# APPENDIX J

# WATERCOURSE AND WETLANDS BACKGROUND / PRIMER

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## J.1 ECOLOGY OF WATERCOURSES AND WETLANDS

The watercourses and wetlands within the City of Santa Cruz are a valuable natural resource supporting a diversity of natural habitats and a great variety of aquatic and terrestrial resources. The riparian zone is the plant community adjacent to a watercourse; this zone serves as the interface between the waterway and surrounding upland habitats. Riparian areas are characterized by high species diversity, due to the presence of water, the use of their linear form as a movement corridor for wildlife and the presence of nutrient-rich sediments and organic matter from floodwaters.

The diversity of riparian habitats is evident in the structural complexity of the vegetation (i.e., presence of trees, shrubs and groundcovers); the deciduous features of most riparian woodland creates a mosaic of sun and shade, an abundance of insects, and a rich duff layer that provides a variety of habitats for wildlife. Coupled with the presence of surface water, riparian areas provide very important habitat for aquatic invertebrates, fish, amphibians, birds and mammals. A number of wildlife species are dependent on healthy riparian and wetland communities for survival. Bird species diversity, for example, has been related to foliage height, diversity and volume, percent cover and plant species diversity (Habitat Restoration Group, 1991). The availability of abundant perch sites and the presence of various food types also contribute to the high habitat value for birds.

Adequate habitat widths are also necessary to maintain some breeding bird populations. Lands that are adjacent to riparian and wetland habitats are also important to some species for foraging and movement. The riparian area, due to its linear nature, provides a high edge-to-area ratio (Odum, 1979). This serves to maximize the interface between riparian vegetation and adjacent upland habitats and between the stream vegetation and the aquatic environment. Both the density and diversity of wildlife species tends to be higher at the land-water ecotone than in adjacent uplands (Habitat Restoration Group, 1991).

Of the numerous species of plants, fish, and wildlife that occur within riparian corridors, several species are now identified as sensitive by State and Federal resource agencies. Streams and riparian corridors are also a valuable visual and aesthetic resource, provide open space and recreational resources, and, within the City of Santa Cruz, contain a portion of the City's urban forest.

Wetlands also occur within the City. Wetlands occur where there is perennially or seasonally saturated soil conditions or open water, such as at lagoons and ponds. Wetland vegetation is often characterized as a marsh, such as the freshwater marsh at Neary Lagoon. Wetlands that occur at the mouth of watercourses where there are tidal inflows from Monterey Bay are considered salt or brackish water marshes. Wetlands are recognized by biologists for their high species diversity, the high use of the habitat by wildlife for foraging and nesting and the presence of nutrient-rich sediments and organic matter. Wetlands also entrap and filter urban runoff through the uptake of materials in plant matter. Typically, three parameters (i.e., wetland hydrology, wetland vegetation and wetland soils) are used to characterize wetlands.

Riparian corridors, wetlands and adjacent upland areas combine to provide the following biological functions:

- Protects water quality, providing habitat for invertebrates and fish, which can support shorebirds, wading birds, and other animals;
- Provides food, cover and migration corridors for a number of amphibians and reptile species including sensitive and threatened or endangered species such as the southwestern pond turtle and California red-legged frog;
- Provides cover and food resources for wildlife species that range between riparian and upland areas;
- Provides forage, cover, and movement for a number of riparian-dependent birds and mammals;
- Provides wildlife movement corridors during high runoff periods; and
- Stabilizes and strengthens stream banks, reducing erosion and sedimentation into the creeks and wetlands.

Despite the importance of riparian and wetland habitats to native vegetation and wildlife, the extent of these areas has been significantly decreased within the local region, and the State as a whole, over the past 200 years. The amount of riparian and wetland habitat has decreased due to the encroachment of agriculture, domestic animal grazing, urban development, roadway crossings, water diversions and channelization for drainage and flood control. As a result, riparian corridors in urban areas are often narrow, constrained by residential and commercial development and have significant gaps where riparian vegetation has been removed. Other factors that affect their value include traffic, bank stabilization projects, pollution, human activities, domestic pets and the presence of invasive, non-native plants. Many species of amphibians, reptiles and mammals that commonly occur in riparian habitats in undeveloped areas are often missing in urban riparian settings, as these animals are least able to co-exist with humans, urban impacts and the lack of adjacent natural upland habitats. Conversely, some riparian birds are able to maintain populations in urban riparian habitat (Habitat Restoration Group, 1991).

The biotic resources of watercourses and wetlands offer many benefits to City residents, including opportunities for fishing (e.g., San Lorenzo River), outdoor recreation, nature study, landscape painting and nature photography. Vegetation also helps prevent soil erosion as plant roots hold the soil from below; from above, the tree canopy lessens the intensity that rain strikes the ground, preventing excessive loosening of the soil particles and thus reducing sheet erosion. Vegetation also moderates local climatic conditions. On hot summer days, temperatures within the riparian woodland are cooler that temperatures in open areas.

The City of Santa Cruz supports a mosaic of riparian and wetland habitats. These include a diversity of riparian woodlands (characterized by the presence of deciduous or evergreen trees and shrubs) and herbaceous riparian and wetland habitats (characterized by the presence of herbaceous and non-woody plants, such as grasses and forbs). The City also has several watercourses that have been modified, into either concrete-lined channels or culverts; some of these modified channels support riparian or wetland habitat. Each of these habitat types are described below.

### J.1.1 Riparian Woodlands

Riparian woodlands occur along most of the watercourses and along the edges of marshes within the City. This streamside vegetation typically grows up to the bankfull flow line and often extends above

this line due to wet winter months when soil moisture levels are high. Three types of riparian woodland habitat have been documented in the City, as described below. The stream channels usually exhibit some evidence of scour and/or deposition. The high water regime of a stream is an important component in the species composition along a watercourse as most riparian plant species are adapted to colonizing recently disturbed (i.e., flooded, scoured or depositional) portions of a watercourse.

Riparian woodland vegetation occurs along perennial streams (typically depicted as a solid blue line on USGS 1:24,000 scale topographical maps) and intermittent streams (typically depicted as a dashed blue line on USGS 1:24,000 scale topographical maps) with well-defined channels.

#### *J.1.1.1 Mixed Riparian Woodland*

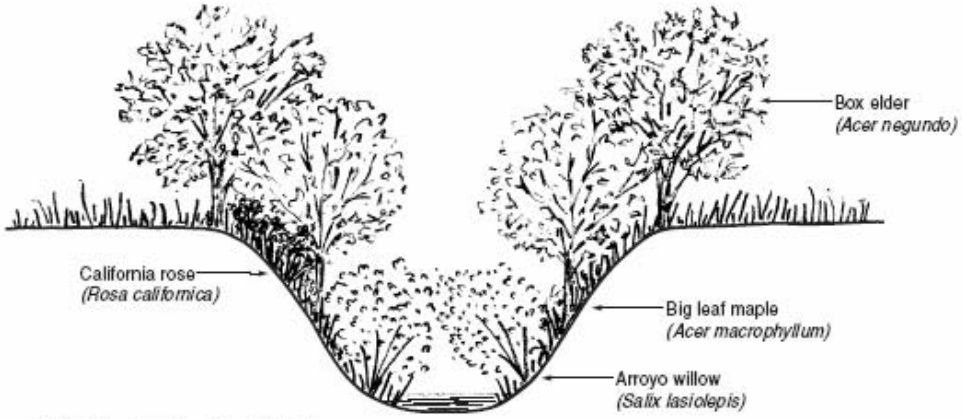
**Vegetation.** This riparian woodland type is distributed along the coast of California, from approximately San Luis Obispo County to Humboldt County (Holland, 1986). The community is characterized by the presence of a dense, winter deciduous thicket of trees, primarily arroyo willow (*Salix lasiolepis)*. The willows respond well to seasonal flooding and easily colonize open sand and gravel deposits left from winter flows. Within the City, mixed riparian woodland is prevalent along several watercourses, such as the upper San Lorenzo, lower Arroyo Seco, Arana and Carbonera creeks (and their tributaries). Chapter 3.0 describes each of these watercourses in more detail.

In addition to willows, other characteristic woody vegetation within the woodland includes (but is not limited to): red alder (*Alnus rubra*), box elder (*Acer negundo*), black cottonwood (*Populus balsamifera ssp. trichocarpa*), big leaf maple (*Acer macrophyllum*), box elder (*Acer negundo*) and coast live oak (*Quercus agrifolia*). Red alder is typically restricted to perennial watercourses, such as Arana Gulch Creek. In some areas within the City, willow is the dominant tree species. In these areas, the understory can be sparse due to the dense cover and shade produced by young trees. Where there are openings in the woodland, or where the vegetation is comprised of older trees (i.e., greater than 10-15 years old), understory plants are more prevalent. Native understory plant species that occur within City watercourses include California blackberry (*Rubus ursinus)*, thimbleberry (*Rubus parviflorus*), stinging nettle (*Urtica doioca)* and creek dogwood (*Cornus glabrata*). Common attributes of mixed riparian areas are depicted on Figure J-1.

In areas where riparian vegetation is naturally re-colonizing previously disturbed areas or abuts developed areas, the riparian woodland often supports invasive, non-native plant species. Commonly observed species within City watercourses include cape ivy (*Delaireia odorata)* (formerly known as German ivy), acacia (*Acacia* spp.) and English ivy (*Hedera helix).* City watercourses offer opportunities for management of mixed riparian woodlands through the removal of invasive, non-native plant species. The watercourses also offer opportunities for riparian revegetation and management, particularly where there has been streambank erosion or removal of vegetation.

**Wildlife Resources.** Mixed riparian habitat has one of the highest values for wildlife species diversity and abundance within the City. Factors that contribute to high wildlife value include the presence of surface water, the variety of niches provided by the high structural complexity of the habitat, and the abundance of plant growth. Mixed riparian habitat may be used by wildlife for food, water, escape cover, nesting, migration and dispersal corridors, and thermal cover. Areas along Arana Gulch Creek, San Lorenzo River (north of Highway 1), and Arroyo Seco Creek (north of Highway 1) provide the contiguous areas of mixed riparian woodland habitat that are valuable for wildlife.

## FIGURE J-1. ATTRIBUTES OF MIXED RIPARIAN HABITAT




**Common Attributes of Mixed Riparian Woodland Habitats:**

- Found along both perennial and intermittent watercourses.
- Growth and width of corridor often confined by previous residential or commercial development.
- Habitat often supports non-native plant species; most common invasive is Cape and English ivy, lesser amounts of pampas grass, periwinkle and acacia.
- Woodland provides movement corridor for wildlife, including special status species.
- Provides opportunities for riparian habitat restoration and enhancement through removal of invasive plants and debris and maintenance of buffer setback areas.

**Sample Locations:**

- Some creeks in the Seabright Area
- Portions of Arana Creek
- Upper San Lorenzo River
- Upper Branciforte Creek

**SOURCE:** Biotic Resources Group, 2001

Common wildlife species that are expected to inhabit the mixed riparian habitat include Pacific treefrog *(Hyla regilla),* bullfrog (*Rana catesbeiana*), western aquatic garter snake (*Thamnophis couchii*), Wilson's warbler *(Wilsonia pusilla),* Bewick's wren (*Thryomanes bewickii*), green heron (*Butorides striatus*), several species of swallows, raccoon (*Procyon lotor*), and opossum (*Didelphis virginiana*). Other wildlife species within these areas may include great blue heron (*Ardea herodia*) and black-crowned night heron (*Nycticorax nycticorax*).

Wooded streams are also important for fish and aquatic species. Shade from trees moderates the water temperature and the tree roots and fallen trees can create pools that benefit aquatic habitat. Perennial watercourses in the City support both native and non-native fishes. San Lorenzo River and Branciforte and Arana Gulch Creeks support steelhead trout (*Oncorhynchus mykiss*), a federally listed species (see discussion under Special Status Wildlife Species); steelhead traverse stream reaches in mixed riparian habitat to upstream spawning areas. Although much work has been done on steelhead, less has been documented about other native fishes within City watercourses. Native, non-game fish are generally less obvious than the sport fish, but are an essential part of the overall aquatic ecosystem and contribute to natural stream health and diversity. Native, non-game fish that have been recorded in the City include three-spined stickleback (*Gasterosteus aculeatus)* (Habitat Restoration Group, 1991), Sacramento sucker (*Catostomus occidentalis)* and prickly sculpin (*Cottus asper)* (Jerry Smith, pers. comm., 2002). Non-native fishes, such as mosquito fish (*Gambusia affinis*), also occur in the City watercourses (Jerry Smith, pers. comm., 2000).

Non-native wildlife species are also present in mixed riparian woodlands. Species such as bullfrogs, Norway rat, black rat, starling, mockingbird, rock dove, house sparrow, domestic dog and domestic cat have been recorded in watercourses in the City (B. Mori, 1999).

Large numbers of starlings have been reported to breed and roost at Westlake Pond (Majors Spring) (San Lorenzo Watershed Management Plan, County of Santa Cruz, 1979). Because starlings are so aggressive, they push other birds out of tree cavities to use the cavities for themselves. Since many birds native to the riparian corridors require tree cavities for nest sites, the presence of starlings will degrade the value of the habitat. The starling roost at Westlake Pond has declined in recent years (probably due to the removal of tules); a few thousand birds may still use the area (Habitat Restoration Group, 1989).

### *J.1.1.2 Oak Riparian Woodland*

**Vegetation.** This riparian community occurs in canyon bottoms and floodplains along the coast range of California, from Sonoma County south to near Point Conception (Holland, 1986). The woodland occurs along both perennial and intermittent watercourses and can become an upland community on hillside edges and terraces, such as at Moore Creek Preserve (City of Santa Cruz, 2001). Oak riparian woodland is prevalent in the Moore Creek watershed and on the City's east side (e.g., Arana Gulch Creek and tributaries).

The woodland is characterized by the dominance of coast live oak; however, there are also occurrences of California buckeye (*Aesculus californica*), California bay (*Umbellularia californica*) and willow. The canopy cover is typically dense (more than 50 percent overstory plant cover). In some areas, such as near DeLaveaga Park, the oak riparian woodland intergrades with adjacent redwood forest and eucalyptus groves. Occurring on many watercourses in the City, the oak riparian woodland probably also occupied the upland slopes and terraces that abut the watercourses; the majority of this habitat, however, has been removed by historic agricultural land uses and, more recently, by urban development.

The understory within the oak riparian woodland is diverse. Commonly observed shrub species include poison oak (*Toxicodendron diversilobum)*, California blackberry, blue blossom ceanothus (*Ceanothus thyrsiflorus*), toyon (*Heteromeles arbutifolia)* and coffeeberry (*Rhamnus californica)*. Hairy honeysuckle (*Lonicera hispidula*), a climbing vine, and yerba buena (*Satureja douglasii*), a groundcover, are also common.

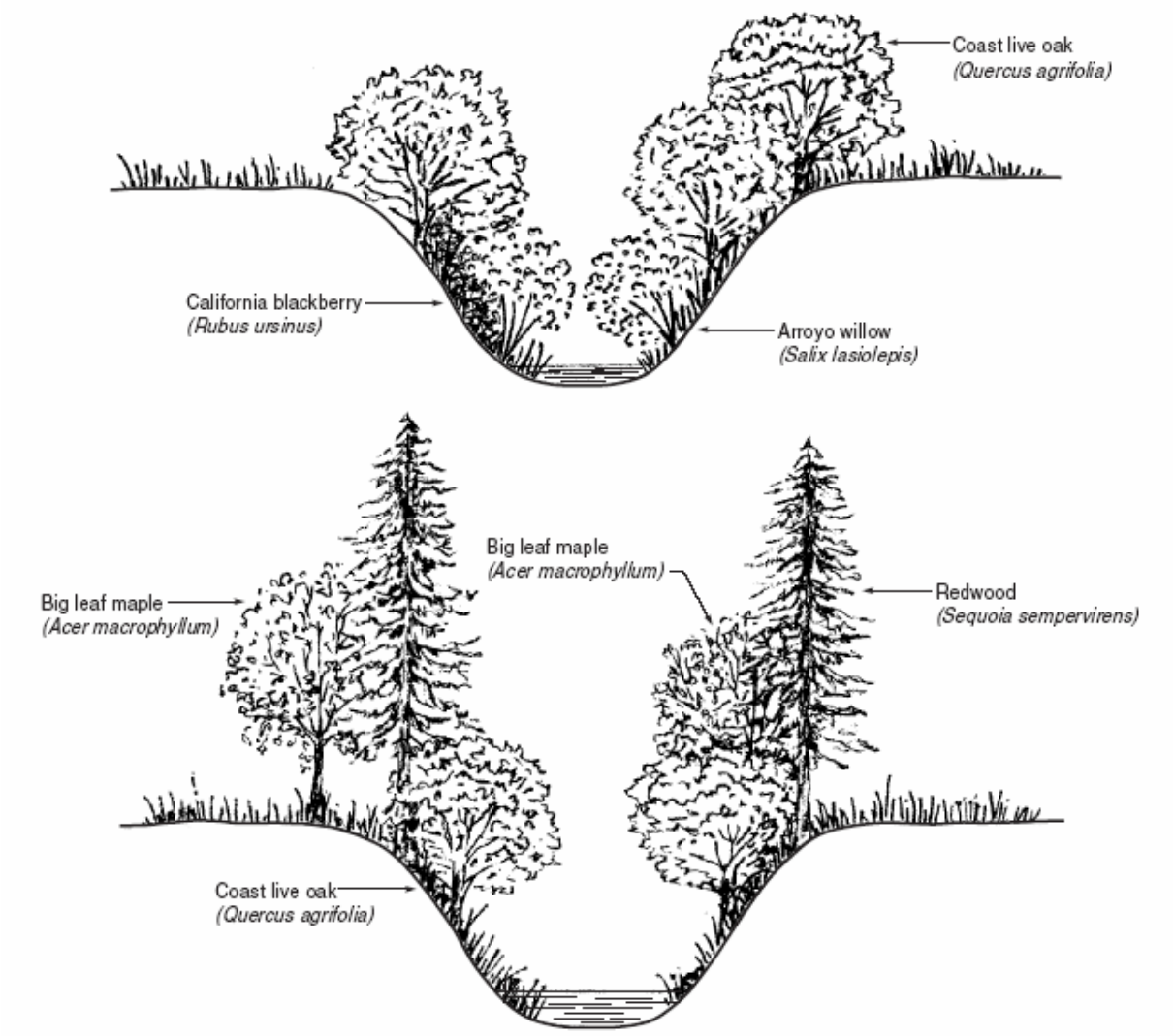
Oak riparian woodlands within the City also support infestations of invasive, non-native plant species and urban landscape plants. Invasive, non-native plant species include French broom (*Genista monspessulana),* pampas grass (*Cortederia jubata),* periwinkle (*Vinca major),* English and Algerian ivy (*Hedera* spp.) and cape ivy. All of these species have been documented within oak riparian woodland. These non-native species thrive in previously disturbed soils within the woodlands, grow into dense stands and exclude the growth of most native plant species, thereby reducing plant diversity of the habitat. The oak riparian woodland along the City's watercourses offers opportunities to remove or control the spread of these invasive understory plant species. Common attributes of oak riparian woodland are depicted on Figure J-2.

**Wildlife Resources.** Like mixed riparian woodland, oak riparian habitat is valuable to wildlife. The wildlife value of oak riparian woodland varies with the degree of canopy cover and the density and diversity of understory plants. Acorns from oaks provide an important food resource for many wildlife species, and natural cavities in oaks provide nesting opportunities for some birds and mammals. Snags are an important component of oak woodlands to some wildlife such as woodpeckers, which excavate nests in snags and holes for storing acorns. Approximately 40 percent of all birds nesting in riparian woodlands nest in tree cavities (Gaines, 1977). Cavity nesting birds generally have better nesting success due to the greater security that holes provide from squirrels, raccoons, jays and other nest predators (Gaines, 1977).

Downed decaying logs and limbs also add to the structural complexity of the habitat, and are important cover, nesting, roosting, and foraging substrate for species such as California newt (*Taricha torosa*) and ornate shrew (*Sorex ornatus*), which are attracted to the moist microclimate and invertebrate food supply. The denser oak woodlands also provide escape cover during the day for species such as deer. The most contiguous area of oak riparian habitat in the City is along Moore Creek north of Highway 1.

Common wildlife species that occur in oak riparian woodland habitat within the City include California slender salamander (*Batrachoseps attenuatus*), arboreal salamander (*Aneides lugubris*), scrub jay (*Aphelocoma coerulescens*), California quail (*Callipepla californica*), red-tailed hawk (*Buteo jamaicensis*), acorn woodpecker (*Melanerpes formicivorus*), chestnut-backed chickadee (*Poecile rufescens*), California myotis (*Myotis californicus*), western gray squirrel (*Sciurus griseus*), and deer (*Odocoileus hemionus*). Moore Creek, an oak riparian dominated riparian area, supports the California red-legged frog (*Rana aurora draytonii*), a species federally listed as threatened. Non-native wildlife species are also present in oak riparian woodland. Species such as bullfrogs, Norway rat, black rat, common opossum, starling, mockingbird, rock dove, house sparrow, domestic dog and domestic cat have been recorded in oak-dominated watercourses in the City.

## FIGURE J-2. ATTRIBUTES OF OAK RIPARIAN WOODLAND HABITAT




**Common Attributes of Oak Riparian Woodland:**

- Found along both perennial or intermittent watercourses, typically in steep-sided arroyos.
- Most habitats in City abut existing residential areas.
- Often support non-native plant species; most common invasive is Cape and English ivy, lesser amounts of pampas grass and periwinkle
- Woodland provides movement corridor for wildlife, including special status species.
- Watercourses provide opportunities for riparian habitat restoration and enhancement through removal of invasive plants and debris and maintenance of buffer setback areas.

**Sample Locations:**

- Tributary to Arana Gulch in Prospect Heights area
- Portions of Arana Creek, upstream of Highway 1
- Branciforte Creek
- Carbonera Creek

**SOURCE:** Biotic Resources Group, 2001

Perennial watercourses supporting oak riparian woodland are also important for fish and aquatic species. As discussed for mixed riparian woodland, shade from trees moderates the water temperature and tree roots and wood can create pools that benefit aquatic habitat. The oak riparian woodland along Branciforte and Arana Gulch Creeks supports steelhead trout; steelhead traverse through the woodland to upstream spawning areas. Other fish species recorded in the City include three-spined stickleback, prickly sculpin and mosquito fish.

#### *J.1.1.3 Non-Native Riparian Woodlands*

**Vegetation.** Woodlands comprised of non-native plant species occur along some of the City watercourses. Non-native plants are species that have been introduced into an environment in which they did not naturally evolve. In general, many non-native plants have no natural enemies or controls to limit their spread and as a result, can successfully compete with native species and dominate the landscape.

Blue gum eucalyptus (*Eucalyptus globulus)*, a non-native tree that occurs throughout coastal California, including many of the watercourses in the City of Santa Cruz, is native to Australia. The species was intentionally brought to California as a lumber source and has since been used for windbreaks, firewood and evergreen landscaping. Since the blue gum eucalyptus readily stump sprouts and can easily regenerate from seed, large groves of eucalyptus have been successful in inhabiting many types of environments. In addition to upland areas, the blue gum eucalyptus has become established along many watercourses in the City, replacing the indigenous riparian vegetation, which was probably oak riparian woodland or mixed riparian woodland. Although the native riparian vegetation is absent (or substantially reduced in its extent), where the eucalyptus trees occur along watercourses in the City, the resulting tree groves or woodland are considered non-native riparian woodlands.

Plant species that are native to California are also considered non-native if they occur in areas that they did not occupy historically (usually considered by most botanists to be before the arrival of Mexican land grantees). The Monterey pine (*Pinus radiata)* is native to distinct populations along California's central coast, yet has been planted as a landscape tree throughout the State (and elsewhere in the world). Where these trees occur outside the native stands, they are considered non-native. The Monterey pine groves that occur within the City of Santa Cruz are non-native and have been planted or have naturally established from planted individuals. Where the pines occur along watercourses they have displaced the indigenous riparian vegetation. The trees do retain some riparian functions, however, such as providing cover for riparian wildlife and are therefore considered to be non-native riparian woodlands.

Although the blue gum eucalyptus and Monterey pine are the dominant non-native tree species within the City watercourses, other tree species also occur. There are several groves of non-native blackwood acacia (*Acacia melanoxylon)* and green wattle acacia (*Acacia decurrens*) as well as other scattered landscape trees. In many instances, the understory beneath the non-native trees is vegetated with non-native shrubs and vines, most notably French broom, pampas grass and Himalayan berry (*Rubus procerus*). Other understory species observed in the non-native riparian woodland are cotoneaster (*Cotoneaster* sp.) and garden nasturtium (*Tropaeolum majus*).

Large expanses of non-native riparian woodland occur along Arroyo Seco Creek and its tributaries and along tributaries to Arana Gulch Creek in DeLaveaga Park. Non-native riparian woodland is also

present along Branciforte and Carbonera creeks. In many instances, residential areas abut these tree groves.

The non-native eucalyptus has adapted to natural fire. In their native habitat (i.e., Australia), eucalyptus tree forests are subject to natural fires. The tree's seed is released from its cap after a fire and, like the native Monterey pine seed, has adapted to germinating in open, fire scorched soil. The thick duff beneath the trees (comprised of leaf and bark litter) as well as the numerous bark peels on the tree trunk, provides favorable conditions for crown fires. In recognition of the fire danger these trees pose to nearby residential areas and the fact that these groves are non-native, there are opportunities to remove these trees and re-establish native woodlands (e.g., oak riparian woodland), where the trees are not supporting overwintering habitat for monarch butterflies (see Wildlife Resources, below). Common attributes of the non-native woodland areas are depicted on Figure J-3.

**Wildlife Resources.** Non-native riparian woodlands are of moderate value to wildlife. Because eucalyptus is not native to California, many native wildlife have not evolved to utilize this habitat type and it does not support a very diverse wildlife assemblage. The oils in eucalyptus bark and leaves are thought to be slightly toxic to amphibians, and leaf-litter invertebrates as food are scarce, and thus these species are not commonly found in eucalyptus groves. Common wildlife species that do utilize eucalyptus groves include alligator lizard (*Gerrhonotus multicarinatus*), red-shouldered hawk (*Buteo lineatus*), great horned owl (*Bubo virginianus*), Anna's hummingbird (*Calypte anna*) and woodrat (*Neotoma fuscipes annectens*).

Eucalyptus and Monterey pine trees are locally important in some locations as they provide potential wintering habitat for monarch butterflies (*Danaus plexippus*). For example, the eucalyptus grove in Natural Bridges State Park along a portion of Moore Creek is an important monarch butterfly wintering site in Santa Cruz.

### J.1.2 Riparian Scrub

This riparian vegetation type is prevalent throughout California and typically inhabits previously scoured riverbeds and stream banks, as well as recent gravel and sand deposits from flood flows. Riparian scrub occurs along intermittent and perennial streams and along the edges of the freshwater marshes.

**Vegetation.** Within the City, riparian scrub is characterized by the dominance of young willows; arroyo willow and red willow (*Salix laevigata*) are common plant species. Although willows are the most prevalent type of vegetation, other plant species also occur, such as California blackberry, water smartweed (*Polygonum emersum*), stinging nettle, spreading rush (*Juncus patens*), nut sedge (*Cyperus eragrostis*) and poison oak.

The presence of riparian scrub vegetation is indicative of high soil moisture during most of the year. Where willows occur at hillside seeps/springs, the vegetation persists as a dense thicket of willows. Other riparian tree species are absent due to the high soil moisture or other hydrological conditions. Where willow scrub has been observed along intermittent or perennial waterways, the absence of mature, large-sized willows and other riparian tree species indicates either natural or human-induced disturbances. Stream bank erosion can result in the loss of riparian vegetation from the streambanks, such that a site is continually vegetated with young willows. Similarly, stream bank disturbances and domestic animal browsing can also result in the maintenance of young willow growth (versus the development of mature trees).

In areas subject to repeated disturbances, invasive non-native plant species have also been documented. The most prevalent invasive plant species within riparian scrub are French broom and poison hemlock (*Conium maculatum)*. These perennial plants are prevalent along the edges of willow riparian scrub and intermix with the willow. Growth of hemlock retards growth of native understory plant species. The City watercourses offer opportunities for the management of riparian scrub areas through the removal of invasive, non-native plant species. Additionally, in areas capable of supporting more diverse and mature riparian woodland (see discussion on mixed riparian woodland, above), these watercourses offer opportunities for riparian revegetation and management.

**Wildlife Resources.** Riparian scrub habitat provides moderate value to wildlife. Native plants provide seeds and berries for wildlife food, and willows host abundant insects, an important wildlife forage. Where vegetation is dense, there may be opportunities for nesting, and daytime cover for nocturnal species. However, scrub areas exist because they are subjected to periodic disturbance, and this limits the long-term value of the habitat for wildlife. Many of the non-native wildlife species described previously can also occur in riparian scrub areas.

Riparian scrub provides moderate value to aquatic resources. Limited shading of the watercourse can result in higher water temperatures that may adversely affect steelhead. Lack of woody cover also reduces the structural complexity of the channel, resulting in poor pool and riffle development.

## J.1.3 Herbaceous Riparian and Wetland Habitats

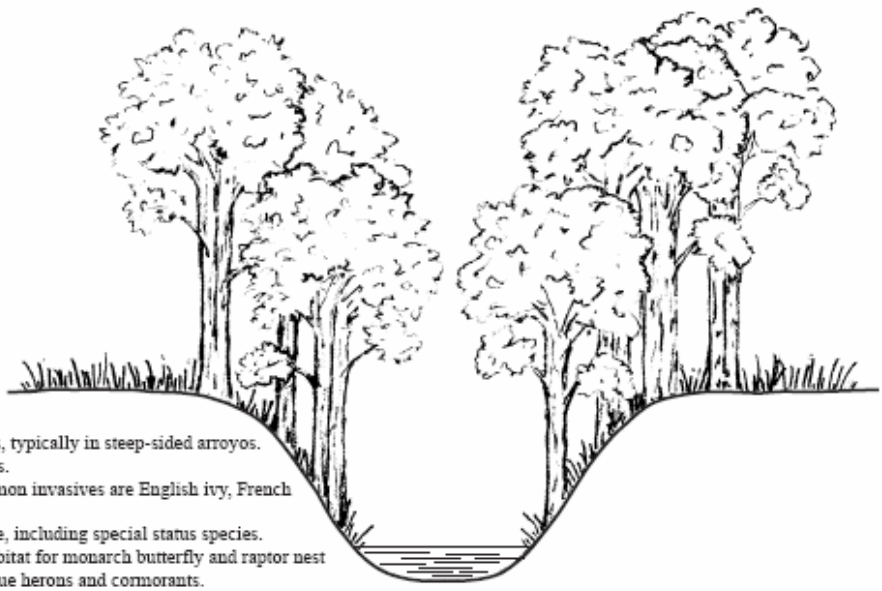
Herbaceous riparian and wetland vegetation types are prevalent throughout California. The community is characterized by the absence of woody vegetation (i.e., absence of trees and shrubs). Herbaceous riparian vegetation typically inhabits previously disturbed riverbeds and stream banks, as well as along hillside drainages where only seasonal water is available for plant growth. Herbaceous wetlands are typical of areas with standing water or perennially saturated soil conditions, such as occurs in salt, brackish and freshwater marshes.

### *J.1.3.1 Herbaceous Riparian Habitats*

**Vegetation.** This plant community type occurs along several intermittent and perennial watercourses in the City. Vegetation is dominated by herbaceous (i.e., non-woody) plant species. Plant species like common rush (*Juncus effusus*), Santa Barbara sedge (*Carex barbarae*), rabbits-foot grass (*Polypogon monspeliensis)*, nutgrass (*Cyperus* spp.), brown-head rush (*Juncus phaeocephalus*), California blackberry and cattail (*Typha* spp.) have been documented within the City. Herbaceous riparian habitat can also occur in areas subject to animal grazing or other land disturbances where the woody riparian cover (usually willow) has been browsed or otherwise removed. Common attributes of herbaceous riparian vegetation are depicted on Figure J-4.

Many watercourses currently supporting herbaceous riparian vegetation probably historically supported mature riparian woodland. The woody vegetation was likely removed during urban development or channel modifications; current site conditions or maintenance activities likely preclude natural re-establishment of woody vegetation. City watercourses offer several opportunities for restoration of these areas through revegetation of riparian scrub or mixed riparian woodland. There are also opportunities to remove occurrences of invasive, non-native plant species.

## FIGURE J-3. ATTRIBUTES OF NON-NATIVE WOODLAND HABITAT



**Common Attributes of Non-Native Woodland:**

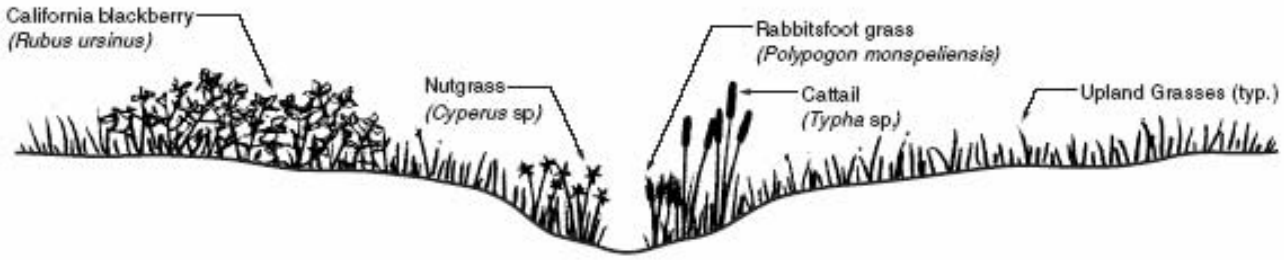
- Typically dominated by eucalyptus.
- Found along both perennial or intermittent streams, typically in steep-sided arroyos.
- Most habitats in City abut existing residential areas.
- Often support non-native plant species; most common invasives are English ivy, French broom and cotoneaster.
- Woodland provides movement corridor for wildlife, including special status species.
- Some eucalyptus tree groves provide wintering habitat for monarch butterfly and raptor nest sites; may also provide seasonal roosts for great blue herons and cormorants.
- The dense shade and tree litter inhibits growth of native riparian woodland species.
- Watercourses provide opportunities for riparian habitat restoration and enhancement through the control of young eucalyptus tree recruitment, removal of invasive understory plants and maintenance of buffer setback areas.
- Eucalyptus are often shallow-rooted and can topple into streams during high winds.
- Low diversity of aquatic insects compared to native riparian woodlands.

**Sample Locations:**

- Moore Creek, near Empire Grade
- Portions of Hagemann Gulch
- Creek in Seabright Area (Peck Terrace)
- Portions of Arroyo Seco Creek (near Meder Street)

**SOURCE:** Biotic Resources Group, 2001

## FIGURE J-4. ATTRIBUTES OF HERBACEOUS RIPARIAN HABITAT




**Common Attributes of Herbaceous Riparian Habitats:**

- Found primarily along perennial watercourses.
- Typically occur along modified watercourses and are confined by previous residential or commercial development.
- Habitat often supports invasive, non-native plant species; most common invasive plant is English Ivy.
- The watercourses provide opportunities for riparian habitat restoration and enhancement through revegetation of trees and shrubs, removal of invasive plants and debris and maintenance of buffer setback areas.

**Sample Locations:**

- Portions of Arroyo Seco Creek
- Portions of Jessie Street Marsh
- Some creeks within the Prospect Heights area

**SOURCE:** Biotic Resources Group, 2001

**Wildlife Resources .** Herbaceous riparian habitat is of moderate value to wildlife. The seeds of rushes and sedges provide forage for small mammals and birds, and where cattails form dense patches, they may provide nesting habitat for some birds. Herbaceous riparian areas provide low to moderate value for aquatic resources. The lack of shade over the watercourse can result in higher water temperatures that are unsuitable for some native fishes, such as steelhead. The lack of woody cover also reduces the structural complexity of the channel, resulting in poor pool and riffle development. Aquatic species, such as dragonfly larvae and adults, damselfly larva and adults and water beetles have been recorded from perennial watercourses with herbaceous vegetation (Habitat Restoration Group, 1998).

### *J.1.3.2 Freshwater Marsh*

**Vegetation.** This vegetation type consists of areas dominated by perennial, non-woody plant species that are adapted to growing in wet conditions. The plants grow in permanently saturated soil, along the edge of marshes. In some instances, confined watercourses are also dominated by freshwater marsh vegetation, such as the lower portions of Arroyo Seco Creek. Winter inundations, creek flows and spring or seeps have resulted in freshwater marsh species growing along the edges and within Antonelli Pond, Neary Lagoon, Jessie Street Marsh and Westlake Pond. Many of the privately owned in-channel ponds along Dodero Creek (in the Spring Street area) also support freshwater marsh vegetation.

Within the City, Neary Lagoon, Antonelli Pond and portions of Jessie Street Marsh support a dense cattail and bulrush habitat. The most common bulrush is California bulrush (*Scirpus californicus*); however; other species are also present, including small-fruited bulrush (*S. microcarpus*) and Olney's bulrush (*S. olneyi*). Cattail (*Typha latifolia*) is also commonly observed where it forms dense stands within the marsh as well as intermixing with the bulrush. Distribution of these plant species is primarily a function of historical land uses, source of water (i.e., groundwater, surface runoff) and water depth. The occurrence of other plant species also varies by water depth and the duration of inundation. Along the edges of the bulrush and cattail stands where periodic flooding often occurs, other wetland plant species are present. Common monkey flower (*Mimulus glutattus*), Pacific silverweed (*Potentilla anserina*), creeping buttercup (*Ranunculus repens*), watercress (*Rorippa nasturtium-aquaticum*), western goldenrod (*Euthamia occidentialis*), brown-headed rush and waterweed (*Polygonum lapathifolium*) are commonly observed in these areas. In open water areas, pondweed (*Lemna* sp.) is also prevalent. Invasive, non-native plants also occur in the freshwater marshes in the City. Neary Lagoon supports dense stands of yellow aquatic iris (*Iris pseudacorus).*

**Wildlife Resources.** The presence of wetland plants such as cattails, bulrush and willows increases the wildlife value of freshwater marshes by providing cover, breeding sites and food. The diversified aquatic invertebrate fauna in the open water and along the edges of marshes provides an important food base for a wide variety of wildlife. Wildlife species from adjacent habitats utilize the marsh habitat for foraging and as a water source. The open water portions of freshwater marshes also provide important resting and foraging habitat for wintering waterfowl. Common wildlife species that inhabit freshwater marsh habitat in the City include Pacific tree frog, bullfrog, western toad (*Bufo boreas*), western aquatic garter snake (*Thamnophis couchii*), mallard *(Anas platyrhynchos)*, ruddy duck *(Oxyura jamaicensis)*, red-winged blackbird *(Agelaius phoeniceus)*, and black phoebe *(Sayornis nigricans)*. Other common wildlife that do not nest or reside in marsh habitats, but that utilize the area for foraging include cliff swallow *(Hirundo pyrrhonota)*, raccoon, and several species of bats.

California red-legged frogs have been observed at Antonelli Pond (J. Bulger, pers. comm., 2000); however, the presence of several non-native predatory fish species makes this pond of low value as red-legged frog breeding habitat. This frog has not been observed at Neary Lagoon or Jessie Street

Marsh. Southwestern pond turtles (*Clemmys marmorata pallida*) have been observed at Antonelli Pond (CDFG 2001); however, some non-native fish can prey on turtle hatchlings and thus reduce the value of the pond as habitat (pond turtles reproduce in upland areas). Pond turtles were known to inhabit Neary Lagoon in the past (last sighting 1985), but are now believed to be extirpated from this site (CDFG 2001). Pond turtles (in addition to non-native red slider turtles) have been recorded at Westlake Pond (Habitat Restoration Group, 1989). Aquatic species, such as three-spined stickleback, mosquitofish, dragonfly larvae and adults, damselfly larva and adults and water beetles have been recorded at marsh habitats within the City (Habitat Restoration Group, 1998).

#### *J.1.3.3 Brackish and Salt Water Marsh*

**Vegetation.** Occurring in areas subject to tidal inflows from Monterey Bay, the salt and brackish marsh vegetation is adapted to prolonged inundation as well as periods of exposure. Found at Jessie Street Marsh, the lower sections of Arana Gulch Creek, the mouth of Younger Lagoon (on UCSC lands) and at the mouth of Moore Creek (within Natural Bridges State Park), the salt and brackish marshes are comprised of emergent plant species tolerant of varying levels of salt water intrusion. Typical plants species within the salt and brackish marshes within the City are salt grass (*Distichlis spicata)*, jaumea *(Jaumea carnosa)*, pickleweed (*Salicornia virginica*) and alkali heath (*Frankenia grandiflora)*. Although the marsh at Jessie Street has been degraded by past land uses and a reduction in historic tidal inflows, brackish plant species, such as salt grass and jaumea persist (Habitat Restoration Group, 1998).

Invasive, non-native plants also occur within the salt and brackish marshes in the City. Plants such as Kikuyu grass (*Pennisetum clandestinum)* have been documented within City marshes. The brackish and salt-water marsh habitats offer several opportunities for restoration through removal of occurrences of invasive, non-native plant species and, for Jessie Street Marsh, management of tidal inflows to increase habitat diversity.

**Wildlife Resources.** Coastal salt and brackish water marshes are biologically productive habitats, and consequently, a wide variety of wildlife species utilize this habitat type. Snakes hunt for small mammals at the edges of salt marsh, shorebirds forage for invertebrates in the exposed mud of the salt water marsh at low tide, herons and egrets forage for fish in the channels, secretive rails may inhabit the denser stands of salt grass, and raccoons may hunt along the shorelines at night. The lagoons also provide important resting and foraging habitat for wintering waterfowl. The salt-water marsh habitat of Younger Lagoon and the small lagoon at the mouth of Moore Creek (within Natural Bridges State Beach) are the only areas in the City expected to support wildlife typical of this habitat type.

Common wildlife in this habitat include gopher snake (*Pituophis melanoleucus*), western aquatic garter snake (*Thamnophis couchii*), great blue heron (*Ardea herodias*), snowy egret (*Egretta thula*), mallard, willet (*Catoptrophorus semipalmatus*), black-necked stilt (*Himantopus mexicanus*), Virginia rail (*Rallus limicola*) (non-breeding season only), belted kingfisher (*Ceryle alcyon*), cliff swallow (*Hirundo pyrrhonota*), ornate shrew (*Sorex ornatus*), harvest mouse (*Reithrodontomys megalotis*), and raccoon. Tree frogs are not typically found in salt water, but they do occur in lagoons when fresh water inundates areas in winter, as discussed above under freshwater marsh. The tidal areas (i.e., Arana Gulch Creek) provide salinity transition zones and feeding areas for juvenile steelhead migrating to the ocean. In summer, sandbar formations can produce shallow, warm, protected lagoons (i.e., Younger and Moore Creek lagoons) used by tidewater goby (*Eucycloglobius newberryi*). The tidewater goby, a federal endangered species, has been historically observed in Woods Lagoon (lower Arana Gulch Creek and a short distance upstream). The species was last observed in 1984, but sampling in 1992 and 1995 and 2000 found no evidence of tidewater gobies in the lower Arana Gulch

Creek/Upper Harbor area. Gobies are present at the mouth of Moore Creek at Natural Bridges State Park although the population was nearly extirpated by drought in 1987-91. Tidewater gobies have also been reported from Younger Lagoon.

### J.1.4 Modified Channels, Culverts and Concrete/Rock-lined Watercourses

Watercourses that have been placed in underground culverts or have been lined with concrete or rock are identified as modified channels. In most instances the riparian values of the watercourse are absent or substantially degraded. The channels typically function as a conduit for water flow to less-disturbed riparian areas and, in some cases, all the way to Monterey Bay. Watercourses that have been replaced by culverts create gaps in the linear continuity of the riparian corridor and may act as barriers to wildlife movement. Common attributes of modified channels are shown on Figure J-5.

**Vegetation.** Vegetation within modified channels is often limited to herbaceous plant species typical of freshwater marsh systems. Plants species include nut sedge, sedge (*Carex* sp.), watercress and patches of cattail. The vegetation grows on natural soils or on sediments deposited onto the concrete bottom. The channelized portion of Branciforte Creek 1 supports discontinuous patches of willows and alders; however, these are periodically removed for flood-control purposes.

Many of the modified channels occur in residential and industrial areas of the City. Underground sections often travel beneath existing residences and roads, such as portions of Pasatiempo Creek. Modified channels may also experience capacity problems if they are not sized to accommodate both natural and urban storm flows. Landowners along portions of Laurel Creek have expressed concerns on the capacity of the modified sections of creek and of localized flooding due to upstream modifications (e.g., storm releases from in-stream ponds) and increased urban runoff (Minutes from public meetings on *Management Plan*, 2000).

Water quality of modified channels can be enhanced through the maintenance of freshwater marsh species; these plants, such as cattails, are capable of nutrient uptake. In locations where channel capacity is sufficient, woody plant species may be suitable for growth along the side slopes of the channel.

**Wildlife Resources.** The value of modified channels for wildlife is low, usually due to lack of or patchy distribution of vegetative cover. Areas lacking adequate vegetative cover often have higher water temperatures that adversely affect native fish and aquatic wildlife species. The lack of cover vegetation also makes some wildlife species more susceptible to predation and thus less likely to inhabit these areas. The culverts, concrete channel sides, and construction of fences that occur along the channels, also degrade the value for wildlife by impeding movement.

### J.1.5 Special Status Plant Species

A number of plant species known, or have a potential, to occur within the City are considered special status species due to their recognized rarity or vulnerability to habitat loss or population decline. As listed on Table J-1, some species are listed by the USFWS, CDFG or CNPS as rare, threatened or endangered.

Most special status species are restricted to specific habitats, such as grasslands or oak woodlands, such as the robust spineflower (*Chorizanthe robusta* ssp. *robusta)* and Santa Cruz tarplant (*Holocarpha macradenia),* which are federally listed species (listed as endangered and threatened,

respectively). Of the special status plant species known or having potential to occur within the City (refer to Table J-1), only two plant species, the San Francisco popcorn flower (*Plagiobothrys diffusus)* and Santa Cruz clover (*Trifolium buckwestiorum),* are known to occur in or immediately adjacent to wetlands; the San Francisco popcorn flower has known occurrences in the Moore Creek watershed. No special status plant species are known to occur within riparian habitats with the City.

### *J.1.5.1 San Francisco Popcorn Flower*

San Francisco popcorn flower is an endangered species listed by the CDFG that qualifies for protection under Section 1901, Chapter 10 of the CDFG Code. The species is also considered a Species of Special Concern by USFWS. CNPS has placed this California endemic plant on List 1B, a list of rare, threatened or endangered plant species. The CNPS listing indicates that this species is rare and endangered throughout its range and existing populations maintain a high degree of vulnerability (CNPS, 1988). The occurrence of this popcorn flower is confined to several populations and its existence is considered vulnerable due to the limited quantity of habitat that will support this particular species, and the encroachment of urbanization (CNPS, 2001).

San Francisco popcorn flower is an annual species in the Borage family. The stem is decumbent to erect, 1-4 decimeters tall. The leaves are cauline (attached directly to the stem) and the lower stems are 3-8 centimeters in length. The flowers are white and small; the corolla is 1.5-3.5 millimeters wide. In this species, the nutlets have cross-ribs that are linear with the ventral keel in a narrow groove. The blooming period is from March to May, depending upon soil moisture.

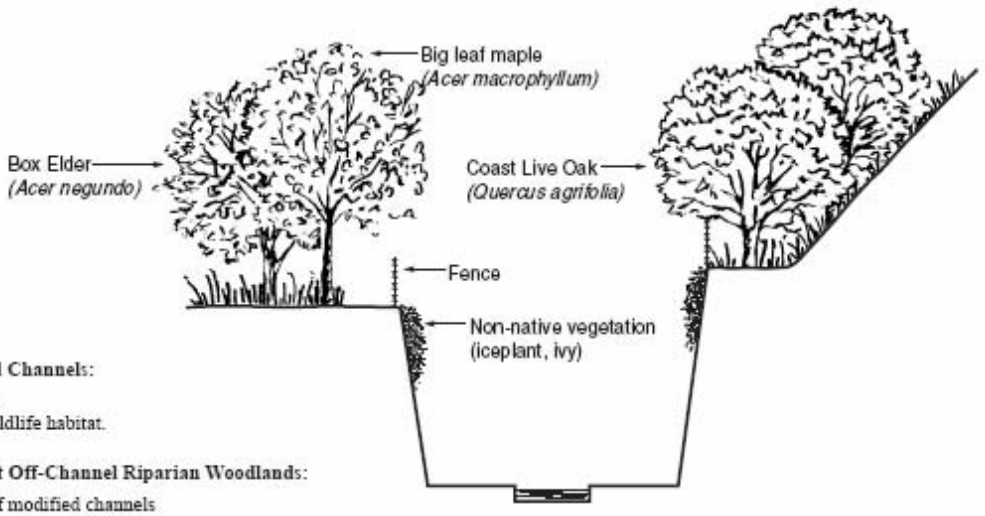
The San Francisco popcorn flower is commonly found in moist places in forests, grasslands and coastal terrace prairies below 1,000 feet elevation (CDFG, 2001b). Within the City, the species is known from Moore Creek Preserve and other areas near Meder Street where the species grows in grassy areas underlain by sandstone/mudstone (Biotic Resources Group, 2001). It often grows in greater densities where the grass is kept short through grazing or environmental constraints. The popcorn flower is unable to successfully compete with non-native grasses and tends to be choked out when the density of non-native grasses increases.

### *J.1.5.2 Santa Cruz Clover*

Santa Cruz clover is known from only a few colonies in Santa Cruz County (CDFG, 2001). The species is listed on CNPS List 1B as a rare species, yet has no Federal or State listing. The species has been recorded from seasonally wet depressions within grasslands (CDFG, 2001).

Santa Cruz clover is an annual, branched herb that lacks hairs on the foliage or stems. Stems may be decumbent or erect and usually do not exceed 4 centimeter in height. The compound trifoliate leaves are borne along the flowering stems. Each of the three leaflets is elliptic or oval, approximately 1 centimeter long. The clusters of flowers are pale-pink or white and are 6-7 millimeters long. The fruit pods contain only one seed. The species blooms from May to October; the plant sets seed and dies each season.

## FIGURE J-5. ATTRIBUTES OF MODIFIED CHANNELS




**Common Attributes of Modified Channels:**

- Open water for waterfowl use.
- In-stream wetlands provide wildlife habitat.

**Common Attributes of Remnant Off-Channel Riparian Woodlands:**

- Found along the top of bank of modified channels
- Many woodland trees have been incorporated into residential landscaping
- Hillside woodlands are dominated by oaks, as well as eucalyptus tree groves.
- Woodland has prevalence of non-native vegetation, including landscape plants, pampas grass, French broom and ivy.
- Woodlands provide movement corridors for wildlife
- Woodland and watercourses may provide opportunities for riparian habitat restoration and enhancement.

**Sample Locations:**

- Branciforte Creek

**SOURCE:** Biotic Resources Group, 2001

## Table J-1. Special Status Plant Species with the Potential to Occur in the Vicinity of Watercourses and Wetlands

| Species | CNPS Status | State Status | Federal Status | Habitat Affinity and Known Occurrences within City or County | Known or Potential Occurrence Within City Watercourses or Wetlands |
|---|---|---|---|---|---|
| Blasdale's bentgrass (*Agrostis blasdalei)* | List 1B | None | None | Upland Grassland Known from Swanton Road and Highway | Unlikely |
| Robust spineflower *(Chorizanthe robusta var. robusta)* | List 1B | None | Endangered | Upland Grassland Known from Pogonip | Unlikely |
| San Francisco popcorn flower *(Plagiobothrys diffusus)* | List 1B | Endangered | Species of Special Concern | Mesic Grassland Known from Moore Creek Preserve and other areas near Meder Street | Yes; potential to occur in or near seasonal wetlands that occur in grasslands |
| Santa Cruz Clover *(Trifolium buckwestiorum)* | List 1B | None | None | Margins of upland forest and grasslands Known from Swanton area and Soquel | Yes; potential to occur in mesic grasslands adjacent to oak riparian woodlands and in seasonal wetlands |
| Santa Cruz tarplant *(Holocarpha macradenia)* | List 1B | Endangered | Threatened | Upland Grassland Known from Arana Gulch Greenbelt, Schwan Lagoon area and Soquel | Unlikely |
| Kellogg's horkelia *(Horkelia cuneata ssp. sericea)* | List 1B | None | Species of Special Concern | Coastal scrub and pine forests | Unlikely |
| Small-leaved lomatium (*Lomatium parviflorum)* | List 4 | None | None | Oak woodland forest Known from Aptos area | Unlikely |
| Santa Cruz microseris (*Microseris decipiens)* | List 4 | None | Species of Special Concern | Areas of loose soil in upland forest and grasslands Known from Swanton area, Scotts Creek and Mill Creek | Unlikely |
| Gairdner's yampah *(Perideridia gairdneri ssp. gairdneri)* | List 4 | None | Species of Special Concern | Margins of upland forest and grasslands Known from Soquel | Unlikely |
| Michael's piperia (*Piperia michaelii)* | List 1B | None | Species of Special Concern | Areas of loose soil in coastal scrub and bluff scrub Known from Scotts Creek | Unlikely |
| Maple-leaved checkerbloom *(Sidalcea malachroides)* | List 1B | None | None | Oak woodland and mixed forests Last record in County from 1932 | Unlikely |
| San Francisco campion *(Silene verecunda ssp. verecunda)* | List 1B | None | Species of Special Concern | Coastal scrub and grasslands Known from Swanton area | Unlikely |

Source: CDFG Rarefind, 2001; Biotic Resources Group, 2001

**CNPS Status:**

**List 1B:** These plants (predominately endemic) are rare through their range and are currently vulnerable or have a high potential for vulnerability due to limited or threatened habitat, few individuals per population, or a limited number of populations. List 1B plants meet the definitions of Section 1901, Chapter 10 of the CDF&G Code.

**List 3:** This is a review list of plants which lack sufficient data to assign them to another list.

**List 4:** List 4 is a watch list of plants with limited distribution in the State that have low vulnerability and threat at this time. These plants are uncommon, often significant locally, and should be monitored.

## J.1.6 Special Status Animal Species

Special status wildlife species include candidate species for listing, those formally proposed for listing, or those currently listed as threatened or endangered under either state or federal endangered species laws. Species listed by the State as California Species of Special Concern also receive special protection under CEQA review standards. Migratory birds are protected under the Migratory Bird Treaty Act and all raptor nests are protected by CDFG Code. Wildlife species identified as sensitive by the City General Plan/LCP are also protected. Wildlife species with special protected status that are known or potential inhabitants of the City watercourses or wetlands are listed in Table J-2.

### *J.1.6.1 Monarch Butterfly*

Monarch butterflies (*Danaus plexippus*) migrate to central California and overwinter in Eucalyptus, pine and acacia trees. They are present in Santa Cruz County generally between September 1 and March 1 and prefer dense stands of trees that provide protection from the wind. The CDFG recognizes monarchs as a "Special Status Animal" because their winter residence in California represents a critical stage in their life cycle and habitat continues to decline.

Within riparian areas, monarchs are known to roost in eucalyptus and pine groves at Natural Bridges, Moore Creek just north of Highway 1, upper Arroyo Seco Creek, lower Pilkington Gulch, Pogonip Creek near Evergreen Cemetery, and lower Branciforte Creek (CDFG, 2001a). Other potential habitat areas include upper portions of Carbonera, Branciforte and Hagemann Creeks, and several areas along Arana Gulch Creek. Monarchs are also known to occur within non-riparian areas in the City. Habitat for monarch butterflies could be restored and/or enhanced by replanting native pines and cypresses where disease has killed trees and planting larval food plants.

### *J.1.6.2 California Red-legged Frog*

The California red-legged frog is a State Species of Special Concern and Federally listed as threatened. This species is found in quiet pools along streams, in marshes, and ponds. Red-legged frogs are closely tied to aquatic environments and favor intermittent streams, including some areas with water at least 2.5 feet deep, a largely intact emergent or shoreline vegetation, and a lack of introduced bullfrogs and non-native fishes. This species' breeding season spans January to April (Stebbins, 1985). Females deposit large egg masses on submerged vegetation at or near the surface. Embryonic stages require a salinity of less than or equal to 4.5 parts per thousand (Jennings and Hayes, 1994). They are generally found on streams having a small drainage area and low gradient (Hayes and Jennings, 1988). Recent studies have shown that although only a small percentage of red-legged frogs from a pond population disperse, they are capable of moving distances of up to 2 miles (Bulger, 1999). The red-legged frog occurs west of the Sierra Nevada-Cascade crest and in the Coast Ranges along the entire length of the state. Much of its habitat has undergone significant alterations in recent years, leading to extirpation of many populations. Other factors contributing to its decline include its former exploitation as food, water pollution, and predation and competition by the introduced bullfrog and green sunfish (Moyle, 1973, Hayes and Jennings, 1988). Historically, it is believed that California red-legged frogs inhabited coastal streams and lagoons in Central California where habitat conditions were suitable.

Within the City of Santa Cruz, California red-legged frogs are known to occur in Moore Creek, Natural Bridges, Antonelli Pond, Younger Lagoon, and the wetlands at Terrace Point (CDFG, 2001). This frog has also been observed in seasonal ponds on UCSC property above Moore Creek. Younger Lagoon and the pond at Natural Bridges provide the best potential breeding habitat for red-legged

frogs in the City. Non-native fish in Antonelli Pond reduce the value of this pond for frog breeding habitat, and the seasonal wetlands at Terrace Point and UCSC may not hold water long enough for successful transformation of tadpoles into juveniles. There are no records of California red-legged frogs in Arana Gulch Creek, and recent surveys of the ponds on DeLaveaga Golf Course did not find this species (B. Mori, pers. comm., 2001). There are no confirmed observations of red-legged frogs in the San Lorenzo River within City limits; however, there are anecdotal accounts of this species at Sycamore Grove (Pogonip Master Plan, City of Santa Cruz, 1999).

Salz Pond is located approximately 0.2 miles upstream of the former Salz Tannery and the San Lorenzo River confluence. The pond is bordered by the Southern Pacific Railroad, Las Animas Concrete and the City of Santa Cruz Corporation Yard. Salz Pond is an unusual feature within the Harvey West area that provides a slow moving, deep-water habitat adjacent to Pogonip Creek and has potential habitat for California red-legged frogs. A red-legged frog survey conducted in 2002, found that the overall habitat for red-legged frogs within the Salz Pond and adjacent Pogonip Creek is of low quality. The pond is deep and provides complex habitat for aquatic biota due to the presence of riparian vegetation surrounding the pond and submerged downed woody debris. Yet, the abundance of signal crayfish present in the pond and the presence of large mouth bass greatly reduce the quality of California red-legged frog habitat. The presence of several nonnative plant species and channelization of Pogonip Creek further diminishes the habitat quality.

Habitat for California red-legged frogs within the City of Santa Cruz could be restored and/or enhanced by protecting the dense riparian vegetation required by this species along Moore Creek (where this frog still occurs), and by implementing programs to remove non-native predators (e.g., bullfrogs, introduced fish). Habitat could be improved if the nonnative flora and fauna within and adjacent to the pond were removed, and could potentially provide an important slow moving, deep water refuge for other listed aquatic species. Eradication of nonnative aquatic species such as signal crayfish and large mouth bass would greatly increase the habitat quality for both steelhead and California red-legged frogs.

#### *J.1.6.3 Southwestern Pond Turtle*

The southwestern pond turtle is a Federal and State Species of Special Concern. This aquatic turtle inhabits ponds, lakes, streams, marshes, and other permanent waters located in woodland, grassland, and open forests below 6,000 feet (Stebbins, 1985). Pond turtles can often be seen basking in the sun on partially submerged logs, rocks, mats of floating vegetation or mud banks. During cold weather, they hibernate in bottom mud. The diet of these turtles consists of aquatic vegetation, insects, fish, worms, and carrion. Females dig soil nests in or near stream banks (Nussbaum et *al.*, 1983). Eggs are deposited between April and August. One factor in the decline of this species is the introduction of non-native fish, which prey on hatchlings and juveniles. Historically, this turtle was present in most coastal drainages in California (Jennings and Hayes, 1994).

Pond turtles are known to occur in Antonelli Pond (last sighting in 1988), Moore Creek, and Natural Bridges (CDFG, 2001). This species is believed to be extirpated from Neary Lagoon (CDFG, 2001). They have also been observed at the pond on UCSC above Moore Creek (D. Laabs, pers. comm., 2001) and in Westlake Pond (Habitat Restoration Group, 1989). Potential breeding habitat for this turtle within the City of Santa Cruz is probably limited to the pond at Natural Bridges. The abundance of non-native fish which prey on hatchling turtles at Antonelli Pond reduce the likelihood that this species can successfully reproduce there.

| Table J-2. Special Status Wildlife Species and Their Potential to Occur in Watercourses and Wetlands | | | | |
|---|---|---|---|---|
| **SPECIES** | **STATUS[1]** | **HABITAT** | **KNOWN OCCURRENCE WITHIN CITY WATERCOURSES OR WETLANDS** | **POTENTIAL OCCURRENCE WITHIN CITY WATERCOURSES OR WETLANDS** |
| **Invertebrates** | | | | |
| Monarch butterfly<br>*Danaus plexippus* | * | Winter roosts in eucalyptus and pine groves protected from wind. | Known roosts at Natural Bridges, Moore Creek just north of Hwy 1, upper Arroyo Seco Creek , lower end of Pilkington Gulch, Wagner Seep and lower Branciforte Creek. | Likely in non-native riparian woodlands that are dominated by eucalyptus Potential habitat in some upper portions of Carbonera, Branciforte and Hagemann Creeks, and several portions of Arana Gulch Creek. |
| **Fish** | | | | |
| Tidewater goby<br>*Eucyclogobius newberryi* | FE, CSC | Coastal lagoons and up to one mile upstream. | Known to occur in Moore Creek from mouth to 0.25 mi upstream and in the lower San Lorenzo River. | Potential in Younger Lagoon (UCSC lands) and mouth of Moore Creek (Natural Bridges State Beach). |
| Steelhead<br>*Oncorhynchus mykiss* | FT | Creeks, rivers and their tributaries. | Known to occur in San Lorenzo River, Branciforte Creek and Arana Gulch Creek. | No other watercourses in the City are potential habitat for this species. |
| Coho Salmon<br>*Salmo gairdneri* | FT, SE<br>(State listing deferred until a Recovery Plan is prepared, Current petition for Federal Listing) | Creeks, rivers and their tributaries. | Historically known from San Lorenzo River. Coho adults have been found in San Lorenzo River during the last several winters and coho young of the year were found in 2005 in the upstream San Lorenzo River. | Potential re-colonization of San Lorenzo River; no other watercourses in the City are potential habitat for this species. |
| **Amphibians** | | | | |
| California red-legged frog<br>*Rana aurora draytonii* | FT, CSC | Riparian woodland, marshes, estuaries and ponds. | Known to occur in Antonelli Pond, Moore Creek, marsh at Natural Bridges, Younger Lagoon and ponds near UCSC arboretum (tributary to Moore Creek, just outside City limits). | No other watercourses in the City are known to support this species. |
| **Reptiles** | | | | |
| Southwestern pond turtle<br>*Clemmys marmorata pallida* | FSC, CSC | Creeks and ponds. | Known to occur in Moore Creek, Antonelli Pond, marsh at Natural Bridges and Neary Lagoon; historic occurrence in Westlake Pond. | No other watercourses or wetlands in the City are potential habitat for this species. |
| **Birds** | | | | |
| White-tailed kite<br>*Elanus leucurus* | FPS | Oak woodland and riparian woodland. | Known to nest in Natural Bridges. | Potential habitat along portions of Moore Creek. |
| Cooper's hawk<br>*Accipiter cooperii* | CSC | Oak woodland and riparian woodland. | Known to nest along Moore Creek. | Potential nesting habitat occurs along upper portions of Arroyo Seco Creek and Arana Gulch Creek. |
| Yellow warbler<br>*Dendroica petechia brewsteri* | CSC | Nests in riparian habitats with dense willows and cottonwoods. | Formerly bred at Antonelli Pond, San Lorenzo River (Sycamore Grove), Carbonera Creek, Branciforte Creek, Westlake Pond, Neary Lagoon and Arana Gulch Creek; not currently known to nest in City. | Potential nesting habitat at Antonelli Pond, San Lorenzo River (Sycamore Grove), Carbonera Creek, Branciforte Creek, Neary Lagoon and Arana Gulch Creek. |

| Table J-2. Special Status Wildlife Species and Their Potential to Occur in Watercourses and Wetlands | | | | |
|---|---|---|---|---|
| **SPECIES** | **STATUS[1]** | **HABITAT** | **KNOWN OCCURRENCE WITHIN CITY WATERCOURSES OR WETLANDS** | **POTENTIAL OCCURRENCE WITHIN CITY WATERCOURSES OR WETLANDS** |
| Yellow-breasted chat<br>*Icteria virens* | CSC | Nests in riparian habitats with dense willows, cottonwoods. | Probably extirpated as breeder in County; more data needed to determine current nesting status in the City. | Potential nesting habitat at Antonelli Pond, San Lorenzo River (Sycamore Grove), Carbonera Creek, Branciforte Creek, Neary Lagoon and Arana Gulch Creek. |
| Tricolored blackbird<br>*Agelaius tricolor* | CSC | Nests in freshwater marshes with dense tules and cattails. | Historically nested at Antonelli Pond and Neary Lagoon. | Potential nesting habitat at Antonelli Pond and Neary Lagoon. |
| **Mammals** | | | | |
| Yuma myotis<br>*Myotis yumanensis* | FSC, CSC | Open forests and woodlands with water nearby; roosts in buildings, caves and crevices. | No survey data for City available. | Potential habitat along Moore Creek, portions of San Lorenzo River, upper portions of Branciforte, Carbonera and Arana Gulch Creeks. |
| Townsend's western big-eared bat<br>*Corynorhinus townsendii townsendii* | FSC, CSC | Wide variety of habitats; roosts in caves, tunnels, mines, and buildings. | No survey data for City available. | Potential habitat along Moore Creek, portions of San Lorenzo River, upper portions of Branciforte, Carbonera and Arana Gulch Creeks. |
| San Francisco dusky-footed woodrat<br>*Neotoma fuscipes annectens* | FSC, CSC | Riparian and oak woodlands. | No survey data for City available. | Potential habitat along Moore Creek, Arroyo Seco, upper portions of San Lorenzo River, upper portions of Branciforte, Carbonera and Arana Gulch Creeks. |

Sources: CDFG Rarefind, 2001; Dana Bland & Associates, 2001; Dr. Jerry Smith, 2000 and 2001; Santa Cruz Bird Club, 2001

[1] Key to status:

FE = Federally listed as endangered species
FT = Federally listed as threatened species
FSC = Federal species of special concern
FPS = State designated Fully Protected Species
CSC = California species of special concern
* = Locally unique species in City of Santa Cruz General Plan and LCP
ST = State listed as threatened
SE = State listed as endangered species

Habitat for western pond turtles within the City of Santa Cruz could be restored and/or enhanced by protecting the dense riparian vegetation along Moore Creek (where this turtle still occurs), Westlake Pond (if still present) and by implementing programs to remove non-native predators (e.g., bullfrogs, introduced fish).

#### *J.1.6.4 White-tailed Kite*

The white-tailed kite does not have any special status, but is listed as a fully protected species by the CDFG for its nest sites. This bird usually nests in trees along riparian areas, willows and live oaks, and in oak savannah. The male parent does all the hunting while the female kite incubates the eggs and broods the nestlings. They prefer nest trees with adjacent open fields for hunting. The favored prey of white-tailed kites is voles and mice. Nesting occurs from April through July. During fall and winter, kites form communal roosts (Roberson and Tenney, 1993).

Within the riparian corridors in the City of Santa Cruz, white-tailed kites have been known to nest in lower Moore Creek within Natural Bridges State Park (S. Gerow, pers. comm., 2001). The best potential habitat for kite nesting in the City is along Moore Creek. Historically, this kite may have nested along the San Lorenzo River. Maintaining the Moore Creek riparian corridor and adjacent grasslands as open space may encourage white-tailed kites to nest in this habitat.

#### *J.1.6.5 Cooper's Hawk*

The Cooper's hawk is a State Species of Special Concern. Cooper's hawks prefer forested habitats in mountainous regions, but also use riparian woodlands. Cooper's hawks feed primarily on small birds, but also take small mammals, reptiles, and amphibians. Foraging occurs in both dense cover and open habitats. Cooper's hawks build stick nests in trees with dense cover and the nest site is vigorously defended by the adults. The local breeding season probably spans March/April through July (Suddjian, 1990). Cooper's hawks are uncommon migrants and winter visitors. Migrant and wintering individuals occur in a variety of habitats, including oak woodland, conifer and mixed broadleaf forests, grasslands, residential areas and riparian woodland. Habitat destruction and falconry practices have been attributed to this species' decline in California (Remsen, 1978).

Cooper's hawk have been known to nest along Moore Creek (S. Gerow, pers. comm., 2001) and on the UCSC campus. Potential nesting habitat for Cooper's hawk includes upper portions of Arroyo Seco Creek and Arana Gulch Creek. Historically, this hawk may have nested along the San Lorenzo River. Maintaining the Moore Creek riparian corridor as open space may encourage Cooper's hawk to continue to nest in this habitat.

#### *J.1.6.6 Yellow Warbler*

Yellow warblers are a California Species of Special Concern. They are common during spring and fall migration in central California and uncommon to locally fairly common during the breeding season (Suddjian, 1990, Roberson and Tenney, 1993). Yellow warblers are obligate riparian breeding birds; they are most numerous where substantial areas of riparian habitat remain along major creeks and rivers. A variety of riparian trees are used during foraging, but habitats with willows and cottonwoods or willows and sycamores, with dense undergrowth, seem to be favored (Robison and Tenney, 1993). Outside the breeding season, this species may occur in a variety of habitats, but is still most numerous in riparian habitats. The yellow warbler's diet consists of spiders and insects, which it gleans from

understory vegetation and the canopies of deciduous trees. Nests are constructed low in trees, typically from 2-12 feet above the ground (Harrison, 1978). Numbers of yellow warblers are greatly reduced over much of their California breeding range, largely due to loss of riparian habitat and nest parasitism by the brown-headed cowbird (Remsen, 1978).

There are currently no known yellow warbler nest sites within the City of Santa Cruz (S. Gerow, pers. comm., 2001). Formerly, this species nested along the San Lorenzo River, near DeLaveaga Park (Carbonera Creek, Branciforte Creek and Arana Gulch Creek), Neary Lagoon, and Antonelli Pond (S. Gerow, pers. comm., 2001).

Habitat for yellow warblers in the City of Santa Cruz could be restored and/or enhanced by revegetating degraded areas where possible (e.g., along the San Lorenzo River) and by monitoring for and trapping brown-headed cowbirds.

#### *J.1.6.7 Yellow-breasted Chat*

The yellow-breasted chat is a State Species of Special Concern. It was once a common summer resident in riparian woodland throughout California. In central California, yellow-breasted chats appear to prefer dense riparian habitats dominated by willows, sycamores, and cottonwoods, with a well-developed understory, and are considered a riparian obligate species (Roberson and Tenney, 1993). They inhabit the area from April to early August (Roberson and Tenney 1993). Yellow-breasted chats forage at various heights in dense riparian foliage, gleaning insects from leaves and bark, and feeding on small fruits. They build their nests in dense vegetation, typically from 1-8 feet above the ground (Harrison, 1978, Ehrlich *et al*., 1988). This species' numbers have declined dramatically in many parts of California, primarily due to loss and alteration of riparian habitat and possibly due to nest parasitism by brown-headed cowbirds (Remsen, 1978).

There are currently no known nest sites of yellow-breasted chat in the City of Santa Cruz (Suddjian, 1990). Historically, this species probably nested along the San Lorenzo River (Suddjian, 1990).

Habitat for yellow-breasted chat in the City of Santa Cruz could be restored and/or enhanced by revegetating degraded areas where possible (e.g., along the San Lorenzo River) and by monitoring for and trapping brown-headed cowbirds.

#### *J.1.6.8 Tricolored Blackbird*

Tricolored blackbird is a Federal and State Species of Special Concern. They inhabit freshwater marshes, stock ponds, and willow thickets. They prefer dense cattails, tules and rushes where they build deep cup nests. They breed in large colonies of 50-100+ pairs, from April to mid-May. During fall and winter, tricolored blackbirds are nomadic and may be observed in pastures, grasslands, cattle pens and marshes throughout the county (Roberson and Tenney, 1993). Extensive alteration of the Salinas River floodplain and drainage of marshes for agriculture and urban development are the main threats to this species (Roberson and Tenney, 1993).

Historically, tricolored blackbirds nested at Antonelli Pond and Neary Lagoon; however, nesting has not been observed at either site in recent years (S. Gerow, pers. comm., 2001). Tricolored blackbirds do still roost at Neary Lagoon (D. Laabs, pers. comm., 2001). Maintaining the freshwater marsh habitat and water levels at Antonelli Pond and Neary Lagoon is the most practical measure to attract tricolored blackbirds to suitable nesting habitat in Santa Cruz.

#### *J.1.6.9 Yuma Myotis*

Yuma myotis is a Federal and State Species of Special Concern. It inhabits a wide variety of habitats at lower elevations and is a year-round resident in California. Day roosts include buildings, trees, mines, caves, bridges and rock crevices. This bat feeds on emergent aquatic insects and forages over the surface of calm waters of ponds, streams and rivers (Heady, 2000).

Surveys for bats have not been conducted along the study area. Potential habitat includes Moore Creek, San Lorenzo River north of Highway 1, and upper portions of Branciforte, Carbonera and Arana Gulch Creeks.

Measures that may enhance habitat for bats in the City include placing man-made snags with suitable roost hollows or bat houses.

#### *J.1.6.10 Townsend's Western Big-eared Bat*

The Townsend's western big-eared bat is a State and Federal Species of Special Concern. Big-eared bats occur in a variety of plant communities throughout California, including coastal conifer and broad-leaf forests, oak and conifer woodlands, arid grasslands and high elevation forests (Williams, 1986). In coastal California, the big-eared bat is primarily associated with riparian forests, where it gleans insects from leaf surfaces. Roosting sites for Townsend's western big-eared bat include limestone caves, lava tubes, mine tunnels, buildings, and other human-made structures within 100m of riparian habitat (Williams, 1986, Pierson, 1988). Townsend's western big-eared bats are extremely sensitive to human disturbances at roost sites.

Surveys for bats are not known to have not been conducted within the *Management Plan* study area. Potential roost sites within the City are limited, with bridges or buildings with access near creeks being the most likely habitat.

Measures that may enhance habitat for the Townsend's western big-eared bat in the City include preserving the Moore Creek riparian corridor, and possible construction of appropriate roost "houses."

#### *J.1.6.11 San Francisco Dusky-footed Woodrat*

San Francisco dusky-footed woodrat is a State Species of Special Concern. These small mammals build large stick nests at the bases of trees and shrubs. They prefer forested habitat with a moderate canopy and brushy understory, and are often found on the upper banks of riparian forests. This woodrat feeds on a variety of woody plants, fungi, flowers and seeds (Jameson and Peeters, 1988).

Although this woodrat is listed as a State Species of Special Concern, it is relatively common in Santa Cruz County. Potential habitat includes areas along all riparian corridors with moderate to dense understory vegetation.

Measures that may enhance riparian habitat in the City of Santa Cruz for the native woodrat include control of non-native competitors (e.g., black rats) and predators (e.g., feral cats).

## J.1.7 Special Status Fish Species

### *J.1.7.1 Steelhead Trout*

Steelhead is Federally listed as threatened (Central California Coast Evolutionary Significant Unit). Steelhead are anadromous fish that migrate from the ocean up freshwater creeks and rivers to spawn. Young steelhead typically remain in freshwater for one or two years before migrating to the ocean. They typically spend one to two years in the ocean before returning to their natal stream to spawn (NMFS, 1997). Steelhead often spawn more than once before they die, and spawning usually occurs between January and April. Eggs are laid in gravels of streams, and take four to six weeks to hatch (J. Smith, pers. comm., 2001). The hatchlings are called alevins and remain in the gravels for two to four weeks until their yolk sac is absorbed, at which time they emerge from the gravels as "fry" and begin actively feeding. After one to two years, the steelhead migrate to the ocean as "smolts."

Steelhead are known to spawn and rear in the San Lorenzo River, Branciforte Creek and Arana Gulch Creek. Steelhead relative abundance increases in wet years when adult and smolt migration and juvenile rearing conditions improve. The San Lorenzo River and its tributaries (outside the City limits) provide over 80 miles of stream for this anadromous fish. The lagoon at the mouth of the San Lorenzo River is a potential nursery area for steelhead but manipulation of the San Lorenzo River lagoon during the summer rearing season presently limits its value (City of Santa Cruz, 1986b). In 1964, the estimated annual run consisted of 20,000 steelhead (County of Santa Cruz, 1979). Major declines in the number of fish migrating up the river appear to have occurred between then and the mid 1970s to early 1980s. Juvenile, and probably adult, numbers appear relatively stable since then, with an adult steelhead run of probably 3,000-5,000 (Alley, 1998). The decline of the fishery is evidence of disruption of the watershed, leading to sedimentation, reductions in streamflow, barriers to upstream migration and alteration of stream habitat. Implementation of the *Lower San Lorenzo River and Lagoon Management Plan* is expected to improve steelhead use of the lower river.

Historically, steelhead trout used to migrate up Pogonip Creek and some were planted and reared in Salz Pond by Monterey Bay Salmon and Trout Project approximately ten years ago. A California Red-Legged frog survey was conducted at Salz Pond in 2002 for the City of Santa Cruz Water Department. Steelhead were observed during the survey visits (approximately four inches in length). If the nonnative flora and fauna within and adjacent to the pond were removed, the habitat value would be measurably increased and could potentially provide an important slow moving, deep water refuge for listed aquatic species. Eradication of nonnative aquatic species such as signal crayfish and large mouth bass would greatly increase the habitat quality for both steelhead and California red-legged frogs (Conrad 2002). However, the fact that the watercourse leading from the San Lorenzo River to Salz Pond is located in an underground culvert limits the overall importance of habitat improvements.

### *J.1.7.2 Coho Salmon*

The Central Coast Evolutionary Significant Unit (ESU) of coho salmon (*Oncorhynchus kisutch)* is listed both with the State and Federal government as endangered. Salmon are anadromous fish that migrate from the ocean up freshwater creeks and rivers to spawn. Salmon spend their first year in freshwater streams and one to two years in the ocean. Coho salmon spawn once before they die, and spawning usually occurs between late November and early February. Eggs are laid in gravels of streams (J. Smith, pers.com., 2001). Hatching takes four to eight weeks and the hatchlings remain in the gravels for two to four weeks until their yolk sac is absorbed, at which time they emerge from the gravels as "fry" and begin actively feeding.

Salmon were known to spawn and rear in the San Lorenzo River until 1981. Salmon disappeared with the 1976-77 drought and cessation of stocking in 1979; however, some adults returned in the 1980s due to stocking of hatchery-reared juveniles. The river is designated within the critical habitat of the species, and recovery actions may be appropriate.

#### *J.1.7.3 Tidewater goby*

The tidewater goby is a small fish that occurs in coastal lagoons. The species is listed as endangered under the Federal Endangered Species Act (FESA). The species has recently been proposed for delisting because threats to the species may be less severe than previously believed and the goby has some ability to re-colonize habitats from which it is temporarily absent (Federal Register: June 24, 1999; Volume 64, Number 121). The tidewater goby is listed as a California Species of Special Concern.

The species is restricted to stream mouth habitats in California. Historically, the species has been recorded from the mouth of the Smith River in Del Norte County, south to San Diego County. Although the tidewater goby is restricted to lagoons and rarely tolerates ocean or tidal conditions, there may be some exchange between populations. Re-colonization of lost habitat has been reported from populations as far as 10-20 kilometers away.

As indicated above, the tidewater goby, a federal endangered species, has been historically observed in Woods Lagoon (lower Arana Gulch Creek and a short distance upstream). The species was last observed in 1984 and sampling in 1992 and 1995 found none (Jerry Smith, pers. comm., 2002). Habitat conditions do not appear suitable for tidewater goby, as they appear to do well only where sandbars produce calm summer lagoons (Jerry Smith, pers. comm., 2002). The goby is present at the mouth of Moore Creek, may also occur in Younger Lagoon, and was recently recorded in the lower San Lorenzo River. Tidewater goby populations are present at Wilder Creek, west of Santa Cruz, and Corcoran Lagoon, east of Santa Cruz.

## J.2 GEOLOGY OF WATERCOURSES AND WETLANDS

Santa Cruz is located on a relatively flat series of marine terraces composed mainly of sandstone, shale and other sedimentary rocks. As part of the California Coast Range, it is one of the most geologically active regions in the world. The mountain range itself constitutes the physical boundary between the Pacific and North American plates, which move along active fault lines. In this region, the San Andreas fault system extends northwest and southeast, paralleling the coastline.

The Santa Cruz Mountains are relatively young and are still rising. There is a series of uplifted marine terraces which indicate a continuing uplift of the region and fluctuation of the sea level. The mountain crests are composed of igneous and metamorphic rocks overlain by thick layers of sedimentary material uplifted from the ocean floor and ancient shoreline. Sheer cliffs with pocket beaches form at the mouths of coastal streams.

The City of Santa Cruz can be divided fairly evenly into two geologic regimes split roughly at the San Lorenzo River where the Ben Lomond fault trends southeast to northwest. The geology on the west side of the San Lorenzo River is composed of a mix of granitic and metamorphic basement rocks overlain by a relatively thin layer of sedimentary rocks. The geology on the east side of the San Lorenzo River, like the west side, is composed of a mix of granitic and metamorphic basement rocks.

Unlike the west side, the east side basement rocks are overlain by a thick layer of sedimentary rocks and marine terraces up to hundreds of feet deep.

### J.2.1 Rock Formations

The basement rock formation far beneath most of Santa Cruz is an assemblage of igneous and metamorphic rocks, composed mainly of granite, schist and marble that outcrop along the mountain ridges. These rocks were formed more than 100 million years ago by processes that occurred several miles deep within the earth's crust. Above these rocks lies a thick layer of much younger sedimentary rock formations. Most of the City of Santa Cruz sits primarily atop these sedimentary rocks, mainly sandstones and mudstones, which were originally deposited as sediments in ancient seas. These include the Purisima formation, which is a fine-grained sandstone formation that was deposited approximately two to six million years ago in a shallow marine environment. The slightly older Santa Cruz Mudstone formation is an even finer-grained silt/mud stone that was also deposited in a shallow marine or estuarine environment. Both of these formations underlie much of the City. Higher in elevation, particularly on the UCSC campus, other sedimentary formations such as limestone as well as the aforementioned metamorphic and igneous formations, begin to appear in outcroppings.

### J.2.2 Marine Terraces

The San Lorenzo River and the other watercourses in the City incise the step-like series of marine terraces that typify the coastline north of town. These flat, wave-cut platforms were formed primarily in the sandstone and mudstone sedimentary layers mentioned above. The marine terraces were created by the interplay between the constant erosive force of waves combined with the fluctuating sea level stands of the Pleistocene (1.8 million years ago to 10,000 years ago), glacial and interglacial cycles and the slow uplifting of the coastline. Each marine terrace is a former part of the continental shelf that has been cut by the waves over many millennia, then uplifted above sea level into its present position. Much of the City sits upon the "first" marine terrace, typified by the flat areas that most of the westside and eastside neighborhoods sit upon. Above that is the "second" marine terrace, typified by the Westlake Pond area and the base of the UCSC campus, and also the DeLaveaga Park area on the eastside. Several additional marine terraces are discernable higher up on the UCSC campus. The downtown area of the City lies below the first marine terrace, within the floodplain of the San Lorenzo River, and is underlain by an approximately 40-foot deep layer of sediments that has been deposited by the San Lorenzo River over many centuries on top of another wave-cut marine terrace.

### J.2.3 Hydrology of Watercourses and Wetlands

The City of Santa Cruz contains a diverse array of watercourses. These range from the San Lorenzo River, including Branciforte Creek, which is a perennial river draining 121 square miles of watershed to small, heavily urbanized watersheds, such as Pilkington Creek, that only have flow during the wetter times of the year.

The City receives, on average, approximately 30 inches of rainfall per year, a much higher rainfall total compared to both Monterey and San Francisco. This is primarily due to the close proximity of the City to the mountain front. Steep mountain fronts force clouds to rise over the mountains, releasing precipitation. The steeper the mountain front, the higher the precipitation rate. This process is known as orographic uplift and provides the City and surrounding area with a wealth of flowing water in the streams and rivers that flow here. It is this abundance of flowing water that attracted the

early European settlers to the area, providing the energy to run the mills and drive the manufacturing industry that Santa Cruz was founded on.

The amount of streamflow in the watercourses that flow through the City is seasonally variable. The period from May to October often experiences no rainfall at all, leaving only stored groundwater as a source of streamflow for the dry summer months. The dichotomy of high winter flows and low summer baseflow characterizes most California streams and rivers that are not significantly influenced by snowmelt.

Due to the geologic conditions present within the City, streams on the west side of the City function significantly different than streams on the east side of the City. Watercourses on the west side radiate from the porous karst landscape located on the UCSC campus. Several sinkholes and underground caverns collect rainfall and release flow underground, emerging as springs and seeps into west side watercourses. The result is a unique system of springs and spring-fed streams that have higher summer baseflow than similarly-sized streams on the east side of the City.

## J.2.4 Characteristics of Watercourses within City Limits

Characteristics of stream channels vary considerably, not only throughout the City, but throughout the world. Many attempts have been made to classify streams based on their dominant characteristics. Dave Rosgen's channel classification system (Rosgen, 1994), a system commonly used in many fields such as geomorphology and fisheries, is based on geomorphic channel characteristics such as channel gradient, entrenchment, and substrate size. Other classification systems use hydrogeomorphic characteristics (Ferren et. al, 1996) or a combination of vegetation and hydrogeomorphic characteristics (Cowardin et. al., 1979) to classify channels. Though these systems provide a wealth of valuable information about channel conditions and a means to differentiate between different channel segments, they are highly specific classifications that are beyond the scope of the *Management Plan*. Additionally, the stated classification systems do not address the unique condition of channels found on the Central Coast.

The classification system developed for the *Management Plan* to describe and differentiate between the many watercourses that occur within the City is based on the flow regime, channel condition, and a description of the contributing watershed. Based on these criteria, the attributes of stream type, source of flow, and channel type are described below.

### *J.2.4.1 Stream Type*

Watercourses can generally be divided into two main stream types: perennial and intermittent. Perennial streams are those that have flowing water year-round, under average rainfall conditions. Intermittent streams are those that dry up during portions of the dry season, under average rainfall conditions. The distinction between perennial and intermittent is often blurred due to prevailing climatic conditions. During periods of drought some perennial streams may dry up as groundwater aquifers contribute less baseflow during the summer months. Conversely, some intermittent streams can flow year-round during wet periods when groundwater aquifers are replenished. For watercourses in the City, this variable is best determined in July and August, as these months are considered to be the lowest flow months.

#### *J.2.4.2 Source of Flow*

This attribute classifies channel segments based on their contributing watershed or catchment. Urbanized settings provide a unique situation in watersheds since much of the flow originates off streets and rooftops, in some cases never flowing over natural, pervious ground. The land use condition of the watershed has a significant influence on the hydrologic and geomorphic condition of the channel. Urbanized watersheds often increase peak flows and reduce baseflow due to an increase in impervious surfaces that allow water to runoff quickly as opposed to being attenuated by soil and surface storage. Since stream channels in the City have developed under a hydrologic regime that lacked significant impervious surfaces, their adjustment to a hydrologic regime with higher storm flows often results in channel width adjustments, bank erosion and channel incision.

To define the dominant source of water to watercourses within the City, each channel segment can be classified as either storm drain, curb and gutter, natural area, mixed source, or seeps and springs. Mixed source is the most commonly used classification in the City since many of the watercourses originate in undeveloped areas then pass through more urbanized portions of the City.

#### *J.2.4.3 Channel Type*

The channel type attribute describes the actual condition of the channel in terms of the overall impacts that urbanization has had on the form and function of the channel. Many channels in the City have been modified to accommodate features associated with urban and residential areas such as roads and housing developments, and to reduce the risk of catastrophic flooding. Many channels have been straightened or moved to allow development.

To differentiate between the many possible channel types, each channel segment can be classified as either natural channel, modified channel, culvert pipe, or flood control channel. Natural channels are those channel segments that are relatively unaltered by humans. There may be significant impacts to these channels due to human activity, such as increased sedimentation or bank erosion due to more impervious areas in the watershed, but the actual channel has not been modified significantly. Modified channels are those that have been altered significantly through straightening, realignment, or significant modification of bank or bed materials (i.e., placement of riprap along a significant portion of the channel segment). Modified channels may still provide hydrologic and biotic functions but have been degraded considerably from their original condition. Flood control channels are those that have been completely modified with the sole purpose of providing flood protection. In many cases these channels have been concrete-lined and built only to convey storm flows. Channel segments classified as culvert pipe are those channels that have been put in a culvert pipe, such as in the case of small watercourses crossing roads.

### J.2.5 Watercourses Originating outside the City Limits

Some of the City's streams originate outside of the City limits. This is the case with the San Lorenzo River, Branciforte Creek, Carbonera Creek, Arana Gulch Creek, Pasatiempo Creek, and a portion of Moore Creek (see separate aerial photo map). Each of these streams has its upper watershed in the Santa Cruz Mountains within the jurisdiction of the County of Santa Cruz. Portions of Carbonera Creek also occur within the City of Scotts Valley. The San Lorenzo River is the largest of these watercourses, flowing through the San Lorenzo Valley where there are many unincorporated communities such as Felton, Ben Lomond, and Boulder Creek.

### J.2.6 Watercourses Originating within the City Limits

The remainder of the City's watercourses originate within City limits, including Moore Creek, Arroyo Seco, Laurel, Pogonip Creek, and several other small watercourses. These watercourses are depicted on separate aerial photo maps. Since the entire watershed of these small streams occur within the City limits, the unique influence of an urban setting dominates the condition and function of these watercourses. Fortunately, the occurrence of these watercourses entirely within the city limits allows for management of each subwatershed by the City using a single set of goals and policies.

### J.2.7 Springs

Springs beneath the UCSC campus are the source for Moore Creek, Arroyo Seco Creek, Pogonip Creek and Laurel Creek. The UCSC campus is unusual because much of it is underlain by limestone, which can contain underground caverns and passageways into which surface waters can flow. Many surface streams on campus disappear underground into these sinkholes and caverns, then reappear to the surface further downstream. The route that the water then takes underground is generally difficult to track and is often unknown. This type of underground flow is the likely source of springs in the Westlake area that give rise to Laurel Creek. These underground flows are also the likely source of the water that enters Pogonip, Arroyo Seco, and Moore creeks.

## J.3 WATERSHED FRAMEWORK

The City can be divided into thirteen primary watersheds, with several of these watersheds consisting of several small watercourses grouped together. These primary watersheds and their contributing secondary watersheds, as further described below, are depicted on Figure J-6. The grouping of watercourses into distinct watersheds is useful for several reasons. First, it quickly provides information on the physical character of the watercourse by defining the drainage area or size of the area contributing flow to the watercourse. This information provides an initial reference point for understanding what type of stream channel may be present. The size, shape, and topographic relief of a watershed directly relates to the size of the stream channel, expected magnitude of winter storm flows, and the overall biological value of the watercourse. In addition to providing information about the physical character of contribution area, determination of subwatersheds also provides valuable information about the land uses and potential impacts on a particular watercourse.

The delineated watersheds can be divided into primary and secondary watersheds. The primary watersheds consist of the larger watersheds and are named for the primary watercourse or landscape feature, such as Moore, Arroyo Seco, Jordan, Pasatiempo, Branciforte, Neary, and Arana. Each of these streams may have several tributaries, such as Branciforte Creek where both Carbonera Creek and Glen Canyon Creek flow into the mainstem of Branciforte, but all the water eventually flows to a common point.

The secondary watersheds are distinguished by the primary tributaries of other landscape features; these include Pogonip, Upper Pogonip, Lower West Side, Lower San Lorenzo, Lower East Side, Younger and Wilder. These watersheds include several small watercourses that do not necessarily flow into a common point, but have been grouped together because they occur in the same vicinity and fall between the primary watersheds. Several of the watersheds, both primary and secondary, are actually part of the larger San Lorenzo River watershed. Those watersheds include Pogonip, Pasatiempo, Branciforte, and Lower San Lorenzo.

## FIGURE J-6. WATERSHEDS WITHIN THE CITY OF SANTA CRUZ

## J.4 HISTORIC DISTRIBUTION OF WATERCOURSES AND WETLANDS WITHIN THE CITY

The location and distribution of watercourses within the City looks much different today than it did prior to European settlement. Many of the watercourses and accompanying riparian corridor vegetation has been modified to provide room for development, drainage improvement or flood protection. These changes include concrete channelization, levee construction, construction of culverts and rerouting watercourses. Despite these alterations, the remaining habitat associated with the City's watercourses and wetlands are a valuable biological and community resource.

### J.4.1 Mission and European Settlement Period

Modifications to stream courses within the City began as early as the founding of the Spanish mission in 1791. Springs on the west side of town were diverted to supply water to the Mission, which was located on a hilltop to avoid periodic flooding of the lowlands within the floodplain of the San Lorenzo River. Much of the downtown is currently built on the San Lorenzo River floodplain, which historically included a connection between the main stem and Neary Lagoon. In fact, Neary Lagoon may have been a historic meander of the San Lorenzo River (Sandy Lydon, local historian, personal communication). During the 1955 flood, this connection was realized again to the dismay of downtown businesses and residents. During periods of flooding, Beach Hill, situated between the river and Neary Lagoon, would essentially become an island.

Upon the arrival of northern European settlers, the founding fathers of the City of Santa Cruz were set on developing the City on the lowlands between the San Lorenzo River and Neary Lagoon. From that time to the present, the history of development within the City of Santa Cruz has been closely tied to controlling flooding on the San Lorenzo River.

Elsewhere in the City, impacts to watercourses were minimal except in the case of the numerous springs emanating from the karst (i.e., limestone) on the west side of town. High water quality and consistent flows, even during drought periods, made these spring-fed streams ideal for local water supply development and integration into residential landscapes.

### J.4.2 Mid 1900s to Present Period

The riparian and wetland resources within the City were significantly altered in the mid 1900's. A review of aerial photos from the 1940s reveals that many of areas in/adjacent to the watercourses were under agricultural cultivation and the historic riparian and/or wetland vegetation was absent. This trend of land use is depicted in Figure J-7 wherein the area around Arana Gulch Creek, as depicted on the 1940 photo, was in agriculture. The lagoon located at the mouth of Arana Gulch Creek was converted to a small craft harbor during this period. The modification of the lagoon for construction of the harbor is depicted in the 1999 photo on Figure J-7. This 1999 photo also depicts residential development along Hagemann Gulch and a tributary of Arana Gulch Creek.

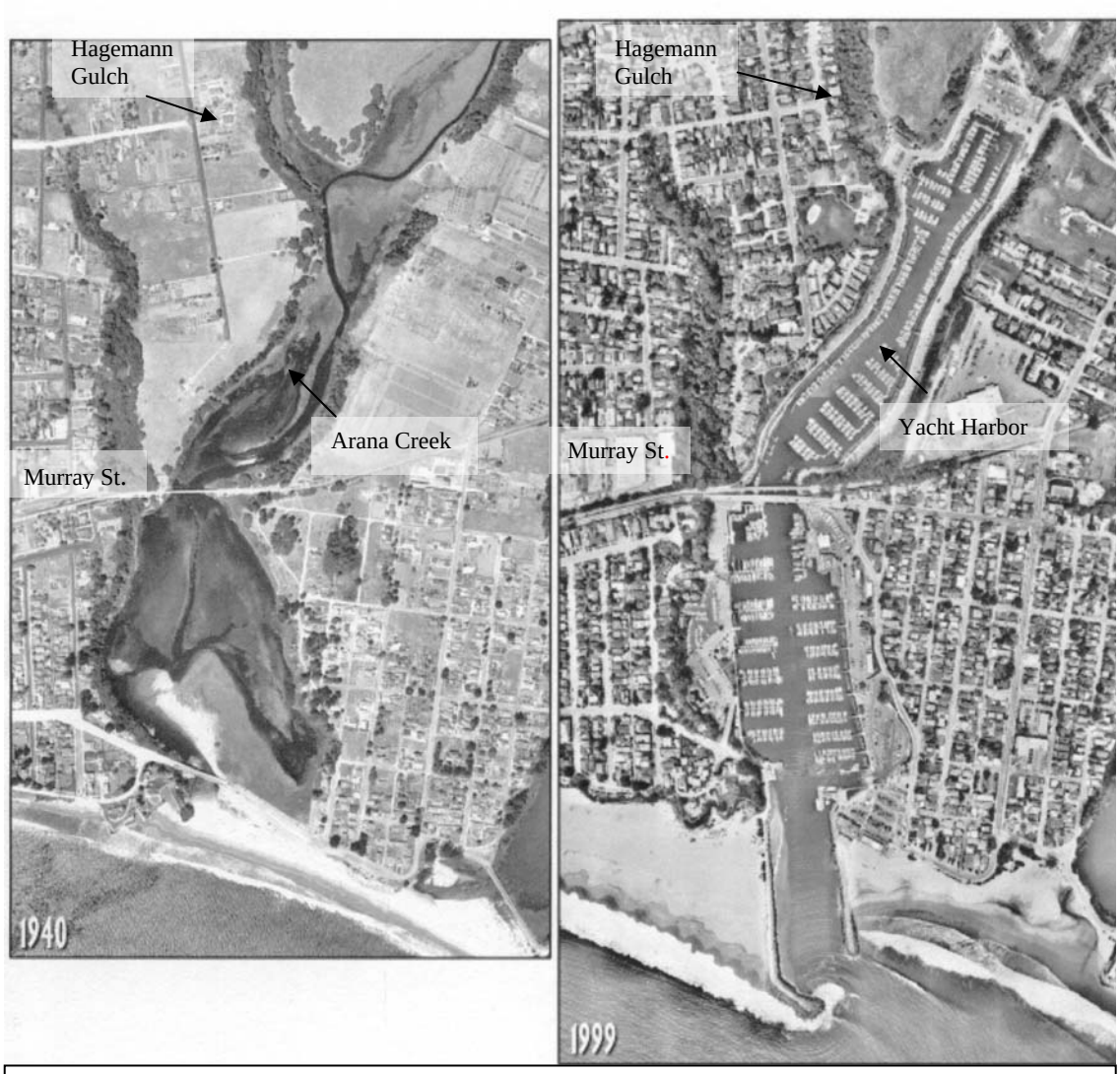



**FIGURE J-7. ARANA CREEK AND TRIBUTARIES IN AERIAL PHOTOS, 1940 AND 1999.**
Source: UCSC Map Library

The post World War II (WWII) era of large public works projects and rapid development of dense residential housing in the 1960s and 1970s resulted in the most extensive period of modification to streams and riparian corridors within the City. Following the major flood on the San Lorenzo River in 1955, the ACOE designed and built the system of levees that we see today.

Figure J-8 shows the changes in land uses in the Moore Creek and Arroyo Seco Creek areas of the City. The 1940 photo shows agriculture lands along both creeks. By 1999, as shown in the 1999 photo on Figure J-8, residential development is located adjacent to Arroyo Seco Creek and the east branch of Moore Creek. Interestingly, some areas along the creeks are more heavily vegetated in 1999, presumably due to the cessation of cattle grazing on the slopes of the arroyo and in the riparian corridor.

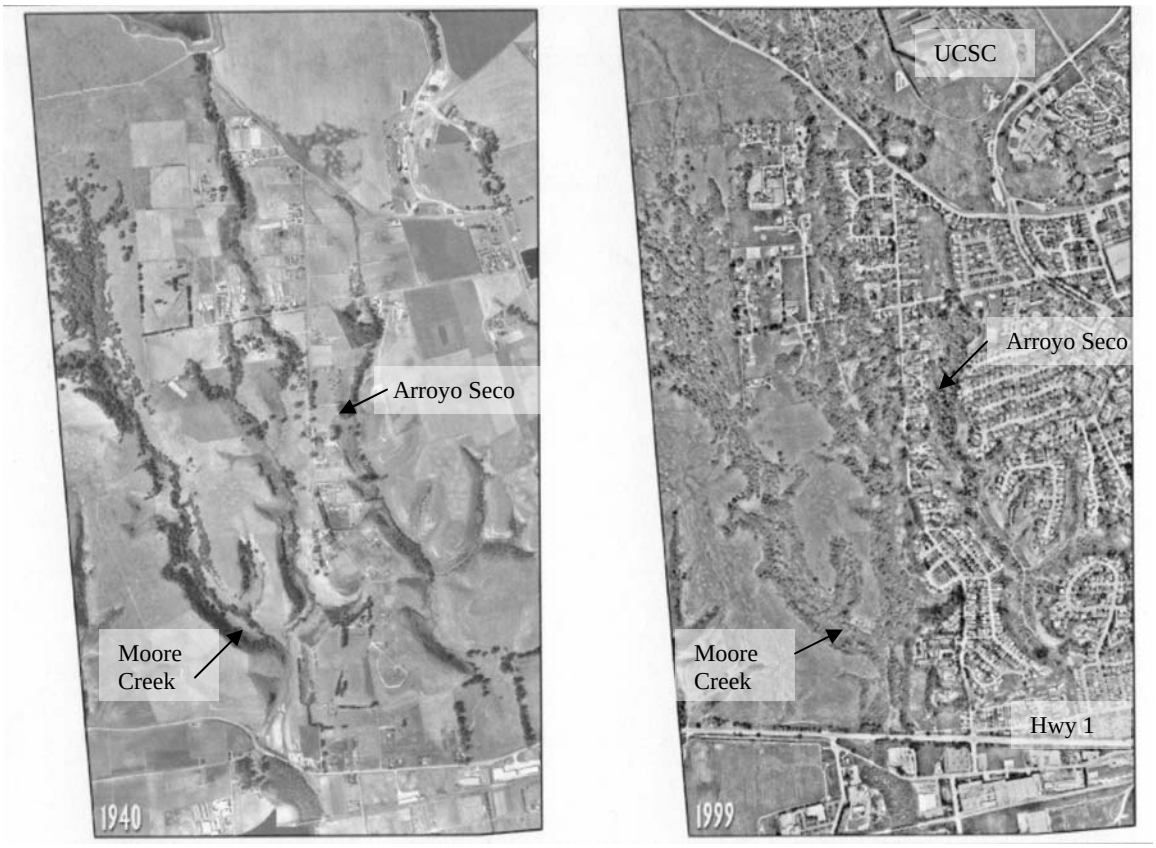



**FIGURE J-8. MOORE AND ARROYO SECO CREEKS IN AERIAL PHOTOS, 1940 AND 1999.**
Source: UCSC Map Library, Aerial Photograph Collection

Many of these land uses, coupled with the accompanying need for flood protection, have, over time, altered the natural features of the City's landscape, including the amount and condition of its riparian resources. Watercourses that historically supported relatively wide corridors of natural vegetation over their flood plains now support narrow bands of vegetation within their banks or have been modified for flood protection.

The majority of the upland habitat adjoining the watercourses has been converted from agriculture to residential, industrial and commercial developments. This development has left the watercourses as the few remaining areas within the City (excluding parks and greenbelt lands) where native habitat has persisted. Despite the reduction of the native riparian habitats to narrow, confined linear corridors, they still provide habitat for native (and non-native) plant and animal species, including special status species (e.g., steelhead trout, California red-legged frog and yellow warbler).

## J.5 IMPAIRMENTS TO WATERCOURSES AND WETLANDS

Urban activities within the City have different effects on vegetation and wildlife that reside in the watercourses and wetland areas. The type of activity (e.g., residential, industrial, commercial or recreational uses), as well as the proximity and duration of such activities, next to the watercourse or wetland determine how the riparian vegetation and wildlife could be affected. Additionally, since urban creeks provide important water quality and drainage functions, land use activities occurring adjacent to watercourses and wetlands can also affect these resources.

More than 38 miles of watercourses exist within the City. The watercourses traverse through or near (within 100 feet) of approximately 1,818 parcels. As depicted on Table J-3, these parcels are designated by land use as either commercial, industrial, institutional, open space or park, residential, UCSC lands or vacant (and not coded).

**Table J-3. Existing Land Uses on Parcels within 100 Feet of Watercourses and Wetlands**

| Land Use | Number of Parcels | Percentage of Total (Parcels) | Parcel Acreage | Percentage of Total (Acres) |
|---|---|---|---|---|
| Commercial | 49 | 3% | 35 | 3% |
| Industrial | 46 | 3% | 118 | 10% |
| Institutional | 27 | 2% | 173 | 15% |
| Open Space/Park | 7 | <1% | 89 | 7% |
| Residential | 1,562 | 86% | 566 | 48% |
| Vacant | 115 | 6% | 168 | 14% |
| Not Coded | 12 | <1% | 40 | 3% |
| **Total** | **1,818** | **100%** | **1,189** | **100%** |

Source: County of Santa Cruz Assessors Office, 2001

Each of these land uses can result in impacts to watercourses. Impacts can be direct, such as the removal of vegetation (and loss of habitat), discharge of pollutants that affect water quality, deposition of debris, and introduction of invasive, non-native plant species. Impacts can also be indirect, such as increases in noise and night lighting affecting wildlife utilization, change in stream dynamics resulting in increased bank erosion, increase in stream temperature from lack of vegetative cover, predation on native wildlife by domestic animals and an increase in non-native animal species.

### J.5.1 Water Quality

Chronic non-point source pollution from urban land uses is the most prevalent deleterious cause for the degradation of water quality of local streams (RWQCB, 1994). Impacts to water quality within the City and the surrounding area vary both spatially, as a result of land use, and temporally, due to seasonal weather and hydrologic variations. The primary sources of pollution within the City includes fine sediment from surface erosion; nutrient inputs from leaky septic and sewer systems; residential lawns; golf courses; agricultural practices; animal and human waste; oil and gas residues from road runoff; heavy metals from automobile and industrial sources; pesticides and herbicides from agricultural practices; and residential and urban waste.

The density of impervious areas, coupled with urban land use activities indirectly impacts local waterways. Impervious surfaces in urban areas increases the peak flow values of a given event due to

the increased efficiency of water transport to the stream. The increased efficiency of water delivery also relates to the delivery of pollutants. Pollutants are deposited on roads and parking lots and stored until surface runoff dissolves the soluble fraction and transports the pollutants to the nearest storm drain. Changes in the amount of impervious surface throughout a watershed also indirectly exacerbate channel and bank erosion and subsequent excessive fine sediment loads within the local channels. These are direct examples of the sources behind streams with continuously elevated total suspended solids (TSS) and turbidity values. Additionally, impervious surfaces reduce soil moisture and groundwater storage, resulting in lower baseflows in the dry summer months.

Nutrient enrichment, high water temperatures, and decreased circulation can lead to eutrophication, low dissolved oxygen, and a shift in the aquatic environment to one more suitable for invasive, non-native species that are well adapted to degraded conditions. Toxins can often accumulate in sediments within streams and estuaries and degrade water quality for a long period of time, even after the input of chemicals and toxins from the contributing watershed have been reduced.

Time of year also plays an important role in the quality of water resources within the City. During the dry season, potential sources of poor water quality accumulate on the landscape but have little impact on water quality in the watercourse because of lack of rain to transport the constituents. After the first significant winter rains in October and November, the 'first flush' of pollutant delivery is characterized by extremely high levels of nutrients, trace metals, and toxic constituent concentrations in the local streams. High groundwater tables and old septic systems can mobilize extreme amounts of nutrients and fecal coliform during rainy months of the year. In spring and summer, as water levels recede, poor water circulation coupled with anthropogenic nutrient levels can lead to eutrophication and low dissolved oxygen values. Eutrophication can lead to the complete elimination of native species, nuisance algal blooms, and fish kills. Many aquatic organisms, especially fish, require high levels of dissolved oxygen. Sufficient levels are usually maintained by low water temperature and high turbulence, which aerates the water. Dissolved oxygen may be depleted under conditions of high temperature, still water or excessive decomposition of organic matter. If oxygen levels are too low, many organisms die.

Human activities within or adjacent to watercourses and wetlands can also affect water quality. In addition to animal wastes, human wastes can result in high levels of coliform bacteria in the water. This bacterium may pose health hazards to both humans and wildlife ingesting water from such areas.

Vegetated stream corridors can provide protection of water quality through preventing direct exposure of sunlight to the surface waters. Vegetation can also serve as a buffer by filtering urban storm water runoff prior to entering the stream and reduce bank erosion and subsequent fine sediment build-up in the stream channel. The infiltration of surface runoff through vegetated land can reduce high levels of nutrients, trace metals, oil and grease from the waters by either particle absorption or biological uptake. Vegetated corridors also can decrease water temperatures in stream habitats, an undisputable benefit of a well-established riparian corridor, but will provide little water quality buffering capacity when the majority of the water volume is directly transported to the local waterways via the storm drain system.

#### *J.5.1.1 Land Use Effects on Water Quality*

Each land use type has a unique set of considerations when assessing impacts to water quality. The watercourses that occur within or flow through the City can be classified as being impacted by commercial, industrial, urban residential and rural residential land uses. These land uses are addressed below.

**Commercial.** The primary impacts of commercial land uses are impervious surface cover. Roads, parking lots and roofs all prevent infiltration and contact of the water with vegetation. As stated above, impervious surfaces impact the delivery rate and magnitude of both water and pollutants to the streams. Ornamental landscaping requiring maintenance and fertilizer will also contribute nutrients to the streams. The most concentrated commercial areas are found in the cities of Santa Cruz and Scotts Valley, potentially affecting Carbonera Creek, Branciforte Creek, Neary Lagoon and the San Lorenzo River.

**Industrial.** The impact of industrial land uses on water quality varies considerably depending on the type of activity. In general, industrial has similar impacts on water quality as commercial land uses. The main difference is industrial facilities commonly store and utilize hazardous materials on site. Improper storage or disposal of these materials can often be the primary cause of pollution loading into local waterways. Leaking underground storage tanks (LUSTs) from gas stations and dry cleaners have been common pollutant sources to groundwater tables in the past. Depending upon the proximity of these unauthorized releases to local waterways, water quality of streams can also be impacted from these leaks. However, regulations and efforts in the last two decades have significantly decreased occurrences of industrial pollution. Industrial facilities are now heavily regulated and unauthorized releases result in extreme financial penalties. Therefore, most operations are now well educated and comply to the appropriate BMPs. The main pollution contributors may now be the small auto repair shops and industrial waste yards. In the City, the watercourses that have a significant portion of industrial land uses within their watersheds are lower Arroyo Seco Creek, Pogonip Creek and Arroyo de San Pedro Regaldo.

**Urban Residential.** The most common residential water quality impacts are from the presence of impervious surfaces and nutrient inputs from fertilized lawns, detergent use, car washing, and improper disposal of constituents such as oil or household hazards wastes. Due to the prevalence of this land use type, most stream courses within the City are affected.

**Rural Residential.** Impacts to water quality from rural residential areas are similar to those discussed for urban residential. Larger undeveloped parcels lessen the relative impact from impervious surfaces. Poorly managed animal wastes from horses and livestock can also adversely impact the local water quality. Watersheds within the City that receive the greatest impacts from rural residential land uses are the Upper San Lorenzo River, Upper Branciforte, Carbonera, Upper Arana and Moore Creeks, the majority of which area is located outside of City limits. Rural residential areas handle their wastewater by on-site septic systems, which can indirectly affect water quality; however, few properties within the City limits are on septic.

#### *J.5.1.2 Current Data on Water Quality within the City's Watercourses and Waterbodies*

The Water Quality Control Plan for the Central Coast Region was compiled by the RWQCB in 1994. The purpose of the Plan is to identify the beneficial use designation for each water basin within the Central California Coast and then provide water quality objectives that should be maintained to allow beneficial use. The San Lorenzo River, Branciforte Creek, Carbonera Creek and the other associated waterways within the City are designated for municipal water supply, contact and non-contact recreational use and biological habitat. This requires that water quality objectives for each of the waterways covered by this plan must maintain contaminant levels below those required for municipal withdrawal, in addition to providing safe and viable aquatic species and fish habitat. Urban runoff and other "non-point source" discharges are regulated by the 1972 Federal Clean Water Act (CWA) through the National Pollutant Discharge Elimination System (NPDES) permit program. The City of

Santa Cruz (City) has developed a comprehensive Storm Water Management Program (SWMP) in order to fulfill the requirements for the Phase II NPDES General Permit for Discharges of Storm Water from Small Municipal Separate Storm Sewer Systems (General Permit) and in order to reduce the amount of pollutants discharged in urban runoff.

The City of Santa Cruz lies within the San Lorenzo River watershed and receives runoff from areas outside of its jurisdiction. There are 13 watersheds (and subwatersheds) within (and including) the San Lorenzo River watershed basin and within the City limits. Prior to developing the SWMP, the City mapped watersheds and land uses within each watershed in order to assess resources and urban runoff issues. The City also identified potential sources of pollutants within each watershed. The City determined that it was preferable to take an overall approach to reducing urban runoff pollution, rather than focusing on reducing certain pollutants within specific watersheds. This is primarily because there are multiple land uses within each of the City's watersheds and because no single watershed is significantly more impaired than another. Also, the City concluded that an overall approach, aimed at reducing urban runoff pollution from each and all of the identified significant sources, would result in a more thorough and effective SWMP.

In compliance with the Phase II regulations, the City has developed a comprehensive SWMP that is designed to protect water quality by reducing the discharge of pollutants to the storm drain system and receiving waters to the Maximum Extent Practicable (MEP). The SWMP is tailored to meet the City's needs and requirements. The SWMP includes six required control programs and two recommended control programs for industrial facilities and commercial facilities. The two recommended programs were included because certain industrial and commercial facilities within the City were determined to be significant or potentially significant pollutant sources within the local watersheds. Thus, the eight control programs are as follows:

- Municipal Operations/Pollution Prevention and Good Housekeeping
- Illicit Discharge Detection and Elimination
- Public Participation
- Public Education
- Construction Site Storm Water Runoff Control
- Post Construction Storm Water Management
- Industrial Facilities
- Commercial Facilities

These eight programs will work together to comprise a well-rounded and multi-faceted approach to reduce urban runoff pollution within the City. The programs include urban runoff control policies, outreach and education efforts, site visits, and the implementation of BMPs. BMPs are pollution prevention practices or structural controls designed to reduce or eliminate pollutant discharges. BMPs typically emphasize "good housekeeping methods," chemical handling procedures, spill prevention, and proper waste storage and disposal. The implementation of BMPs by industrial facilities, commercial businesses, contractors, and residents is an important factor in ensuring the success of the SWMP.

The City currently has a Storm Water Ordinance, which became effective on May 28, 1998, that established the legal authority to prohibit illicit connections and pollutant discharges to the City's

storm drain system. The ordinance also provides the City with the legal authority to conduct inspections and sampling. In addition, the ordinance contains a provision requiring the implementation of BMPs, as published by the Public Works Department, by certain types of facilities. The City also has the authority to terminate illicit connections and discharges, and to initiate enforcement actions for violations of the code. The ordinance also enables the City to initiate enforcement procedures, such as written notices, citations, termination of discharge, and monetary penalties, for violations of the code.

Funding for the SWMP will be obtained from the City Storm Water Utility fees charged to each property within city limits. The Storm Water Utility fee was initiated in May 1994. The storm water utility fees are included on the property tax bills from the Santa Cruz County Tax Collector.

In summary, the Storm Water Management Program is a comprehensive program focused on reducing the discharge of pollutants to the storm drain system, which flows to local creeks and Monterey Bay. Polluted urban runoff is a widespread threat to water quality and clean water is critical to the continued vitality of the City of Santa Cruz and the Monterey Bay National Marine Sanctuary. The City is dedicated to implementing the Storm Water Management Program, in compliance with the General Permit requirements, in order to protect water quality and preserve our environment.

The Central Coast Ambient Monitoring Program (CCAMP) is the Central Coast Regional Water Quality Control Board's regionally scaled water quality monitoring and assessment program. Its primary mission is to collect, assess, and disseminate scientifically based water quality information to aid decision makers and the public in maintaining, restoring, and enhancing water quality and associated beneficial uses. The CCAMP strategy of establishing and maintaining permanent long-term monitoring sites provides a framework for trend analysis and detection of emergent water quality problems. CCAMP uses a variety of monitoring approaches to characterize the status and trends of coastal watersheds, including bioassessment using benthic invertebrate counts, water quality parameter analysis, chemical analysis of tissue, water, and sediment, toxicity evaluations, habitat assessments, and sedimentation evaluations. By furnishing continuous access through SIMoN (Sanctuary Integrated Monitoring Network) for data to be accessed by scientists, cities, and regulators, CCAMP and SIMoN allow meta-analyses and direct analyses for stakeholders to understand regulatory impacts; regional and site-specific needs. The CCAMP website (http://www.ccamp.org/) allows both direct access to, and input of various water quality, biotic, and sediment sampling data from a number of watersheds throughout the Central California Coast. While the web site was not fully operational at the time of this report, it does contain a compilation of data from the Big Basin water basin, within which the City of Santa Cruz waterways lie. This type of data compilation and management is an excellent means by which water quality within and across various watersheds can be monitored and the results may be easily compared to other similar streams.

City water bodies that have been studied and for which water quality data are available include: the San Lorenzo River, Moore Creek, Branciforte Creek, Carbonera Creek, Pogonip Creek, Arana Guclh Creek , Neary Lagoon, Westlake Pond and Antonelli Pond. Available data has been collected by several agencies and entities including the RWQCB, the City of Santa Cruz, the County of Santa Cruz, the Coastal Watershed Council and the Arana Gulch Watershed Alliance. The most comprehensive and reliable source of water quality data for the subject streams is the on-going monitoring project conducted by the County of Santa Cruz Environmental Health Department. This data provides seasonal and long-term variations on water quality trends within these various waterways. This type of consistent monitoring data will also be very useful in the future, following the implementation of various management actions or restoration projects, by which the success of such efforts can be evaluated.

The most common parameters that are measured include pH, water temperature, bacteria, dissolved oxygen, and electrical conductivity (a measure of the dissolved constituents). Except for bacteria, these parameters are fairly easy to measure and the information can be obtained quickly at the site (bacteria must be analyzed at a lab). The data can provide a useful indication of the overall health of a waterway. Fecal coliform is regularly measured at many sites and is an indicator to the amount of bacteria present, and high levels suggest unsafe conditions for human contact. Total dissolved solids and turbidity measure the fraction of suspended and dissolved particles contained in the water column, and high levels can be indicative of a highly erosive watershed. Nutrients (nitrate, nitrite, ammonium, and phosphate) are regularly measured but require water sample collection and laboratory analysis. Nutrients are the building blocks for vegetation and biological growth at the base of the food chain. Application of fertilizers and leaking human and animal waste residue will enrich the local waterways with nutrients, thus fertilizing the surface waters. High nutrient levels will lead to high chlorophyll, low dissolved oxygen levels and are strongly correlated with elevated fecal coliform levels. Trace metals (mercury, lead, chromium, copper, zinc, nickel) are released to the waterways by automobile use, wastewater discharge, and various industrial and agricultural practices. Proper collection and analysis of trace metal and pesticides (DDT, dieldrin and others) samples is difficult and expensive; therefore, much less information exists on trace metal and pesticide levels in local waterways.

Not all creeks within the City have been sampled and analyzed, and even those that have been tested were not consistently tested for all constituents and parameters. The San Lorenzo River, Moore Creek, Carbonera Creek, and Branciforte Creek have been monitored fairly consistently since the mid-1970's by the County of Santa Cruz and the City of Santa Cruz Water Department has monitoring data going back decades. Small projects and various non-profit organizations have performed ancillary water quality monitoring in streams such as Arana Gulch Creek, Branciforte Creek, Antonelli Pond and Westlake Pond. For purposes of the *Management Plan*, the compiled information provided by the County of Santa Cruz, with limited modification from the Public Works Department, was used in the following general assessments of each waterway. Efforts by local groups and agencies are being made to compile a more comprehensive database of all available data, and such efforts may prove useful as future management actions are contemplated. It should also be noted that additional data gathered by volunteers organized by the Coastal Watershed Council as part of "snapshot day" and "first flush" is also available through the Coastal Watershed Council.

**Neary Lagoon.** Since it's acquisition by the City of Santa Cruz as a park site in the 1950s, Neary Lagoon has been maintained by the City of Santa Cruz Public Works Department and the Parks and Recreation Department. Neary Lagoon is a wildlife refuge, but it has historically been used for retention of stormwater runoff and flood control. The historic use of Neary Lagoon to retain urban runoff is of concern because pollutants like nutrients, heavy metals, pesticides, and other synthetic organic compounds are commonly present within the lagoon sediment (RWQCB, 1987). A general understanding of water quality and presence of contaminants within the sediments of Neary Lagoon is an important element in understanding the conditions present in the watershed draining into the lagoon, including Laurel Creek and other small, spring-fed streams.

The County of Santa Cruz has monitored Neary Lagoon fairly regularly for ancillary parameters and fecal coliform since 1986; however, nitrate data is much more sporadic. Documented problems in the past include high bacteria levels, turbidity, low dissolved oxygen, and high ortho-phosphate concentrations (City of Santa Cruz, 1991). Neary Lagoon is a highly eutrophic lagoon (which tends to reduce aquatic species diversity) as a result of elevated nutrient levels and low water circulation. With the exception of high levels of orthophosphate, water quality is fair to good (City of Santa Cruz, 1991). In addition, a large amount of cattail, bulrush and other wetland vegetation significantly enhance the uptake of nutrients and pollutants within the water column by providing a large carbon

source to facilitate denitrification and other geochemical breakdown processes. The presence of dense vegetative stands may be the cause for the relatively lower fecal coliform counts than those recorded in Antonelli's Pond (see discussion on this pond, below). In addition to maintaining the lagoon, the City of Santa Cruz Public Works Department monitors Neary Lagoon for Flow levels; Fecal Coliforms; Enterococcus; Ammonia Nitrogen; and pH. Although the monitoring effort was initiated for documenting maintenance effectiveness and for potential water use planning, it has recently been incorporated into the BMPs for the site.

To prevent discharge of water with high bacterial counts to Cowell's Beach, the City diverts lagoon water to the wastewater treatment plant during the dry season (when the plant has the extra capacity). During the wet weather, the lagoon water is allowed to flow to Cowell's Beach, and during storms, is manually pumped to Cowell's Beach to prevent flooding of adjacent areas. However, just prior to onset of the rainy season, the City must conduct wet weather preparations (flushing the storm water conveyance pipes running between the lagoon and Cowell's Beach, and some of the lagoon water) in order to reduce high bacteria levels in the water.

**Antonelli Pond and Moore Creek.** The County of Santa Cruz has been seasonally monitoring both the contributing waters (Moore Creek) and Antonelli Pond since 1986. The mouth of Moore Creek, just prior to discharge into Antonelli Pond seems to consistently contain elevated levels of nitrates and fecal coliform. The high nutrient levels may be due to neighboring agricultural, animal grazing activities in the watershed and human wastes. In addition, Moore Creek has a regular population of birds that contribute to the bacteria population both at the mouth of Natural Bridges Beach and at Antonelli Pond.

The Coastal Watershed Council began a monthly monitoring project in Antonelli Pond in 1999. Volunteers collected ancillary data and attempted nutrient analyses with in-field analytical kits (i.e., Hach kits). These Hach kits have not proven reliable for this effort; therefore, efforts to determine nutrient levels were later abandoned. The County of Santa Cruz has generated data regarding fecal coliform levels within Antonelli Pond.

The minimal data available for Antonelli Pond shows elevated levels of nutrients and bacterial counts. The low amount of circulation within Antonelli Pond, coupled with the high level of nutrients, has lead to cultural eutrophication during the warmer months of the year. Low bottom water dissolved oxygen levels are the result of excessive algal loading from the surface waters. Decades of industrial and agricultural runoff have also resulted in the invasion of non-native plant and fish species. Fecal coliform levels of well over 10,000 counts have been recorded several times by the County of Santa Cruz; most of the high counts were in the winter. The water in Antonelli Pond is not suitable for either municipal supply or recreational contact, due to extremely high levels of fecal coliform.

**Arana Gulch Creek.** The Coastal Watershed Council and the Arana Gulch Watershed Alliance have mobilized volunteer monitoring efforts within Arana Gulch Creek over the last 5 years. The primary focus of the monitoring has been sedimentation and erosion studies, and the collection of ancillary parameters. According to Coastal Watershed Council, the primary problem with Arana Gulch Creek is the chronic high sediment load contributed from the surrounding watershed. The outlet of Arana Gulch Creek is the Santa Cruz Yacht Harbor, and the high amount of sediment increases the frequency of dredging that must occur within the harbor to maintain navigation. No information was available on the levels of nutrients or fecal coliform.

**Pogonip Creek.** Neither the County of Santa Cruz or the City maintain any monitoring stations on Pogonip Creek, though the City of Santa Cruz Water Department collected streamflow data in 2002.

Due to a lack of data, no assessment of the current water quality of this waterway was conducted as part of the *Management Plan*.

**Carbonera Creek.** The County of Santa Cruz has monitored ancillary parameters and fecal coliform levels at various locations in Carbonera Creek sporadically since 1976, but they now sample Carbonera on a quarterly basis. At each of the locations monitored, ancillary parameters are within the limits set by the Basin Plan for aquatic habitat. Fecal coliform levels are consistently fairly low to moderate, below 1,000 counts. The presence of a city-wide sewer system in Scotts Valley most likely contributes to the low bacterial counts. Carbonera Creek is on the list of water bodies that does not meet water quality objectives for sediment and nutrients (see Section J.5.2 for further detail on sediment issues).

**Branciforte Creek.** The County of Santa Cruz has been monitoring water quality in both the Upper and Lower reaches of Branciforte Creek. For the purposes of the *Management Plan*, the division between the upper and lower reach is just above Water Street, where the stream is confined within a trapezoidal concrete structure until its discharge to the San Lorenzo River. High nutrient values at both County monitoring locations (Isbel Dr. and just above the confluence with the San Lorenzo River) display peak nutrient values during the winter months when stream discharge is high. The rural residential land use in portions of the upper watershed is supported by septic systems, most of which may be old or not functioning properly, providing a source of chronic nutrients that are transported from the upper watershed to the lower stream reach. The cemented channel of the lower reach of Branciforte Creek provides limited habitat value. In addition, the lack of well-developed riparian vegetation results in high water temperatures and efficient pollutant and water transport from the neighboring urban areas. Branciforte Creek is on the list of water bodies that does not meet with quality objectives for sedimentation/siltation (see Section J.5.2 for further detail on sediment issues).

**Westlake Pond.** The County of Santa Cruz collected some ancillary water quality data and a small amount of nutrient and fecal coliform information from the pond in the early 1990's. The pond has been sampled by the County approximately 35 times with variable results. The relatively small volume of water contained within Westlake Pond was unable to handle the nutrient enrichment from the continual fertilizer applications to the neighboring athletic fields. According to Ken Bruland of UCSC, in the early 1990s the waters of the pond would continually go anoxic in the warm summer months as a result of the eutrophic conditions. Waterfowl is also a major contributor to the bacteria/nutrient population. A fountain is present in the pond and provides an additional source of oxygen to the water column so that the bacteria can aerobically breakdown the high levels of algae produced in the pond.

**Other Creeks.** Much data exists on the San Lorenzo River itself and is the focus of other on-going studies and investigations by the City and County of Santa Cruz, such as the Nitrate Management Plan, City Watershed Lands Management Plan, San Lorenzo Watershed Management Plan and sediment Total Maximum Daily Load (TMDL) study. Since the San Lorenzo River has its own management plan, the data is not summarized in this report. Additional data on Moore Creek; Branciforte Creek; and San Lorenzo River water quality have been compiled by the Central Coast Long Term Environmental Assessment Network (CCLEAN) and the City of Santa Cruz Public Works Department. This effort was initiated in July 2002 and includes data collection for: Nitrates; Silicates; Urea; Suspended Solids; Total and Fecal Coliforms; E.coli; and Enterococcus. The quality assurance program for this exercise allows for higher confidence levels in planning and management of the rivers and creeks. Under the same rigorous data quality objectives, and from the same time period, the San Lorenzo River has been monitored for Petroleum Aromatic Hydrocarbons (PAHs); Chlordanes; DDT;

DDD; DDE; PCB; Endosulfans; and Dactals. This data will provide additional insight and leverage into managing the impacts of urban runoff into San Lorenzo River.

Finally, the Public Works Department has implemented a continuous monitoring program at the San Lorenzo River for collecting data on Dissolved Oxygen; temperature; Conductivity; pH; Nitrate; and Chloride. The data is collected every half hour and transmitted to a website for review and follow up. This will allow for better tracking of illicit discharge detection at the river by the Environmental Compliance program of the City of Santa Cruz.

#### *J.5.1.3. Sediment and Erosion*

Fine sediment inputs into watercourses and wetlands within the City of Santa Cruz has a significant impact on water quality, the frequency of flooding, and beneficial uses. The primary sources of bed-impairing sediment and the resulting impacts depends greatly on the watershed and the adjacent land uses. Fine sediments typically are flushed with big storm events, while larger grain sizes such as sand impair the bed. The distribution of bed-impairing sediment also varies within a particular watershed with some sections of a watercourse experiencing downcutting and bank erosion, with other sections experiencing heavy sedimentation from delivered sediments.

Section 303(d) of the Clean Water Act requires states to identify and prepare a list of water bodies that do not meet water quality objectives, and then to establish load and waste load allocations (collectively known as TMDLs) for each water body, in order to ensure attainment of water quality objectives. The City of Santa Cruz storm drain system discharges into four water bodies that are currently on the 303(d) list. These water bodies are the San Lorenzo River, Carbonera Creek, Branciforte Creek, and the San Lorenzo River Lagoon. The RWQCB recently developed a TMDL report that establishes standards on the amount of sediment from the watershed that would need to be controlled to improve habitat conditions for salmonids. Sediment sources have been identified as both natural and anthropogenic from sources such as public and private roads, landslides, timber harvest activities, and grading in highly erodible soils.

The San Lorenzo River, Branciforte Creek, and Carbonera Creek were identified as impaired by sediment/siltation on the 1998 Clean Water Act Section 303 (d) list of impaired water bodies (see www.swrcb.ca.gov/tmdl/docs/2002reg3303dlist.pdf). On May 16, 2003, the RWQCB adopted a sediment TMDL (Resolution No. R3-2002-0063) for these water bodies and, thereby, incorporated the TMDL and associated Implementation Plan into the Basin Plan.

The TMDL Implementation Plan identifies the Cities of Santa Cruz and Scotts Valley, the County of Santa Cruz, and the owners and operators of construction sites of one acre and greater as Responsible Dischargers. To attain required water quality objectives the City Public Works Department has developed and implemented the SWMP and Storm Water Pollution Prevention Plans (SWPPPs) consistent with NPDES Phase II Storm Water regulations. In addition, the San Lorenzo River Watershed has been identified as a priority for site inspection and enforcement of control measures in the SWMP and SWPPPs. Establish a mechanism by which operators and owners of one acre and greater construction projects are notified of the requirement to prepare SWPPPs. The Department of Public Works is also considering incorporation of sediment control programs/projects into the SWMP.

Other water bodies/impairments on the 303(d) list include the following:

- The San Lorenzo River is listed for nutrients, with the potential sources being non-point source and septage disposal, and pathogens, with the potential sources being septage disposal and urban

runoff/storm sewers. As stated previously, the San Lorenzo River is also listed for sedimentation/siltation.

- Carbonera Creek is listed for nutrients, with the potential sources being non-point source, and pathogens, with the potential sources being septage disposal and urban runoff/storm sewers. As stated previously, Carbonera Creek is also listed for sedimentation/siltation.
- Branciforte Creek is listed for sedimentation/siltation. The potential sources are non-point source, road construction, and silviculture.
- The San Lorenzo River Lagoon is listed for pathogens, with the potential sources being natural sources and urban runoff/storm sewers.

To date, no TMDLs have been established for the above impairments (with the exception of nitrates for the San Lorenzo River and the sediment TMDL), although the TMDLs are in various stages of development. Upon the RWQCB adoption of TMDLs for the above water bodies, the City will determine whether the existing SWMP meets the TMDL implementation requirements within its jurisdiction and, if necessary, revise the SWMP accordingly. Refer to the State Water Resources Control Board website for the most recent information (available online at www.swrcb.ca.gov/tmdl/docs/2002reg3303dlist.pdf.

Other watercourses within the City of Santa Cruz that are experiencing increased fine sediment input and channel sedimentation include Arana, Arroyo de San Pedro Regaldo, Arroyo Seco and Pogonip creeks. A watershed assessment has recently been completed for Arana Gulch Creek to identify sediment sources and develop watershed-wide strategies to reduce sediment inputs and enhance salmonid habitat (Bobby Haver, pers. comm. 2001). Arroyo de San Pedro Regaldo is experiencing erosion and sedimentation due to land disturbances in the vicinity of Evergreen Cemetery. Much of this sediment ultimately reaches the San Lorenzo River.

The remaining watercourses in the City are experiencing a different sort of sediment problem related to urbanization of the watershed and reductions in pervious surfaces. An increase in the impervious area of the watershed results in an increase in peak storm flows over time. As the volume of water increases, the channel must become larger to accommodate the flow. The result is often channel downcutting and bank erosion, loss of riparian vegetation as the banks undercut, and further erosion as the banks become destabilized. This result is evident along Arroyo Seco Creek, Branciforte Creek, Pasatiempo Creek, portions of Moore Creek, and many of the watercourses draining DeLaveaga Park (tributaries to Arana Gulch Creek).

Excessive sedimentation can degrade the quality of watercourses and wetlands for aquatic resources. Anadromous fish (salmon and steelhead) require silt free gravel for successful spawning, shelter and production of the small aquatic organisms that serve as food for young fish. Excessive amounts of sediment washing into watercourses change the character of stream bottoms, greatly reducing fishery productivity (County of Santa Cruz, 1990). However, it is important to note how little anadromous habitat is associated with downstream reaches of creeks within the City. For instance, impacts in the San Lorenzo and Branciforte are almost completely a result of upstream practices in the County

### J.5.2 Invasive, Non-Native Species and Pathogens

#### *J.5.2.1 Invasive, Non-Native Plant Species*

The occurrence of invasive, non-native plant species within the City's riparian and wetland areas is widespread. Almost all the watercourses and wetlands in the City were observed to support at least one plant species (and usually more) that is considered invasive. The most widespread plant species are Cape ivy and English ivy; however, periwinkle, French broom, Himalaya berry and eucalyptus are also abundant. Due to the aggressive growth of these species and their ability to out compete native plants, riparian areas quickly become dominated by non-natives. The value of the riparian corridor to native wildlife is significantly reduced due to lack of food (e.g., reduction of native seeds, berries and flowering plants) and a decrease in structural diversity of the habitat, which is important to wildlife for their cover and foraging needs. Some non-native plants, such as acacia, can also present health problems (i.e., an irritating pollen source). Figure J-9 depicts a eucalyptus-dominated riparian corridor.

**FIGURE J-9. VIEW OF EUCALYPTUS-DOMINATED NON-NATIVE RIPARIAN WOODLAND.**

Several non-native plants are recognized as invasive by the California Invasive Plant Council (Cal-IPC) (a non-profit organization that monitors invasive plants within the State) and are on the State's Noxious Weeds List (a list of agricultural pest plants, as maintained by the U.S. Department of Agriculture). Many invasive, non-native plants that occur along watercourses and wetlands in the City were introduced in the late 1800's as landscaping plants. Periwinkle, English ivy and cape ivy, aggressive hardy plants adapted to shady conditions, are prevalent in riparian woodlands in the City. They provide no food or cover for native wildlife and easily out compete other plants that do. Other invasive, non-native plants invade sunny, disturbed areas, such as French broom, Scotch broom and pampas grass. These plant species are able to invade many habitat types and can quickly spread, creating dense thickets. As previously discussed, eucalyptus, Monterey pine and acacia are tree species non-native to the City. With the exception of some wildlife species (e.g., raptors, monarch butterfly and hummingbirds), these tree species do not supply valuable habitat to native riparian wildlife.

The following invasive, non-native plant species have been documented within City watercourses and wetlands:

**Trees**
- Acacia *(Acacia* sp.)
- Blue gum eucalyptus (*Eucalyptus globulus*)
- River red gum (*Eucalyptus camaldulensis)*

**Shrubs and Vines**
- French broom (*Genista monspessulana*)
- Pampas grass (*Cortederia jubata*)
- Cape ivy (*Delaireia odorata*) (previously referred to as German ivy (*Senecio mikanoides*)
- English ivy (*Hedera helix*)
- Himalayan Blackberry (*Rubus procerus* or *R. discolor)*
- Nasturtium (*Tropaeolum majus)*
- Mattress Vine (*Muhlenbeckia complexa)*

**Herbaceous Plants and Groundcovers**
- Periwinkle (*Vinca major*)
- Poison hemlock (*Conium maculatum*)
- Italian thistle (*Carduus pycnocephalus*)
- Ice plant (sea fig) (*Carpobrotus edulis*)
- Wild mustard (*Brassica* spp.)
- Wild radish (*Raphanus sativus*)
- Harding and canary grass (*Phalaris* spp.)
- Kikuyu grass (*Pennisetum clandestinum)*
- Mexican Eupatory or Sticky Ageratina (*Ageratina adenophora)*

#### *J.5.2.2 Plant Pathogens*

A fungus responsible for California Oak Mortality, formerly known as Sudden Oak Death, is a water mold fungus in the genus *Phytophthora*. This fungus has been reported within northern Santa Cruz County and may occur in the City. Although no oak trees along watercourses were observed with obvious signs of California Oak Mortality during the 2000 and 2003 field surveys, it may occur now (or in the future) in the oak riparian woodland.

If California Oak Mortality becomes prevalent within City's watercourses in the future, significant areas of oak woodland, as well as other species, may be susceptible to death. Current information on California Oak Mortality, including host plant information, symptoms and preventative and treatment measures is available through the University of California Cooperative Extension, Sudden Oak Death website (http://cemarin.ucdavis.edu). Opportunities exist in the watershed to inform property owners on measures to prevent/control the spread of this fungus.

#### *J.5.2.3 Non-Native Wildlife Species*

Urban activities in and adjacent to watercourses and wetlands can encourage the colonization by non-native wildlife. Norway and roof rats, for example, are capable of colonizing riparian areas, as the vegetation provides cover. Natural and human food sources are also plentiful. The brown-headed cowbird, a non-native bird, is also known to occur along the City's riparian corridors. This bird frequents developed urban areas and often invades the outer edges of the riparian corridor, parasitizing the nests of native songbirds. When riparian corridors are narrow, cowbird activity can permeate the

entire corridor width, and significantly deplete the populations of native birds. Feral cats, as well as domestic cats and dogs, also pose significant impacts to riparian and wetland wildlife populations.

Several aggressive non-native animal species have spread into creeks and wetlands within the City and pose many problems for both native wildlife and adjacent property owners. These include bullfrog and introduced fishes (e.g., large-mouth bass, green sunfish, mosquito fish, bluegill and bullheads), non-native birds (e.g., European starling and brown-headed cowbird), non-native mammals (e.g., Norway rat, feral house cat, red fox, and feral pig). Glassy winged sharpshooters, a non-native insect, are a threat to vineyards because they carry Pierce's disease that kills grape vines. Although they may occur in the region in the future, their presence is not likely to affect habitat within watercourses or wetlands within the City.

**Bullfrogs and Introduced Fishes.** Bullfrogs (*Rana catesbeiana*) and introduced fishes are harmful to several native aquatic wildlife species. Bullfrogs are native to the east coast of the United States (east of the Rockies) and were imported to the west coast as a food source early in the 1900s (Stebbins, 1985). The large and aggressive bullfrog competes with other native amphibians (e.g., red-legged frogs) for limited food resources and directly preys on native amphibians (Hayes and Jennings, 1988). Bullfrogs have been observed at Antonelli Pond, Moore Creek just downstream of Delaware Avenue, at the pond in Natural Bridges State Park, along the San Lorenzo River, at Neary Lagoon, and probably use other perennials creeks and ponds within the City (Tim Hyland, pers. comm., 2001).

Fish species that do not occur in naturally in City watercourses and wetlands may disrupt the aquatic ecosystem and reduce the productivity of native fish species. Non-native fish can also prey on native fish, amphibian eggs and larvae, and juvenile pond turtles (Shaffer et al., 1993, Jennings and Hayes, 1994). Non-native fish occurring in the City include large-mouth bass (*Micropterus salmoides*), green sunfish (*Lepomis cyanellus*), and mosquitofish. These fish are known to occur in Neary Lagoon and Antonelli Pond; mosquito fish are also expected to occur in most perennial ponds in the city, such as Westlake Pond and portions of Jessie Street Marsh.

**Non-native Birds.** European starlings (*Sturnus vulgaris*) are aggressive and will usurp nest cavities from native birds such as woodpeckers, swallows, and purple martins; in some areas, the takeover by starlings has led to local extirpations of native species (Roberson and Tenney, 1993). Brown-headed cowbirds (*Molothrus ater*) are nest parasites, meaning they lay their eggs in the already occupied nests of other birds such as vireos. The cowbird eggs hatch first and push the eggs of the native birds out of the nest, and the host parent birds feed the cowbird nestlings. This type of nesting strategy has been detrimental to several native birds, such as willow flycatcher, Bell's vireo, warbling vireo, Wilson's warbler, and yellow warbler because native birds have not evolved with parasitic breeding species and thus have no defense strategies (Roberson and Tenney, 1993). European starling and brown-headed cowbird have been observed at Neary Lagoon and are expected to occur along other creeks in the City that support riparian woodland habitat, such as along the San Lorenzo River. A large colony of starlings has been documented at Westlake Pond (Habitat Restoration Group, 1989).

**Non-native Mammals.** Feral pigs (*Sus scrofa*) cause damage to wildlife and their habitat in a variety of ways. Pigs can kill trees by girdling the trunks, digging up extensive areas of grassland searching for bulbs, plant roots and insects, and competing with native wildlife for acorns. In areas where pigs have rooted, the exposed soils may be more prone to erosion, and in some cases, invasion by non-native plants (Kurdila, 1995, Peine and Farmer, 1990). Feral pigs can spread aquatic borne parasites such as Crytosporidium and Giardia (Atwill et al., 1997). Feral pigs are expected to occur along Moore Creek (they are known to inhabit nearby Wilder Ranch) and in the upper portions of Arana Gulch Creek.

Red fox (*Vulpes vulpes*) are native to the high Sierra Nevada, but the eastern species were introduced to the valleys (Ingles, 1965). Red fox and feral house cats prey on ground and marsh nesting birds, and in some areas have seriously impacted populations of native birds. Red fox and feral cats have been observed at Neary Lagoon.

Feral house cats (*Felis catus*) prey on many native birds, particularly those that nest or forage on the ground and in lower portions of vegetation (e.g., quail) (Roberson and Tenney, 1993).

Feral dogs may also occur in some watercourses in the City. Their presence may be more of a public safety nuisance than a threat to native wildlife, although dogs are known to chase and kill mammals, such as deer.

Thought to be native to China, the Norway rat (*Rattus norvegicus*) is now distributed worldwide (Ingles, 1965). It is a prolific breeder, continuously producing litters of eight-12 young beginning from an age of only 12 weeks (Ingles, 1965). It competes with native mammals for food resources, and is known to carry many diseases that can be passed to humans including plague, hepatitis, worms, and typhus (Jameson and Peeters, 1988). These rats are also known for their ability to gnaw through wood and enter buildings, and can cause fire hazards when they chew through electrical wiring.

## J.5.3 Habitat Alteration and Development

### *J.5.3.1 Land Uses Adjacent to Watercourses and Wetlands*

As previously summarized on Table J-3, approximately 1,818 parcels abut watercourses and wetlands in the City. The majority of these parcels are private property.

Many watercourses support narrow bands of riparian vegetation that are currently encroached upon by residential, commercial or industrial land uses. Several watercourses have development (such as main dwellings and/or accessory structures) within or immediately adjacent to riparian vegetation. There is evidence that intact riparian corridors contribute economic value to a community by adding to property values and providing attractive environments for businesses and their employees. Residential, commercial, industrial, institutional, open space and recreational lands that abut riparian corridors and wetlands within the City benefit from aesthetic value of these habitats. Conversely, there are hazards associated with living near watercourses, such as winter flooding, streambank erosion, and vegetation that may support non-native (and possibly undesirable) animals (i.e., rats, skunks, feral cats, etc.).

Six primary land use categories (as identified by the County of Santa Cruz Assessor's Office) occur in the City. These include:

- Residential (single and multi-family)
- Commercial (retail, services, etc.)
- Industrial
- Institutional (e.g., government buildings, schools, churches, public facilities, etc.)
- Parks/Open Space (including cemeteries)
- Vacant Land

Many existing residential, commercial or industrial structures are located within the existing 100-foot setback area. For developments without an adopted management plan, the structures are considered

non-conforming under the City's regulations. Modifications to these structures are currently not allowed (with the exception of maintenance or other similar modifications) unless a management plan is prepared and adopted by the City (and Coastal Commission, if in the coastal zone).

**Residential Areas.** In residentially zoned areas, residential yards typically abut the riparian edge. While these urban-influenced riparian habitats provide important habitat features as well as aesthetic qualities, their value to riparian-dependent biotic resources is moderated by the close proximity of existing developments. Based on County Assessor's data and field checking of this data, the majority of vacant residential parcels within the City occur as infill parcels (i.e., one or two vacant parcels amid an otherwise developed area). Land use activities that typically occur next to watercourses include existing residential units, accessory buildings, such as garages and accessory dwelling units; driveways or other paved or impervious surfaces; and landscaping of front, side or rear yards. In addition to the effect of structures, yards and driveways on riparian and wetland areas, human activities and noise associated with human activities also affect wildlife use of these habitat areas. Approximately 86 percent of parcels located within 100-feet of a watercourse or wetland support a residential land use (refer to data presented in Table J-3). Approximately 1,818 residential parcels occur adjacent to watercourses or wetlands.

**Commercial and Industrial Areas.** In commercial and industrial-zoned areas, parking lots and loading docks typically abut the watercourse. In some areas, the watercourse supports only herbaceous vegetation and is confined between industrial/commercial buildings (e.g., portions of lower Arroyo Seco Creek). Existing land use activities occurring next to watercourses include: existing commercial or industrial units; parking lots, service entrances, loading docks or other paved or impervious surfaces; and landscaping of the front, side or rear of the buildings. Approximately six percent of parcels located within 100-feet of a watercourse or wetland support either commercial or industrial-zoned land uses (refer to data presented in Table J-3). Approximately 95 commercial and industrial parcels occur adjacent to watercourses or wetlands.

**Institutional Areas.** Land use activities within institution-zoned areas are similar to commercial and industrial areas, Approximately two percent of parcels located within 100-feet of a watercourse or wetland support an institutional land use (refer to data presented in Table J-3). Approximately 27 institutional parcels occur adjacent to watercourses or wetlands.

**Parks and Open Space Areas.** Parcels that are zoned parks and open space or private recreation typically have less intensive land uses adjacent to watercourses and wetlands. These include: recreational and maintenance facilities; trails and overlooks; and playfields and ball fields. Less than one percent of parcels located within 100-feet of a watercourse or wetland support either open space or park land uses (refer to data presented in Table J-3; excludes open space lands with an adopted management plan). Approximately seven open space or park parcels occur adjacent to watercourses or wetlands.

**Vacant Land.** Only six percent of parcels located within 100-feet of a watercourse or wetland are vacant (refer to data presented in Table J-3). Approximately 115 parcels are designated as vacant by the County Assessors office.

**Not Coded.** Twelve parcels located within 100-feet of a watercourse or wetland are not coded as to land use (refer to data presented in Table J-3).

#### *J.5.3.2 Removal or Loss of Vegetation and Habitat*

Many riparian corridors within the City are constrained by residential and commercial/industrial development and have significant gaps where riparian vegetation is absent. Gaps may be due road crossings, creek channelization or culverts and other vegetation removal. As many riparian-associated wildlife species depend upon a continuously vegetated corridor for movement, cover and food, narrow corridors and gaps may cause population declines or extirpation from the stream system. Gaps may also be associated with structural barriers to wildlife movement (such as roads or culverts), which can also fragment the habitat and lower wildlife species diversity.

Human land uses may also alter the type of vegetation along a watercourse or wetland. This often occurs through the removal of native trees and understory. Alterations in the plant species composition and structure of the riparian habitat may also significantly affect its value to riparian-dependent wildlife, thus leaving gaps in essential habitat features. This may occur, for example, through hardscaping (i.e., placing rock riprap) on bare stream banks, resulting in the loss of bank nesting sites for the belted kingfisher. Similarly, removal of mature trees and snags (i.e., dead trees and tree limbs) can result in the loss of tree nesting cavities. As approximately 40 percent of the birds that exist in riparian habitat are cavity-nesters, removal of this habitat feature can significantly lower the density of cavity-nesting birds.

#### *J.5.3.3 Land Uses Within Watercourses and Wetlands*

Land uses within watercourses and wetlands are generally limited due to the limitation of such activities under the existing City General Plan/LCP. Generally, authorized activities within watercourses and wetlands are limited to recreational trails; streambank erosion repair; flood control activities; maintenance, replacement or restoration of existing public work facilities; maintenance of existing improvements; landscaping designed to provide a natural buffer; and habitat restoration. Loss of native riparian vegetation and watercourse features can occur from these authorized activities, however, permitted actions typically include revegetation of disturbed areas.

Unauthorized activities within watercourses and wetlands also occur in the City. Examples of such activities include dumping of debris, unauthorized trails and unauthorized camping. Unauthorized access to watercourses and wetland areas may impact riparian and wetland habitat through the trampling of vegetation and deposition of organic and inorganic debris. These actions may also pose a constraint to resource management and restoration. This is evident within some areas of the City where unofficial access trails cause bank erosion and result in barren areas.

#### *J.5.3.4 Changes to Flow*

Changes to streamflow can directly reduce the quantity of habitat for riparian and aquatic resources, including the ability of fish to utilize that habitat. As expected, waterflows are needed in fish-bearing watercourses throughout the year to provide sufficient living space for growth of juvenile fish. The degree of habitat fluctuation on each watercourse depends on the natural flow pattern of the individual watercourse as well as human-induced activities, such as water diversions.

The City maintains diversions on the San Lorenzo River. Most are located in the upper watershed (outside the City limits). Other smaller private or municipal diversions may occur in the City on other watercourses. If not done correctly, diversions can lower waterflows which degrade aquatic habitat, including inhibiting the movement of fish over shallow riffles, rock falls or other obstructions.

Diversions can also affect the health of riparian vegetation (and its use by wildlife) if sections of watercourses are dewatered.