buffers to minimize adverse impacts (see

Human access setbacks



Section 2.2). Wildlife protection and enhancement requires that cats and dogs be kept out of the pond area and that there be little human intrusion. A fence around the pond area will keep out people and dogs and deter cats. If fences are located down slope and below eye level, they will seem to disappear and be less intrusive to people. Additional care in the dry season needs to be taken to prevent domestic pets from entering the pond zone through storm drains. Recreational parks and schools make useful buffers, although they will not reduce the need to limit human access. If the pond is surrounded by non-residential uses, such as business parks, then barriers may be quite limited.

The ability of people to enjoy the wildlife is very important to enhancement of the urban village quality of life. Provision of a trail around 50 percent of the pond, and a boardwalk that extends out over part of the pond and provides a large viewing platform, is very beneficial and has minimal pond-wide impacts on the wildlife. Having one or more areas where schoolchildren and others can visit the mudflats and waters edge without disturbing wildlife in the rest of the pond provides a great deal of educational opportunity. This area can be fenced off from the rest of the pond system.

Proximity of one or more ponds within a quarter to a half mile of high density, mixed use, urban village areas provides easy foot and bicycle access for urban village residents and visitors. Travel routes from the high density regions to the ponds may be marked and there should be transit access to at least some ponds.

Development of educational programs and clean-up days that focus on the pond systems will foster stewardship and develop greater public understanding of the ponds' values and needs, including the importance of minimizing stormwater runoff. In Davis, this education has greatly reduced residential use of pesticides and herbicides

4.4 WETLAND PATCHES

DEFINITION OF WETLAND PATCHES

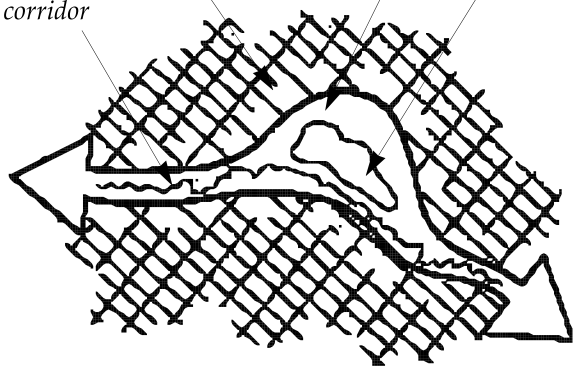
A patch of natural habitat with a perennial or seasonal wetland, other than vernal pools, and containing characteristic native vegetation such as cattails. Effective wetland patches also contain adjacent upland areas.

Examples
Laguna Creek in Elk Grove has examples of wetland patches. There are many small metropolitan wetland patches, with cattails or other reed species, located along stream corridors or adjacent to development projects.

URBAN VILLAGE CONTEXT

Wetlands can occur close to urban villages, especially if they are connected to other habitat elements such as a stream corridor or a stormwater detention basin which is doubling as a wildlife pond. A system of constructed wetland patches could provide biological purification of stormwater runoff, especially if the polluted waters from the winter's first storm are treated by oil trapping filters and passage through vegetative strips and swales.[8] This approach would provide major benefits to an urban village, coupling additional stormwater treatment with provision of local wildlife habitat patches.

PATCH DESIGN GUIDELINES



Wetland patch with upland and land use buffers

Wetland patches can provide for the protection or restoration of existing wetlands. Leaving wetlands areas intact during urban development can meet legal requirements of the federal Clean Water Act.[14] Even a very small wetland, for example a one-acre patch, will provide useful benefits if it is part of a larger habitat system. Patches along a stream corridor provide habitat for a wide variety of species and may consist of both perennial and seasonal wetlands.

Seasonal wetlands dry up during the hot summer months, but perennial wetlands must have some water throughout the year. Summer water might be partially provided by urban irrigation runoff, providing the level of nutrient and toxic contamination is sufficiently low. It can be provided by decentralized waste-water treatment systems.[15] It may also be provided by a perennial stream flow, or by pumping of groundwater. Adjacent upland areas are an important component of a wetland patch. These will provide habitat for multiple habitat species such as the giant garter snake, and provide a buffer against impacts of the neighboring urban matrix (see Section 4.2). An upland buffer of at least 100 feet in width provides effective filtration of non-point source pollution.[7] Grasslands and woodlands both make suitable upland areas, although they will provide for different species.

COMMUNITY / HUMAN DESIGN NEEDS

Convenient public access to some of the urban region's wetlands provides great community benefit. People will most likely walk for 10 minutes or a half mile or bicycle a couple of miles from an urban village center to a wetland area. Viewing areas around the wetland should include a raised walkway into a corner of the wetland area and a trail outside the habitat area. It is usually necessary to have a fence around the habitat area.

4.5 VERNAL POOL GRASSLANDS

DEFINITION OF VERNAL POOLS GRASSLANDS

Vernal pool grasslands are open grassland areas with scattered vernal pools and swales that can be close to an urban village. The pools and swales contain water during the rainy season and are underlain by impermeable soils. Water is lost from pools by evaporation, rather than flowing into a stream system. The pools and swales possess a wide variety of plants and invertebrates that are unique to vernal pools and include a growing number of species listed under federal or state Endangered Species Acts. The grasslands consist of native or non-native grasses, as well as a variety of flowering annuals, and provide habitat for several rare animal species.

Examples

The Central Valley still possesses a number of large vernal pool grassland landscapes.[16] Some growing metropolitan areas are spreading across vernal pool landscapes and we are beginning to see establishment of vernal pool grassland preserves or mitigation banks in these urbanizing areas.[17] There are several examples along the Jackson Highway corridor in south Sacramento County in an area where development is just beginning to occur and to the east of Chico and Merced.

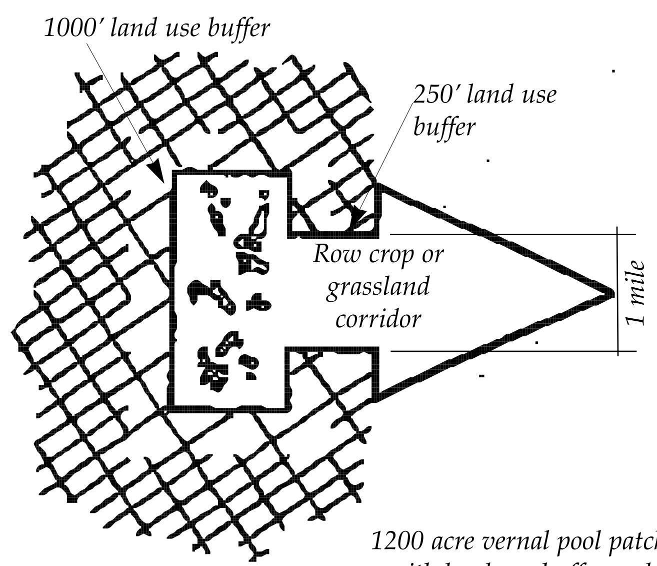
URBAN VILLAGE CONTEXT

Potential relationships of urban villages and the grasslands is a critical issue, since this declining habitat is such an important Central Valley resource and is impacted by spread of urbanization.[18] Some vernal pool grassland preserves can exist adjacent to urban areas, as long as they are a large size and have compatible adjacent uses. [Such preserves do not, however, substitute for large rural landscape beyond the metropolitan area (see Section 2.4 and 2.6)]. These areas will provide open space and educational opportunities that enhance the quality of life for urban village residents. Since vernal pools dry up in the summer and the grasses die back, programs to increase public awareness and appreciation are a critical component.

PRESERVE DESIGN GUIDELINES

Urban setting vernal pool grassland preserves should be at least 500 acres and preferably 1,000 or more acres (see[4] for caution on size). A preserve needs to be connected to the larger rural landscape by a wide corridor of grass or field crops. In exceptional circumstances an isolated preserve (see Section 4.1), or a small preserve of 400 acres or less, is warranted but will require much more active management.[19] This will be the case where there are extremely high quality vernal pools, or a vernal pool complex with unique features, and a larger conservation area is logistically impossible. Coupling of smaller, isolated preserves in urban areas with educational programs will increase both their biological and social value.

Preservation of the preserve's hydrology is critically important.[20] Each year, pools and swales form after winter rains begin. While conditions vary according to the year's rainfall extent and pattern, there are pools that attain different depths and harbor different species of plants and invertebrates as a result. The hydrological regime for a protected vernal pool complex should not change as a result of surrounding development. Stormwater runoff from developed areas around the preserve should not flow onto the preserve. Any irrigation waters from surrounding areas, including the buffer zone, must not flow into the vernal pool preserve. Conversely, development around the preserve should not cut across small watersheds in such way as to impair hydrological functioning.



1200 acre vernal pool patch with land use buffer and corridor to rural landscape

Preserve shape is important, since surrounding developed lands will have negative impacts on the preserve. Circular preserves are much more effective than thin, linear preserves (see Section 4.2).

Inclusion of extensive upland areas that are not flooded after heavy winter rains is essential. Not only does this provide for many additional grassland species, including the declining burrowing owl, it also provides for species important to vernal pool ecosystems such as solitary bees.

URBAN VILLAGE DESIGN GUIDELINES

Urban village and other high-density, intense use areas should not be immediately adjacent to a vernal pool grassland preserve. The most suitable types of development around the preserve are business parks and public parks, excluding recreation systems that use evening floodlights. Adjacent residential development should be buffered by a road, a green area such as a narrow public park, and a fence, to minimize impacts from pets and human activity. Whenever possible, streets adjacent to the preserve should have low traffic levels.

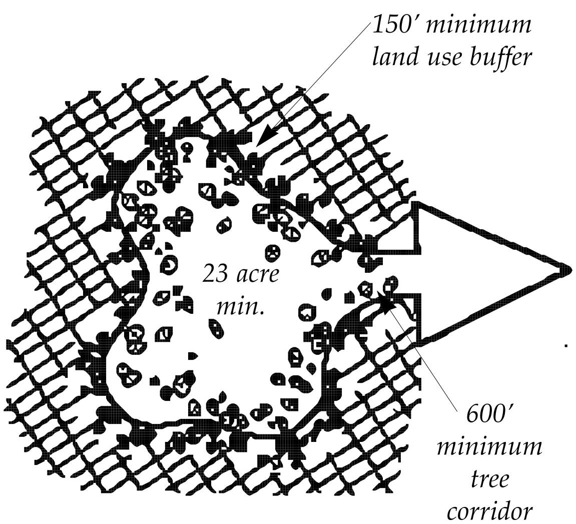
The presence of large trees in parks, business and residential areas around the preserve may provide nesting habitat for some of the hawk species that forage in open areas and are an integral part of a functioning vernal pool grassland ecosystem.

COMMUNITY / HUMAN DESIGN NEEDS

Some public access to the vernal pool preserve area is necessary for nature appreciation and education. A vernal pool natural history trail in the part of the preserve closest to the urban village, coupled with a visitor center and an extensive education program, will provide for resident's enjoyment of spring flowering and help build support for protection of the preserve.

4.6 WOODLAND PATCHES

DEFINITION OF WOODLAND PATCHES



23 acre woodland patch with buffer and corridor

Woodland patches are patch of habitat dominated by trees, especially native species, and often with a variety of under story shrubs and forbs. This may be part of a stream corridor system, with riparian tree species such as cottonwood, box elder and sycamore.[2] It may be near a riparian system in an area with a high water table, such as a valley oak woodland. Or it may be a dry upland patch, in particular a blue oak woodland.

Many urban woodland patches consist of non-native species, especially various species of eucalyptus and certain kinds of pine. These usually provide fewer benefits for native animal species than patches of native woodlands.[3]

We distinguish a woodland patch from an urban park with lawn grasses under various densities of trees.

Examples

Woodland areas along the American River Parkway provide examples of extensive riparian woodland patches that are part of a river corridor system. There are examples of upland blue oak woodland patches in communities like Folsom and Roseville.

URBAN VILLAGE CONTEXT

Woodland patches can be very close to an urban village and still provide biological as well as social benefits. Trees greatly improve the quality of life and ambience of an urban area and a woodland patch can provide a strong sense of nearness to nature.

PATCH DESIGN GUIDELINES

Size, shape, species composition and position relative to urban uses and to other habitat areas are critical components, determining the biological benefits of each patch. Woodland patches have the highest biological value when they are of a large size,[21] separated from intensive urban use by other habitat or by low-impact human uses, and connected by woodland corridors to other woodland areas and the rural landscape beyond the urbanized region (see Section 2.1).

Adjacent urban uses will have a variety of impacts on the woodland (see Section 2.2). For example, a ten-acre square patch will be a 660-foot square, with significant microclimate and other edge effects probably extending at least 150 feet from each side into the woodland patch. In consequence a maximum of three out of the 10 acres will provide interior woodland habitat with minimal impacts from surrounding urbanization (see note[4] for caution). Patches will provide the most biological value when they are at least 1000 feet wide (thereby having a 700 foot width beyond the major edge effects zone) or 23 acres if a square patch.[4] It is likely that these patches will provide habitat for a variety of Central Valley woodland birds, terrestrial vertebrates and insects. However, patches close to residential sources of domestic cats will need to be far larger to avoid major negative impacts from cat predation.

The patch location with respect to waterways, water table and soils will determine which tree species to use. Some areas with impermeable soils, such as hardpan clay soils, close to the surface may not be suitable for any trees without major modification of the soil. Areas adjacent to streams that historically (1850 and earlier) possessed riparian woodland are suitable for native cottonwood, willow, box elder and sycamore species.[2] As the trees mature, this type of woodland should have a variety of native understory shrubs, vines and forbs. Valley oaks may be used in these locations and in areas away from the watercourse that have a high water table.

Blue oaks are only suitable for upland areas that are above the floodplain and receive no summer water once seedlings are established. These trees are adapted to the hot dry summers of interior California and will get root diseases if watered during the summer.

CORRIDOR CONNECTIONS

Ideally, a woodland patch is connected to other woodland areas and to the rural landscape by a habitat corridor (see Section 2.1). This corridor should also be woodland to provide for movement of woodland animal species. A 600 foot width should provide a reasonable amount of interior woodland habitat.

Some birds will move to and from a patch through a short distance of the urban matrix. Woodland birds are more likely to travel greater distances across a matrix possessing large trees and significant canopy cover, such as is found in the Land Park and Curtis Park districts of Sacramento. A wide greenway with large trees forming a continuous canopy may also provide this function.

COMMUNITY / HUMAN DESIGN NEEDS

Public access may be less important for woodland patches in an urban setting. Much of the social benefit of these patches comes from proximity to a woodland patch, while safety issues can be a deterrence to wandering in the woods.

An organized educational program will provide significant benefits to adjacent urban village residents. A woodland nature trail with periodic guided trips will allow residents to experience the woodland in safety and with minimal biological impacts. The presence of an interpretative center at the edge of the woodland patch which is closest to the urban village will provide ongoing educational opportunities.

4.7 NOTES

(1) For the importance of riparian and floodplain areas and the need for upland connections, see Naiman. R, ed. (1992) Watershed Management: Balancing Sustainability & Environmental Change. Springer-Verlag. Also Naiman RJ, DeCamps H and Pollock M (1993) "The Role of Riparian Corridors in Maintaining Regional Biodiversity." Ecological Applications. 3: 209-212.

(2) For characteristics of Sacramento Valley riparian forests, see Conrad, SG et.al. (1980) "Riparian Vegetation and Flora of the Sacramento Valley." In Sands A, ed. Riparian Forests in California: Their Ecology and Conservation. Division of Agricultural Sciences, University of California.

(3) For birds, see Rottenborn, SC. (1999). "Predicting the Impacts of Urbanization on Riparian Bird Communities." Biological Conservation. 88:289-299.

(4) Important caution. There is little scientific data demonstrating the exact minimum sizes and widths needed for various Central Valley habitats to provide for different animal species, especially in an urban setting. Even less is known about minimum widths and maximum lengths of corridors. We have chosen minimum widths for various situations based on our best judgement coupled with cases of local planning limitations. In the absence of specific knowledge, a conservative approach is essential, and provision of the greatest width and size feasible.

(5) Mount, JF (1995) California Rivers and Streams: the Conflict Between Fluvial Process and Land Use. University of California Press. p. 288.

(6) Faber, PM et.al. (1989) "The Ecology of Riparian Habitats of the Southern California Coastal Region: a Community Profile." US Fish and Wildlife Service Biological Report 85(7.27).

(7) The effectiveness of riparian buffer strips to protect water quality from runoff pollutants and trap sediments depends on the structure of the buffer and local conditions. For example, see Hill, AR (1996) "Nitrate Removal in Stream Riparian Zones." Journal of Environmental Quality. 25: 743-755; Schultz, RC et.al. (1995). "Design and Placement of a Multi-species Riparian Buffer Strip System." Agroforestry Systems. 29:201-226; and Wirka J. (1998) "Natives and Nonpoint Source Pollution." Grasslands. 8:1-9. The Natural Resource Conservation Service of the U.S. Department of Agriculture published riparian forest riparian guidelines based on studies of eastern forest riparian areas. These studies recommend a buffer of at least 90 feet, with forested and grass components. See Welsch J. (1991) Riparian Forest Buffers: Function and Design for Protection and Enhancement of Water Resources. NA-PR-07-91. U.S. Forest Service, Radnor, PA.

(8) A range of modern techniques both reduce the amount of runoff and remove a great deal of contamination. See Coffman L. (2000). Low-Impact Development Design Strategies: an Integrated Design Approach. Department of Environmental Resources, Prince George's County,

Maryland.

(9) Dahl, TE. (1990) Wetland Losses in the United States 1780's to 1980's U.S. Fish and Wildlife Service, U.S. Department of the Interior.

(10) Schoenherr, AA. (1992) A Natural History of California. University of California Press.

(11) See for example Scott, MJ., Auble, GT. and Friedman, JM. (1997) "Flood Dependency of Cottonwood Establishment Along the Missouri River, Montana, USA." Ecological Applications 7: 677-0690.

(12) Chainey, S. et. al. (1989) Wildlife Habitat Enhancement and Management Plan for West Davis Pond. Jones and Stokes Associates.

(13) There are generic studies of how open space increases property values in the U.S. Information is available on The Conservation Fund's Web site, *www.conservationfund.org/conservation/amgreen/index.html*

(14) Wetlands are protected under Section 404 of the Federal Clean Water Act. Filling or destruction of wetlands requires a permit from the U.S. Army Corps of Engineers. The U.S. Environmental Protection Agency has an advisory role in wetlands permitting, and the U.S. Fish and Wildlife Service has a consultative role under Section 7 of the federal Endangered Species Act.

(15) The 21st Century will see major changes in waste-water treatment, with a movement away from sewer lines and centralized treatment plants to decentralized systems coupled with local water re-use. See , for example, Pinkham R (2000) Twenty-first Century Water Systems: Scenarios, Visions and Drivers. Rocky Mountain Institute, Snowmass, Colorado. Wetland areas can provide effective treatment of waste water in these systems. See, Crites, R and Tchobanoglous G (1998) Small and Decentralized Wastewater Management Systems. WCB/McGraw Hill.

(16) Holland, RF. (1998) "Great Valley Vernal Pool Distribution : Photo-revised 1996." In Witham, CW., ed. Ecology, Conservation and Management of Vernal Pool Ecosystems. California Native Plant Society. Holland, R. and Jain, S. (1988) "Vernal Pools." In Barbour, MG and Major, J., Eds. Terrestrial Vegetation of California. California Native Plant Society.

(17) See, for example, Map of Protected Areas in South Sacramento County. (2000) Sacramento County Planning and Community Development Department.

(18) Jokerst J (1993) "An Alternative Approach to Vernal Pool Mitigation Planning in Sacramento County." In Keeley, J.E., Interface Between Ecology and Land Development in California. Southern California Academy of Sciences.

(19) Clark, G.M., et.al. (1998) "Management Considerations for Small

Vernal Pool Preserves - The Phoenix Vernal Pools." In Witham, C.W., ed. Ecology, Conservation and Management of Vernal Pool Ecosystems. California Native Plant Society. Holland, R., and Jain, S.,(1988) "Vernal Pools" In Barbour MG and Major J, eds. Terrestrial Vegetation of California. California Native Plant Society.

(20) Hanes, T., and Stromberg, L., (1998) "Hydrology of Vernal Pools on Non-Volcanic Soils in the Sacramento Valley" In Witham, C.W., ed. Ecology, Conservation and Management of Vernal Pool Ecosystems. California Native Plant Society. Holland, R., and Jain, S., (1988) "Vernal Pools" In Barbour, MG., and Major, J., eds. Terrestrial Vegetation of California. California Native Plant Society.

(21) Analysis of isolated woodlots in farmland areas of the North East and Mid West U.S. shows that patches of about 50 acres are needed to ensure presence of a full suite of birds. It is likely that woodlots under 200 acres in this area have little likelihood of preserving viable songbird populations. See Robinson, SK., Brawn, JD., and Hoover, JP., (1997) "Effectiveness of Small Nature Preserves for Breeding Birds." In Schwartz, M.W., ed. Conservation in Highly Fragmented Landscapes. Chapman and Hall. However, urban woodlots in California's Central Valley have different conditions, different patch/matrix interactions and different species, so extrapolation is uncertain.

Ecological Planning and Urban Village Design

5.0 Conserving Central Valley Ecology by Urban Village Design

5.1 Introduction
5.2 Ecological/Urban Design Opportunities and Constraints
5.3 An Ecological/Urban Village Planning Method
5.4 Summary
5.5 Notes

Urban villages, communities that feature concentrated amenities, services and population, can attract high numbers of people to small geographic areas. By being land efficient, a village can generate numerous open space and ecosystem conservation benefits.

Livable villages studied for this project accommodate up to 14 times more people per acre than the average people per acre density of Central Valley communities.[1] Using a mixture of village densities in the Sacramento region, it could be feasible to achieve an overall efficiency of 18 people per acre. For each million new Valley residents, this efficiency ratio would consume 111,000 less acres than conventional development. The land not needed for urban development can then incorporated into for large reserve conservation, critical ecosystem preservation, and farmland protection.

Section 5.0 applies the biological and ecological information from the preceding chapters. We present a method that uses geographic information systems (GIS) with an easy to use GIS model. We then apply biological based planning criteria to the model and generate a conceptual ecological conservation plan. Urban village planning guidelines are then used to integrate urban development with the protected elements of the ecological system.

In the final analysis, this approach conserved key ecosystem features representing 38% of the total study area. Even with 70% of the total housing units in single family residential development, the village accommodated twice as many homes as compared with a conventional development plan that does not include conservation.

5.1 INTRODUCTION

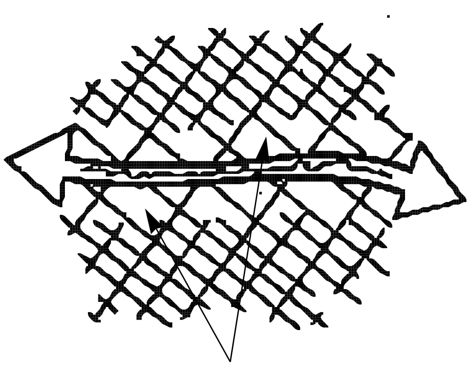
Urban villages help to conserve Central Valley ecosystems because they consume considerably less land than conventional development. Combined with sound conservation programs and permanent land protection policies, villages can set aside generous riparian corridors within cities and provide land for open space reserves while accommodating population growth.

In turn, nearby natural areas and the presence of urban-adaptable wildlife in urban settings help make villages more enjoyable for people. In a recent study of places that contribute to the enjoyment of life in the Sacramento Valley region, residents felt that nearby native plant and animal habitats were of more interest to them than conventional urban parks.[2]

Access to rich natural and urban amenities is part of what makes urban village living so satisfying. For example, one of the most livable and land use efficient villages in North America is the West End district of Vancouver, BC. Over 41,000 people live in the 480 acre village, a ratio of 85 people per acre. Nevertheless, the access to open space and nature is outstanding, with virtually every dwelling unit being within a 4 minute walk to a beach. The average walk to a nearby 1,000 acre forest and park is 12 minutes.

5.2 ECOLOGICAL / URBAN DESIGN OPPORTUNITIES AND CONSTRAINTS

OPPORTUNITIES



Land use buffer at the edge of riparian corridor

While villages produce beneficial relationships between nature and urban life by land conservation; they can also protect, create, and restore natural places within the urban environment. Land uses can be selected that help buffer protected natural areas from detrimental edge effects (see chapter 2, Section 2.2). Development can provide funding to help restore, create, and maintain critical systems, such as riparian corridors along streams and rivers (see chapter 4, Section 4.1).

Resource flows can be engineered to serve both people and wildlife. For example, stormwater runoff can be channeled to on site water treatment areas and off site multi-purpose detention ponds (see chapter 4, Section 4.3). The ponds can also provide recreation and increase urban wildlife habitat. Urban vegetation can provide food, cover, roosting, and breeding areas for species that can adapt to urban development. Greenlinks that provide walking/biking systems through villages can also improve connectivity for certain species.

CONSTRAINTS

It is impossible to urbanize a habitat or farmland site without disturbing or displacing existing habitat on the land that is affected. Even the best ecologically sound urban development will alter the local ecology by destroying and fragmenting habitats. In addition, the new urban environments however well designed for habitat value, will not maintain the vast majority of the species that are currently declining in the Central Valley (see Section 2.6).

Long-term ecosystem health requires preservation of wide riparian corridors that are sufficiently connected to large tracts associated rural habitats. Improving urban development efficiencies and conserving land are the keys to balancing human and natural community needs.

The following chart summarizes the ecological opportunities and constraints associated with Urban Village development.

Urbanization and Ecological Impacts: Opportunities and Constraints

ISSUE	OPPORTUNITIES	CONSTRAINTS
Native Plant and Animal Species	Can support species that are adaptable to urban settings.	Displaces species that cannot adapt to urban settings. Urban areas do not support Valley species that are declining.
Threatened and Endangered Species	Some T&E species, such as Swainson's Hawks, have utilized certain urban areas for nesting and cover.	While urban areas may support limited T&E species, urban environments do not provide adequate habitat association or protection for long term T&E support.
Habitat Quality	Funds for protection, restoration and management. Funding large scale, permanently protected habitat outside of the urban growth boundary has the most native species benefit.	Urban development removes, rather than generates, habitat. Inadequately sized and unconnected habitat patches in/near urban areas can easily be more fragmented and degraded by continuing urban development.
Urban Vegetation	Native/non-native plantings can provide food, cover, roosting, and breeding sites. Use of native plant species tends to reduce water, pesticide, and fertilizer use.	Exotic vegetation may not support native species. Nearby natural areas will likely suffer invasion by exotics, threatening native vegetation and habitats.
Water Flows	Detention ponds located near the urban fringe can provide limited wildlife habitat and benefit human recreation. On-site urban runoff treatment areas can improve local water quality. Treated gray water can provide irrigation for urban vegetation.	Increased urban runoff changes volumes, velocities and duration of high flow and flood events. Uncontrolled urban runoff can promote erosion and pollute water resources. Detention ponds and wetlands as wildlife and recreation areas are not always accepted by agencies. Wastewater often not available for local use.
Human Access and Proximity	Nearby natural areas can provide multiple educational, recreational, and wildlife benefits and are seen as important to Valley residents.	Nearby human activities and cats and dogs can disturb native species. Cats will reduce local species populations.
Ecosystem Knowledge	Ecology, bio-regional planning and environmental sciences provide a theoretical base for planning. Natural areas within and adjacent to the urban fabric can stimulate local information gathering, and can increase understanding of the local natural environment.	Local ecosystem knowledge is often limited. Specific ecological design and planning criteria are frequently not verified by field studies. Urban impacts on local ecosystems, especially long-term impacts, are often not known.

5.3 AN ECOLOGICAL / URBAN VILLAGE PLANNING METHOD

This section illustrates how the information in this document can be applied by planners, designers, and communities in conducting initial "sketch" studies of undeveloped lands. The method uses a variety of sources, such as geographic information (in Arcview a GIS software) data bases combined with critical analysis and best practice assumptions.

Overlaying different data sets in Arcview, such as general plan land uses with natural features, builds understandings of the dynamics affecting the landscape. Arcview can automatically apply the appropriate corridor widths and land use buffer dimensions recommended in the preceding sections. ModelBuilder, (an extension of Arcview software), can take this information and create an ecological conservation model that integrates geographic data, ecological criteria, and community/user weighting criteria.

The data sets used in our studies come from a variety of sources, including the:
- Sacramento Area Council of Governments
- City of Sacramento
- County of Sacramento
- GAP data
- Teale Data Center

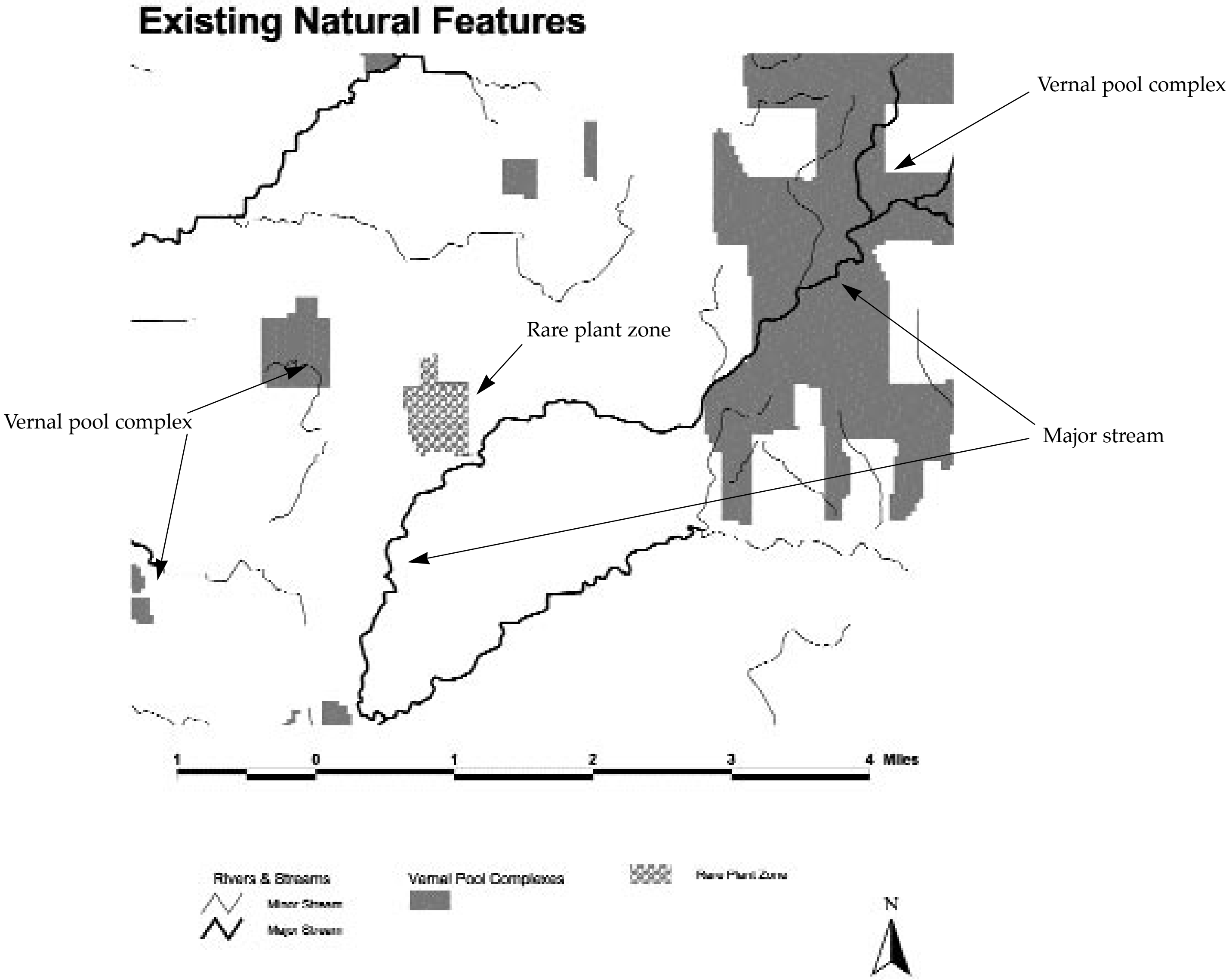
This method is very generalized and suitable for a sketch study. In actual practice, more studies and considerable stakeholder and community input would be required for plan development.

<u>ILLUSTRATIVE REGIONAL STUDIES</u>

To illustrate this approach, we have adapted geographic data from Sacramento County. The study area includes certain existing features as well as others that we created. Sacramento County was selected because we have the data sets and prior knowledge of the area. *However, our analysis and proposed locations for urban village development and ecosystem preservation <u>are conceptual only,</u> and do not necessarily reflect any current land uses, habitat conservation planning efforts, private property interests or approved land use policies.*

Study I. Existing Natural Features
The method begins with understanding the existing features of the study area with minimum reference to human impacts on the landscape. (Ideally, the geographic information systems (GIS) database should be at as fine a resolution as possible).

Our 15,440 acre hypothetical study area includes major and minor streams, vernal pool complexes, and a rare plant species habitat zone. The upper right portion of the area has a large zone of concentrated



vernal pools bisected by a major stream. A rare plant species zone is located in the middle of the study area. To the west are smaller and less dense vernal pool complexes. Steams running east to west bisect the study area at roughly 1 mile intervals.

Other possible considerations for a GIS based natural features analysis could include:
- Department of Fish & Game species and habitat data
- Natural communities in addition to vernal pools, such as wetlands, grasslands, and woodlands
- Slopes/topography
- Hazards, such as fire and flood plains

- Soil types

Studies can complement standard geographic data sets (and generate new layers), such as:
- Obtaining local biological information
- Identifying networks of patches and linking corridors
- Identifying sites for potential urban natural areas
- Identifying fragmented and declining patches
- Identifying ideal sizes of local patches, including species zones and habitat associations
- Understanding previous impacts to the landscape, such as stream channeling for agricultural land uses
- Identifying native species that are adaptable to urban settings
- Verifying quality habitat of different ecological areas

A literature review may provide more ecological/biological species and system information. Often local level scientific and geographic data is limited or not available. When funding permits, conduct field studies. Use empirical data as required, such as input from local biologists, environmentalists, agencies, and residents.

Study II: Community Context

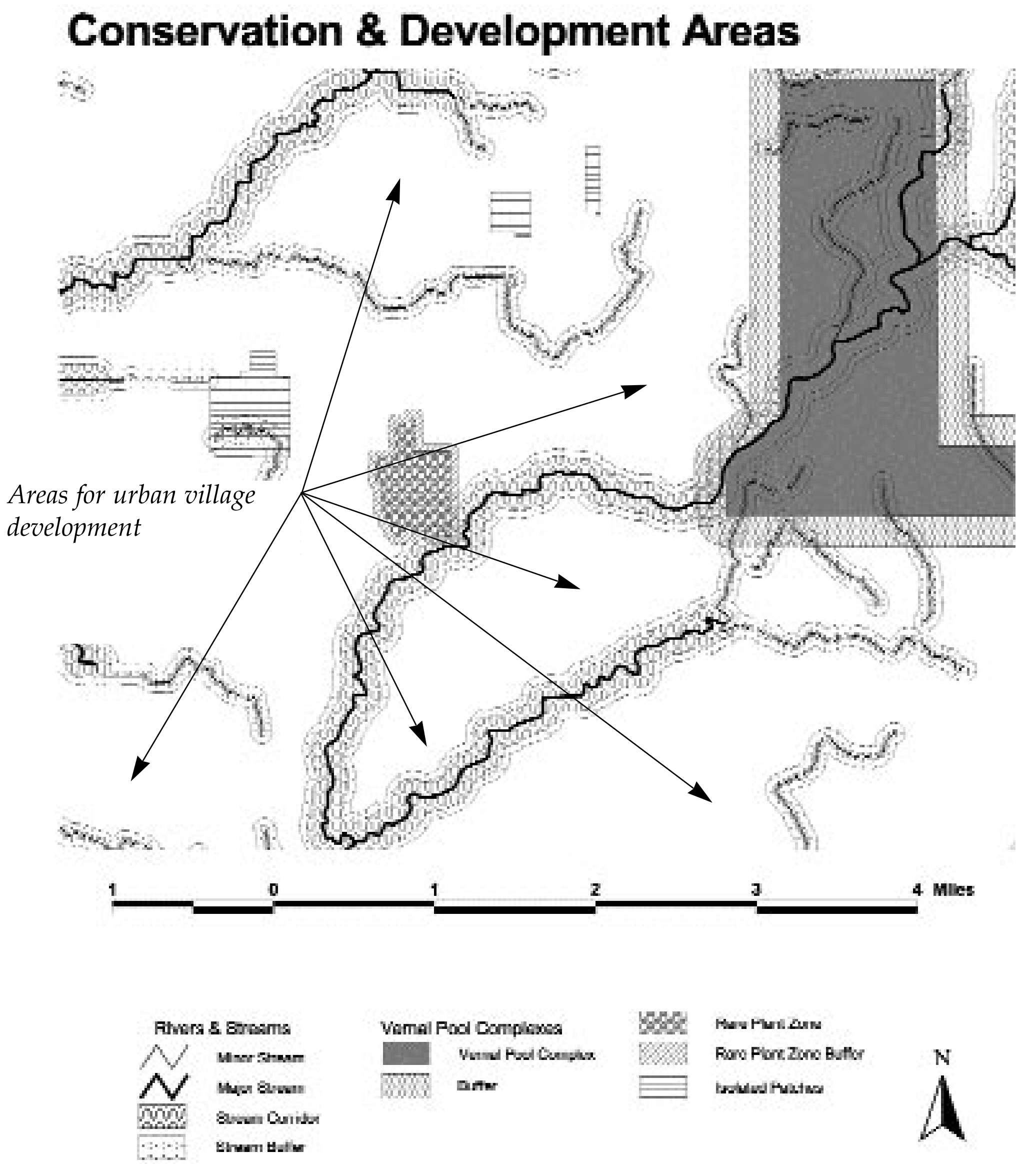
The human use of and attitudes to the study landscape form the basis of the community context study. Given the degree of private land and the number of jurisdictions in the Central Valley, ownership and regulatory information needs to be understood. General plan information is also important. We did not conduct a public value and preferences information process, but used a survey prepared for the Sacramento Housing and Redevelopment Agency.[3] Given that our study area is a mixture of existing and hypothetical features, we did not use an existing general plan layer.

GIS data layers that are often readily available and should be used include:
- General Plan
- Existing urban
- Existing land uses at a parcel level
- Roads, freeways, rail, transit corridors, etc.; existing and proposed
- Utility corridors
- Land ownership

As is possible, assemble/prepare other geographic layers that map:
- Local community goals and preferences, treasured places, preferences for natural and developed landscapes
- Cultural and historic resources

Study III: Develop a sketch ecosystem conservation strategy within urban growth zones.

Ecological planning criteria in this document (and other sources) should be applied in developing the conservation strategy. To help assess complex information, we applied Arcview's ModelBuilder extension of Spatial Analyst and built a model that applies ecological criteria



to the geographic database.[4] The model automatically applies the user's or community's criteria for buffers, riparian corridors, habit and natural community reserves and reserve buffers. Also, based on user data weighting input, ModelBuilder will prioritize elements of a conservation strategy. The model is flexible, and different criteria, weights, and other ecological data can be added as needed.[5]

In our ModelBuilder run we applied:
- Riparian corridor widths to the streams, using 1000 feet for major streams and 200 feet for minor streams
- A land use buffer (a zone that has low disturbing land uses)along the streams at 250 feet wide on each side of the riparian corridor
- A land use buffer surrounding vernal pool zones at 1000 feet wide

- A land use buffer of 250 feet for the rare plant species zone

The sketch plan suggests that the upper right area of the site with the large vernal pool complex may be suitable for a reserve. In addition, two major streams flow through the vernal pool complex, with one stream linking with the rare plant zone in the middle of the study area.

A check of regional conditions beyond the study area boundaries is also important to verify potential ecological benefits. Streams in the upper portion of the study area terminate in urban areas, implying less opportunity for habitat connectivity. The middle stream runs east from the study area to other existing vernal pool complexes that connect to oak woodland uplands and the Sierra foothills. The stream then continues west through the study area, and connects with wetlands adjacent to a major river. This stream then, offers real potential for some habitat connectivity in the local region.

However, the data also suggests some areas may not be suitable for conservation or restoration. Several small vernal pool sites are isolated and may be subject to species loss in a future urban matrix.

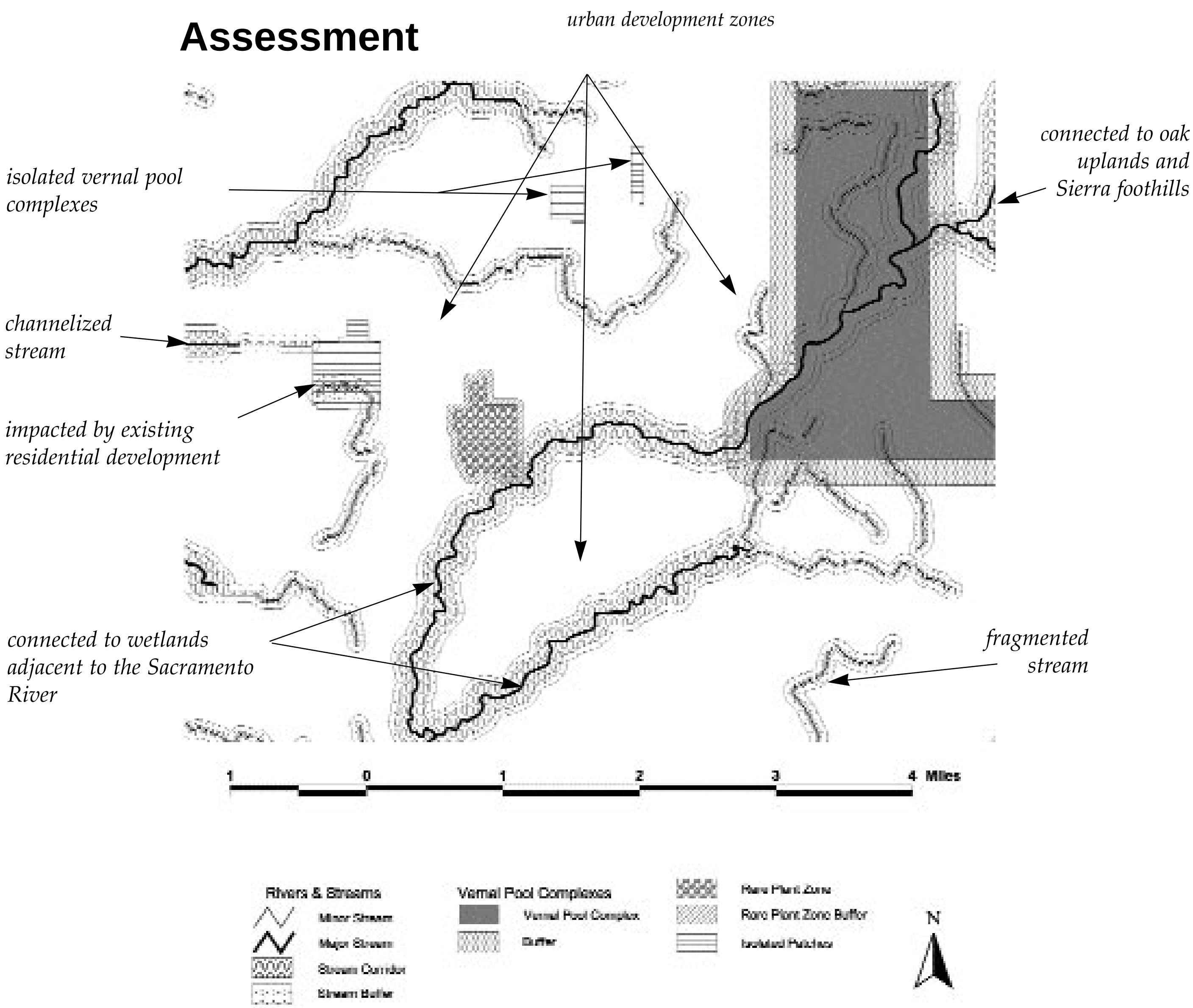
Other considerations for an ecosystem conservation strategy can include:
- Assessing areas to restore
- Evaluating human access, including areas appropriate and areas to be restricted
- Checking ecotones and edge effects at urban/rural edges
- Identifying agricultural areas that support habitat or could be habitat beneficial
- Saving areas of beneficial agricultural uses
- Phasing development over time to establish replacement habitat for species in the path of development, especially listed species that will be adversely affected by urbanization.

In developing the strategy, consider the following :
- River and stream corridors in urban areas can contribute to the Central Valley ecosystem. These should be conserved and/or restored (see chapter 4, Section 4.1). Riparian corridors in urban areas that connect to large, nearby rural open spaces may have particular value.
- The regulatory requirements of federal and state water quality acts and endangered species acts, combined with sound conservation principles, must be met.
- Patches should be sized to support their habitat over the long-term (often impossible to achieve in an urban setting). (See chapter 2, Section 2.3).
- The network, the links between patches and larger landscapes, also needs consideration. Maintaining corridors between patches and corridors from patches to the rural landscape is usually critical in maintaining long-term viability (see chapter 2, Section 2.1).

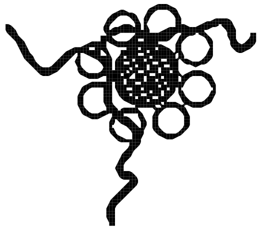
Study IV: Assess areas suitable for conservation and urban village development

This study critically reviews and modifies the sketch conservation layer produced in #3 as appropriate by applying local political, economic, and other local criteria.

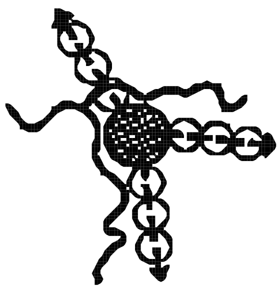
In our example, natural features and patches that were not seen as a functioning part of the new ecosystem once the villages are developed, were set aside to be nearby nature amenities. In a 'real' site, patches and stream corridors already impacted by urban development may not contribute to the local ecosystem, yet these could be saved and/or restored for nearby nature uses.



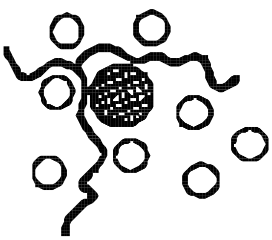
Village Planning Structures



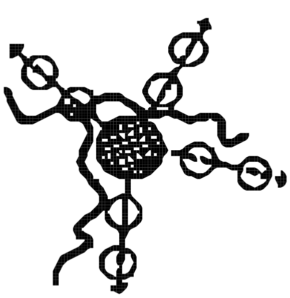
1. CORE DENSIFICATION
increases the density of existing urban core



2. CORRIDOR DEVELOPMENT
focus development along existing transportation corridors



3. NEIGHBORHOOD DEVELOPMENT
promotes development in neighborhoods to create villages and village clusters



4. TRANSIT ORIENTED DEVELOPMENT
develops villages along public transit line stops

Study V: Apply urban village planning structures to development zones

As our study area is 14 miles from the metropolitan center, we used the village structure #3, neighborhood development. Our structure is based on a village unit that varies from 250 to 500 acres. The units can be placed individually within the rural matrix, clustered with other villages around regional centers, or placed along vehicular and light rail corridors.

To assess development zones, we overlaid a 1 mile square grid (similar to the existing sections in the Central Valley). Areas most suitable for development include those that have enough area, 600 or more acres, for cluster styled village development. We also avoided areas that would generate small or isolated villages, and assumed that these are best suited to conventional development at 6 persons per acre.

Other more detailed considerations that can be used to assess urban village development suitability include:
- Existing/planned employment centers
- Existing/planned transit corridors, thoroughfares, freeways, and off ramps
- Amenities, such as activity, cultural, and entertainment centers
- Ownership, easements, utility corridors, and other considerations that could limit land use
- Vacant land and underused land, especially in zones that are not residential
- Slopes
- Nearby infrastructure
- Floodplains, fire hazards, geotechnical features

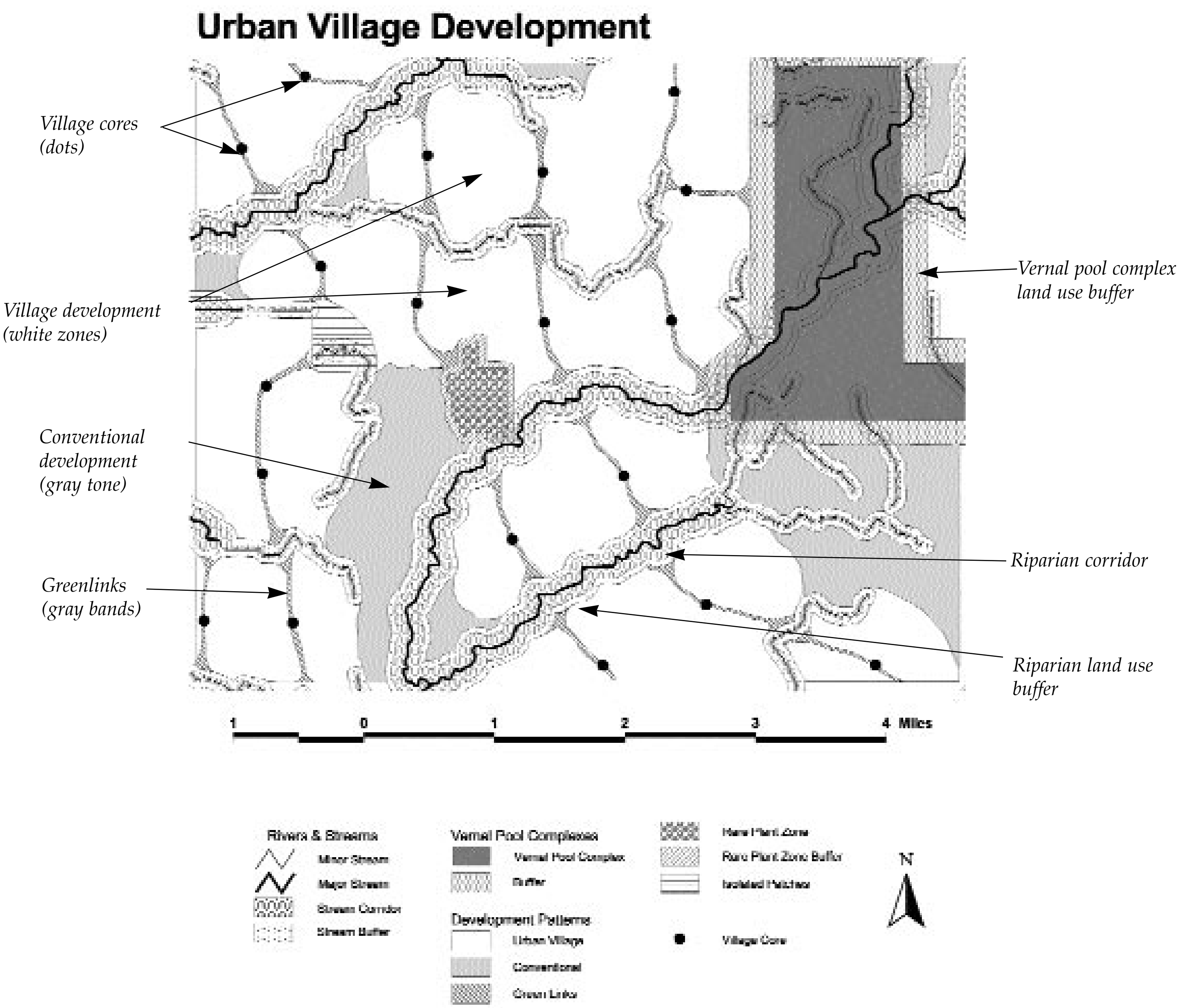
Village clusters will likely have more service, amenities, and employment opportunities than isolated villages. Clustered villages, especially villages located near more dense urban centers, tend to generate more environmental benefits than outlying centers. For example, Midtown Sacramento households average 10,100 vehicle miles per year as compared to about 20,000 or more for suburban communities.[6]

In our review, we focused on:
- Zones that could have clusters of villages rather than single village locations
- Locations that could provide centrally located commercial, employment and entertainment activity areas, avoiding areas that would fragment village connectivity
- Villages that could incorporate existing natural features into the urban fabric and be properly sited to place low disturbance land uses near elements of the conserved ecosystem

Other considerations can include:
- Developing villages as close as possible to existing urban centers
- Locations that could have good pedestrian and transit systems.
- Blending existing residential and commercial development into new village development

- Respecting the land use designations in the existing General Plan

At this stage we employed manual Arcview tools to create the village development plan. Using village templates of 250 to 500 acres, we inserted these into the development spaces identified in Study IV and developed the following plan. The plan was embellished with greenlinks that provide north/south connectivity for residents as well as corridors for urban adapted species. (The greenlinks and conserved areas can also be buffered with adjacent naturescaping zones, and these assumptions added to the ModelBuilder layer).



Study VI: Assess the land conserved, developed, and total population

To find the lands left in open space, we subtracted the land to be developed into villages and conventional development from the study area total. Of the total study area of 15,440 acres, 5,867 acres are conserved as open spaces including riparian corridors, vernal pool reserves and the rare plant habitat.

Population estimates in the urban village areas are based on land use typologies developed as part of the EPA funded Urban Village Initiative. As our study area is 14 miles from the metropolitan core, we used a village system that contains 70% single family homes. Based on housing type and other land use assumptions, the village system, meaning all aspects of the community such as roads, housing, schools, recreation, urban parks and commercial uses will have an efficiency ratio of 18 people per acre.

The 18 people per acre figure is in part based on percentages of housing units living in the following types:

1. 15%: Small slot, single family homes.

Aggie Village in Davis, California

2. 30%: Single family homes that also have a second unit cottage.

400 square feet cottages in Aggie village, Davis, CA that feature separate pedestrian entrances

3. 25%: clustered single family homes.

Metro square in midtown Sacramento

4. 10%: 2 to 6 unit multi-family house scaled buildings that blend into single family neighborhoods.

Midtown, Sacramento

5. 10% multi-family garden style apartment units.

Midtown Sacramento

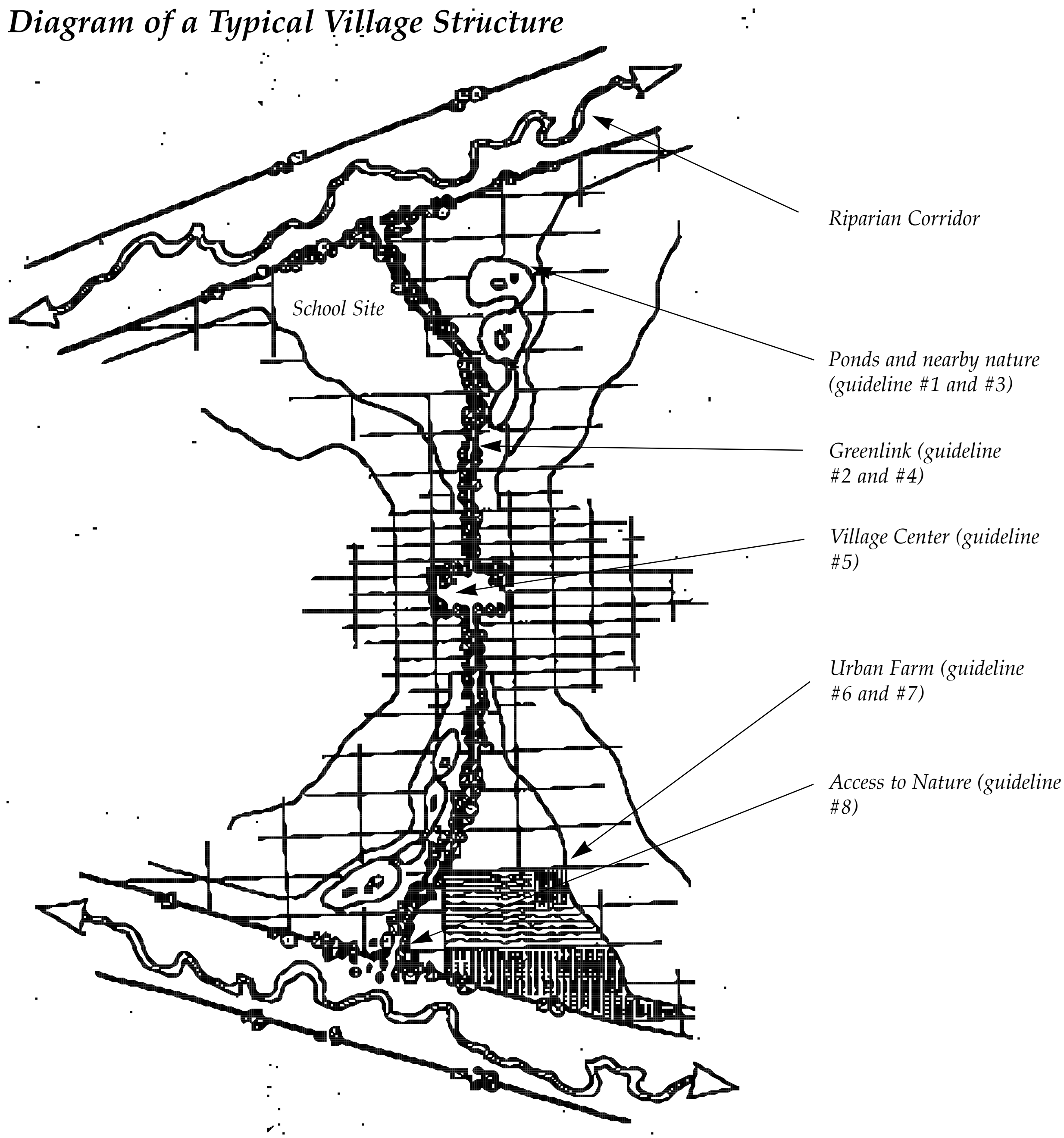
6. 10% housing over commercial.

Midtown Sacramento

To estimate population in the conventional development zones, we used Sacramento's ratio of 6 people per acre.[7] The above assumptions generate a village population of 164,000 plus 12,000 more living in conventional development, for a total of 176,000. If the same area was built to conventional densities, it would have 69,000 residents.

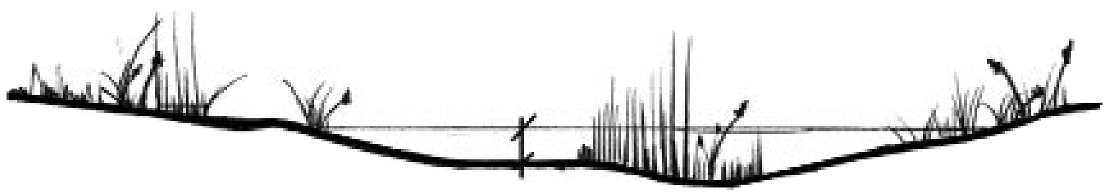
Study VII: Apply urban ecological and quality of life design guidelines to village development zones
Increasing quality of human life by providing vigorous, land-efficient communities enriched by nearby open spaces is essential to protect ecological systems in the Central Valley. The following guidelines can improve quality of life and the role of nature in urban environments by increasing access to urban amenities and open spaces, improving air and water quality, and improving ecological value in urban areas.

Diagram of a Typical Village Structure



Guideline 1: Design urban runoff detention ponds as urban wildlife habitats and as community open space (see chapter 4, Section 4.3)
Ponds can buffer corridors and habitats, and can function as fingers that extend nature serving open space into the urban matrix. The ponds are intended to be very accessible to residents, and in our village plans they are within a 5 minute walk of residential areas. To achieve this, the ponds have a small watershed and size, with around 3.5 acres of pond per 100 acres of development.[8]

Multi-purpose stormwater detention ponds have sophisticated design criteria to balance water quality requirements, habitat needs, mosquito controls, and human access. For an introduction to this issues, see Chapter 4, section 4.3.

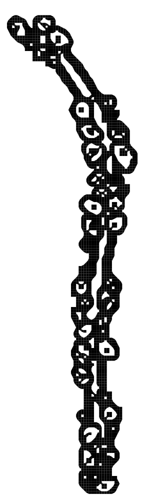


*Section of a typical shallow detention pond that can provide habitat support with 4 - 12" depth of wat*er

Guideline 2: Build greenlink corridors for human access and urban wildlife habitat connectivity.
A greenlink is a primary village street, pedestrian, and bicycle route that is designed and landscaped to support habitat and human connectivity through the village. The greenlinks should bisect the urban village and provide a safe bicycle and pedestrian path system to the central activity/commercial zone, to village schools, and other village amenities.

The greenlink should also connect the village to accessible open spaces that are part of the ecosystem buffers, such as nearby nature areas, ponds, urban farms, and parks.

For convenience and safety, the greenlink paths are adjacent to streets[9] yet setback about 20 feet from the vehicular street. Access to garages of homes facing the greenlink path should not cross the path, but rather be located in the rear along an alley or secondary street. The greenlink should be naturescaped (planted) with a variety of tree types and heights to provide limited habitat and connectivity for wildlife that can adapt to urban settings. To allow adequate space for pedestrians and bicycles, the path should be wider than 8 feet.



Greenlink paths should be well planted. Curves in the street and path system help reduce sight line distances, an important design aspect of pedestrian friendly path systems

A nearby nature site that incorporates elements of regional landscapes (design by Eric Rowell)

Guideline 3: Provide nearby nature for recreational, educational, and urban adaptable wildlife uses.

Nearby nature sites are areas intended for human access and some limited urban wildlife use. Nearby nature sites can occur adjacent to areas where human access may need to be restricted;[10] such as in habitat reserves or the habitat corridors along streams and rivers. The sites can be designed as part of, or as replacements to more urban-styled parks.

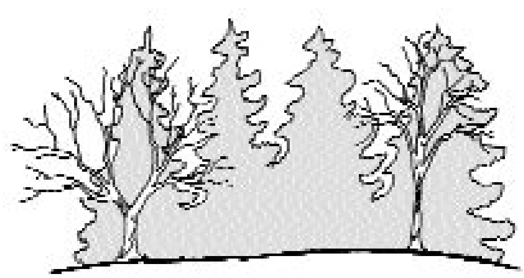
Nearby nature sites should also have educational signage or a nature center to increase local ecosystem understanding, appreciation, and natural land stewardship. Interviews with residents who live near these sites, such as Laguna Creek in South Sacramento,[11] suggest that nearby residents have greater stewardship values than those who live farther away and visit the sites.[12]

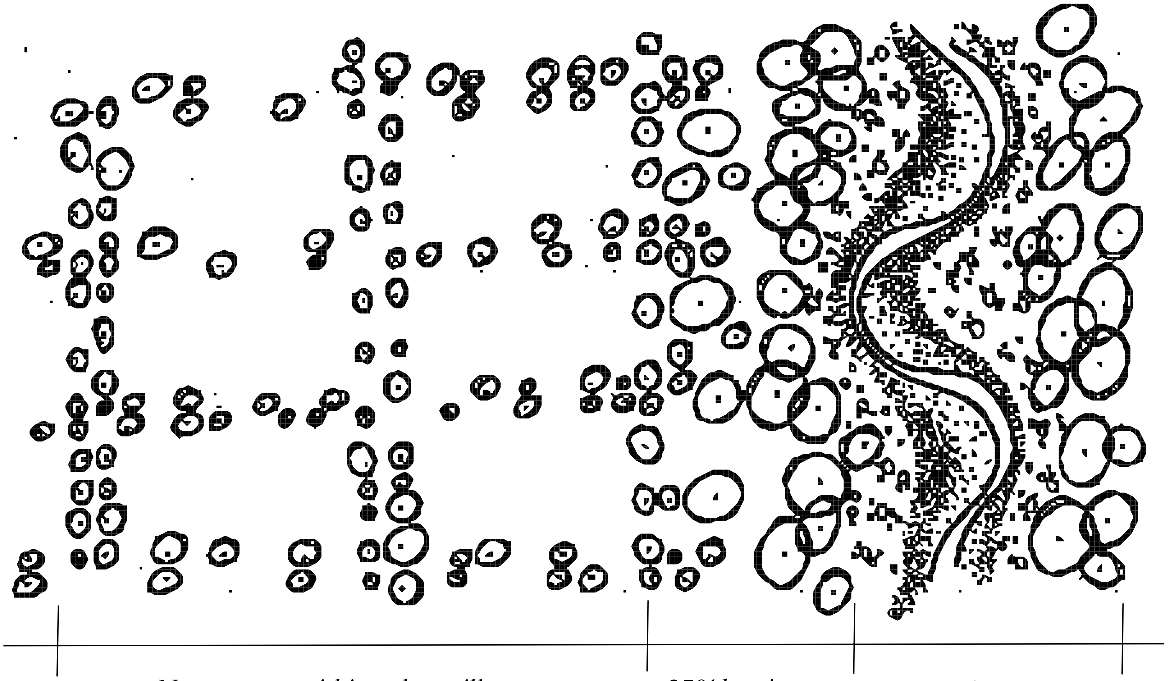
Guideline 4: Naturescaping; planting native and habitat serving vegetation in urban landscapes.

This guideline can generate many benefits, including providing habitat value for urban adaptable species, using less water for irrigation, and reducing applications of pesticides and chemicals in the landscape.

Naturescaping in urban areas that are near open spaces, riparian corridors, and rural landscapes have more potential to support adaptable animal species than inner city locations (see *Bird Lists* in Section 7.2). Use of wildlife-serving plant materials in zones of around 1,500 to 2,500 feet paralleling habitat areas and riparian corridors may extend habitat benefits for urban adaptable species in the Central Valley.

Grove of mixed tree species 40′- 60′ tall can provide habitat for raptors



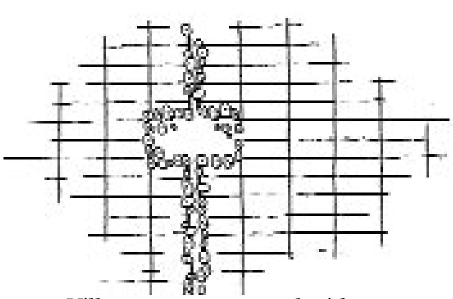


Naturescaping along a riparian corridor can extend habitat benefits into the village residential areas and generate beneficial edge effects

The above plan drawing illustrates the relationship of naturescaping with buffers and corridors. On the right, the major stream corridor, at 600-1000 width, protects the stream and riparian habitat. The low impact land use buffer, whether schools, parks, recreation, business parks, and others, helps to protect the stream corridor as these uses have less negative impacts than residential development.

Guideline 5: Develop a village center.

The center should be accessible within a short walk from all the dwelling units in the village. As in the case of Washington Square in San Francisco, the center includes a multi-purpose community 'living room.' Surrounding the living room, or community open space, are civic facilities such as church, library, post office; as well as neighborhood services such as cleaners, market, coffee houses, restaurants, etc.



Village center connected with a greenlink

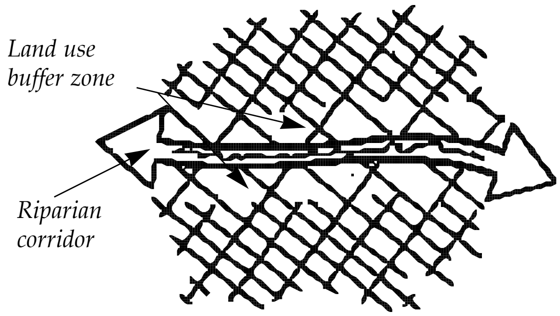
A 320 acre urban village at 18 people per acre has 5,760 residents within a maximum 8 minute walk of the center. With an average household income of $60,000; the village center could have about 270,000 square feet of shops and services. These can be organized around a square, on a main street, or core grid. (Actual supported retail will vary with income, population, and nearby competition.)

Community food center that can combine a local urban farm with a market, restaurant, and neighborhood open space *(design by Eric Rowell)*

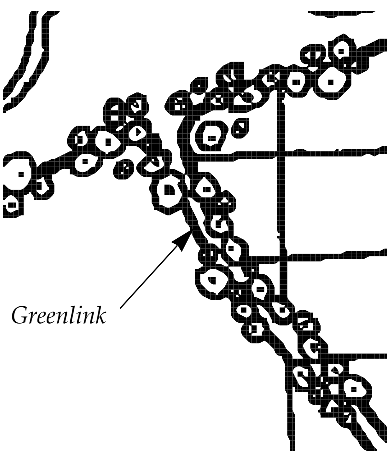
Guideline 6: Provide nearby food production
While the agricultural landscape dominates the Central Valley, it is generally not an amenity integrated into communities. Urban farms can help restore this heritage into daily community life. An urban farm appears to require about 15 to 40 acres to be self sustaining.[13] Residents support the farm by buying produce or with community supported agriculture, subscribe to the operation and receive a share of the produce in return.

As with wildlife ponds and nearby nature sites, urban farms can offer multiple benefits to village residents. A successful urban farm examples is Fairview Gardens in Goleta, a suburb of Santa Barbara.[14] This 15-acre farm is surrounded by conventional residential development. It sells produce on site, in local farmer's markets, and has subscriber families in the neighborhood. The farm is 100 percent accessible open space, and has self-guided trails with informational signs explaining crops, organic farming methods, composting techniques, etc.

When the land was put up for sale for residential development, the neighbors established a non-profit foundation to buy the land and support the farm operation.



Land use buffer at the edge of a riparian corridor



Greenlink connecting to a riparian corridor

Guideline 7: Land use buffers

Land use buffers help protect habitat areas while accommodating urban facilities and human uses. With proper design, schools, parks, recreation facilities, nearby nature sites, community farms, business parks, and commercial centers can make good land use buffers. The primary objective is to seek land uses that can have landscaped open spaces, that are not a source of dogs and cats (as is residential development), and land uses that tend to buffer or limit human access to the protected habitat.

Guideline 8: Provide access from villages to natural landscape features.

South Sacramento residents living near the study area see creeks as positive open space, and ones that can provide linkages between urban parks.[15] Village greenlink and other trails can provide good access to natural systems. In our village planning, open spaces, natural areas, and urban farms are within 12 walking minutes of the village core.

5.4 SUMMARY

Applying urban village/ecological planning and design guidelines to the study area illustrated in this report achieved the following:

Saved 5,867 acres (or 38% of the total area) of riparian corridors, vernal pools, and rare plant patches for limited local ecological purposes.

Improved urban stormwater management by generating approximately 386 acres of multi-purpose detention, wildlife and recreation ponds.

Provided 17 miles of pedestrian and bicycle greenway systems that link human communities as well as nearby nature sites and open spaces.

Generated approximately 5,500 urbanized acres planted with vegetation that can support urban adaptable wildlife.

Provided local open space for 175,5000 residents that is accessible by an average 12 minute walk.

Improved air quality by reducing the vehicle miles traveled by possibly 418 million miles/year.[17]

5.5 NOTES

(1)From studies for the Urban Village Initiative funded by the Environmental Protection Agency.

(2) From Living in the Region: Survey of Residents' Treasured Places, by Randall Fleming and Chris Weiss. Sustainable Communities Consortium, UC Davis. 1998.

(3)South Sacramento Suburban Community Study: Strategies for Community Based Change. Trish Davey Consulting, 1993.

(4)See Section 15; of Extending Arcview GIS. Ormsby, Tim & J. Alvi. ESRI Press, Redlands, CA. 1999.

(5) ModelBuilder is in effect an icon based system of programming Arcview. While Arcview skills are needed, it requires no programming ability, is easy to learn, and it takes little time to build a model. The model we used took about 1 hour to build.

(6) From John Holtzclaw, Using Residential Patterns and Transit to Decrease Auto Dependency and Costs. 1994.

(7) Sokolow, Alvin. Municipal Density and Farmland Protection: An Exploratory study of Central Valley Patterns. Agricultural Issues Center, UC Davis. 1996.

(8) This ratio is based on the West Davis pond, and is derived from Aspen Wildlife Habitat Enhancement & Management Plan for West Davis Pond, by Jones & Stokes. Sizing ponds is complicated, and includes analyzing local conditions such as rainfall, soil percolation, amount of permeable and impermeable soils, and vegetation conditions within the pond's watershed.

(9) Sacramento County planners prefer greenways that are part of front yards, and see backyard greenways as less secure systems.

(10) The City of Sacramento has considered an ordinance that fines/jails individuals who violate access restrictions along the restored wetlands of Laguna Creek.

(11) See the "Our Wetlands" section in the North Laguna Creek Neighborhood organization website; *www.northlagunacreek.org*

(12) Fleming, Randall; et al. Can Urban Development be Good for the Environment? UC Davis, 1999. Page 91.

(13) The financial criteria for urban farms needs more research. It is highly likely that the farms will need some public subsidy, such as provision of land. It would be interesting to assess the benefits and public costs of urban farm operations compared with benefits and costs of other accessible public open spaces.

(14) See From the Good Earth, by Michael Abelman. Times Mirror Co. New York, NY 1993.

(15) From South Sacramento Suburban Community Study. Trish Davey Consulting. 1993.

(16) An Urban Village Initiative study in late 2000 will quantify trip, VMT, and emission impacts of several urban village development scenarios. This figure is based on household unit from the Rockridge neighborhood in Oakland, CA, at miles per household.

ECOLOGICAL PLANNING AND URBAN VILLAGE DESIGN

6.0 Conclusion

We have shown how to combine our existing knowledge of ecological principles, the limited information on individual species needs, and urban village design principles. The result is a method to provide land-efficient human communities with a high quality of life, access to nearby nature, and much greater biological benefits than conventional development.

Six basic principles summarize our approach.

Fundamental Ecological / Urban Village Planning Principles

1. Livable development and successful conservation planning are interlated.

2. Conservation in and outside of urban areas requires more efficient use of urban land.

3. Public accessible urban amenities, including meaningful nature, need to increase significantly as urban efficiencies increase.

4. By intergrating biological sciences and design processes, urban places can enhance habitat quality for urban adaptable wildlife, and provide some habitat for non-urban adaptable species.

5. Even the best designed urban areas will not support the vast majority of species that are declining in the Central Valley.

6. Long term ecosystem sustainability requires permanent and largescale habitat protection outside of urban areas.

TOOLS AND SCIENTIFIC INFORMATION

Ecological conservation planning tools, such as Arcview and the ModelBuilder tool used in this document, offer good resources to process complex information, yet as with any tool, the products need critical review. As more information is developed, such as better understanding of local patch and corridor requirements and urban impacts; the data bases, models, and criteria can be modified and updated.

Many of the guidelines and specific criteria presented need further study to verify and refine the assumptions, design criteria, and associated outcomes (see *Limitations of Knowledge* in chapter 2, Section 2.5). The adaptable species benefits generated by naturescaping need to be verified in the Central Valley context. Riparian corridor criteria should to be studied to see if they actually function as intended. More data on detention/wildlife/recreation ponds performance need to be developed, in part to assure the interests of responsible agencies. The long term vitality of patches and reserves, given various degrees of urban isolation and fragmentation, needs to be better understood. Design criteria for species, including associated habitats, needs to be available.

To support quality of human life, we need to understand more about how these open space features serve the interests and needs of residents. We need to know how, and to what degree, open spaces, urban adaptable wildlife, and village design criteria generate marketplace support for urban village living in the Central Valley.

ECOLOGY AND ONGOING URBAN DEVELOPMENT

Even with imperfect information on the needs of individual species and maintenance of healthy ecosystems, ecological principles suggest relative degrees of ecosystem benefits that could be achieved by these recommendations. Building land-efficient communities and applying development generated funds for permanent conservation areas of large (1000s of acres) of rural land should have a very positive impact on ecosystems. Conserving generous riparian corridors in urban areas could provide some benefit for non-urban adaptable species, and a higher positive impact for urban adaptable species. Increasing the urban habitat value in urban areas will have high benefit for urban adaptable species, especially in urban areas that are located near rural lands, large patches, and riparian corridors.

Ecosystem conservation and open space preservation in the path of urban development should be standard practice in the Central Valley. In addition, new urban areas should provide better habitat for urban adaptable wildlife and improve air and water quality impacts. Achieving these goals requires use of the best principles, scientific information, planning tools, and planning patterns available.

ECOLOGICAL PLANNING AND URBAN VILLAGE DESIGN

7.0 Appendix

7.1 GLOSSARY

100 year floodplain The area of land that, on average, is flooded once every 100 years.

Avifanua Birds.

Bottom-land Land in the low part of a valley, usually adjacent to a river or stream.

Buffer A strip of land that protects a habitat area from edge effects.

Channelized stream A stream that has been converted from its natural condition by creating artificial sides and bottom and often straightening its course.

Cover Vegetation or physical habitat structure providing a particular animal species with safe haven from predators and other threats.

Detention basin An artificial hole in the ground for temporary storage of stormwater runoff.

Disturbance regime Periodic fires or floods, or other disturbance, that occur naturally in an ecosystem.

Ecotone The junction between two adjacent habitats or between a habitat area and the surrounding matrix.

Ecological processes A variety of biological and physical activities that occur in ecosystems and which are important for the long term health of the ecosystem. Examples are periodic flooding or fire, cycling of nutrients, and flows of energy and water.

Edge effects Impacts on a habitat area originating in the different area adjacent to the habitat.

Floodplain Land alongside a river or stream that is occasionally flooded.

Grassy swale Shallow channels that carry runoff away from roads and parking lots.

Habitat corridor A linear stretch which connects habitat patches to each other or to the larger rural landscape.

Habitat island A patch of habitat that is completely surrounded by a matrix which some species cannot cross and so the individuals in the habitat island are isolated.

Habitat network A system of habitat corridors and patches.

Habitat patch A discrete land area or water body with suitable vegetation to support plant and animal species.

Infiltration trenches Artificial trenches filled with material such as gravel that allow temporary storage of stormwater runoff.

Low density development Development in a city or suburb that only has about 4 houses, or less, per net acre.

Matrix The land surrounding a patch or corridor, and which is distinguished by different vegetation or uses.

Mesopredator Smaller predators, like skunks, raccoons and cats.

Naturescaping Vegetation such as tall trees, shrubs and large perennials that attract native birds, butterflies and other animals and is located in public green spaces or individual gardens.

Nearby nature Natural habitat patches and corridors close to people's homes or work places.

Non-point source pollution Pollution that comes from many dispersed sources, rather than a small number of factories, treatment plants etc. Examples are runoff from roads and agricultural fields.

Riparian The interface zone between aquatic and terrestrial ecosystems. Plant species that need high watertables and which tolerate or even needperiodic flooding grow here. Thus "riparian wood land".

Stewardship program A project that involves local people in caring for the health of a natural habitat area.

Suite of species A group of species that use similar habitat (e.g. riparian, wetlands)

Stormwater runoff Water running off roads, parking lots, roofs and other impervious surfaces during a rainstorm.

Terrestrial vertebrates All vertebrates that do not live in the water (term includes birds).

Understory Layer of vegetation that has another layer of different vegetation above it. For example, shrubs underneath a tree canopy.

Upland Lands above the floodplain.

Urban fringe The edge of the urban area.

Viable population A discrete population of an animal or plant species with enough individuals and habitat that the species is likely to persist over a long time period.

Vegetative filter strips A strip of vegetation which filters runoff from roads and parking lots and removes pollutants.

7.2 BIRD LISTS

These following four lists show birds seen in very different urban settings. The American River Parkway bird list is courtesy of American River Natural History Association. Mike Conner, City of Davis Public Works Department, provided the West Davis Pond list. The American River Parkway includes river and riparian woodland habitat in a very wide corridor extending from the urban fringe deep into the metropolitan area. The West Davis pond has pond, wetland, mudflat, and riparian woodland habitat in a residential setting very close the extensive farmlands. These lists include visiting and resident birds, ranging from common to very rare. The inner suburb and city center lists represent typical lists of birds liley to be seen in these situations (from author's observation).

American River Parkway	West Davis Pond	Inner suburbs with large trees	City centers
Pied-billed grebe	Pied-billed grebe	Cooper's hawk	Rock dove
Great blue heron	Eared grebe	Red shouldered hawk	European starling
Green heron	Double-crested cormorant	Rock dove	House sparrow
Mallard	Canada goose	Mourning dove	
American wigeon	Snow goose	Western screech-owl	
Wood duck	Mallard	Barn owl	
Ring-necked duck	Gadwall	Anna's hummingbird	
Common goldeneye	American wigeon	Rufous hummingbird	
Common merganser	Northern shoveler	Nuttall's woodpecker	
Turkey vulture	Cinnamon teal	Northern flicker	
White- tailed kite	Wood duck	Purple martin	
Sharp-shinned hawk	Canvasback	Scrub jay	
Cooper's hawk	Bufflehead	American crow	
Red-tailed hawk	Hooded merganser	Bushtit	
Red-shouldered hawk	Common merganser	White breasted nuthatch	
American kestrel	White tailed kite	Bewick's wren	
California quail	Cooper's hawk	Ruby-crowned kinglet	
Mountain quail	Northern harrier	American robin	
Common gallinule	Red tailed hawk	Northern mockingbird	
American coot	Red shouldered hawk	Cedar waxwing	
Killdeer	American kestrel	European starling	
Spotted sandpiper	Ring-necked pheasant	Orange crowned warbler	
Greater yellowlegs	Great egret	Yellow-rumped warbler	
Least sandpiper	Snowy egret	Wilson's warbler	
Herring gull	Great blue heron	House sparrow	
California gull	Green heron	Purple finch	
Ring-billed gull	Black-crowned night heron	House finch	
Mew gull	American coot	Spotted towhee	
Forster's tern	American avocet	California towhee	
Rock dove	Black-necked stilt	California towhee	
Mourning dove	Killdeer	Golden-crowned sparrow	
Barn owl	Bonaparte's gull	White-crowned sparrow	
Western screech owl	Caspian tern	Dark-eyed (Oregon) junco	
Great horned owl	Barn owl		
Burrowing owl	Belted kingfisher		
White-throated swift	Black phoebe		
Black-chinned hummingbird	Say's phoebe		
Anna's hummingbird	Barn swallow		
Rufous hummingbird	American crow		
Belted kingfisher	European starling		
Common flicker	Western meadowlark		
Acorn woodpecker	Brewer's blackbird		
Yellow-bellied sapsucker	Brown-headed cowbird		
Downy woodpecker	American goldfinch		
Nuttall's woodpecker	White-crowned sparrow		
Western kingbird	Lincoln sparrow		
Ash-throated flycatcher			
Black phoebe			
Willow flycatcher			

American River Parkway	West Davis Pond	Inner suburbs with large trees	City centers
Western flycatcher Western wood pewee Violet-green swallow Tree swallow Rough-winged swallow Barn swallow Cliff swallow Scrub jay Yellow-billed magpie Common crow Plain titmouse Common bushtit White breasted nuthatch Brown creeper House wren Bewick's wren Rock wren Mockingbird American robin Varied thrush Hermit thrush Western bluebird Blue-gray gnatcatcher Ruby-crowned kinglet American pipit Cedar waxwing Phainopepla Starling Hutton's vireo Solitary vireo Warbling vireo Orange-crowned warbler Nashville warbler Yellow warbler Yellow-rumped warbler Black-throated gray warbler Townsend's warbler MacGillivray's's warbler Wilson's warbler House sparrow Western meadowlark Red-winged blackbird Northern oriole Brewer's blackbird Brown-headed cowbird Western tanager Black-headed grosbeak Lazuli bunting Purple finch			

American River Parkway	West Davis Pond	Inner suburbs with large trees	City centers
House finch American goldfinch Lesser goldfinch Rufous-sided towhee Brown towhee Savannah sparrow Lark sparrow Dark-eyed junco White-crowned sparrow Golden-crowned sparrow Fox sparrow Lincoln's sparrow Song sparrow			