

## *Chapter 3. The Refuge Environment*

### **Geographic/Ecosystem Setting**

The Sacramento River runs through the center of California's Sacramento Valley, beginning in the volcanic tablelands of Shasta County and ending in the broad alluvial basins of Colusa, Sutter and Yolo Counties (Helly and Harwood 1985; Warner and Hendrix 1985). Just downstream of Shasta Dam, the Sacramento River is mostly confined by stable geologic formations, resulting in a narrow riparian corridor of trees and other vegetation adjacent to the river itself. As it travels south from Red Bluff towards Chico, the river begins to meander over a broad alluvial floodplain, which is constrained by more erosion-resistant geologic formations. Here, the river still receives water from many tributaries. As it travels south from Chico toward Colusa, the river receives water only from the Stony Creek tributary. During high flows, the river in this reach will drain into sloughs that empty into the large basins that flank its sides. Setback levees and weirs control the release of flood waters into these basins, but in areas where there is no bank revetment the river meanders and creates areas of riparian vegetation. South of Colusa, the river is confined to its main channel by tight levees, and high flows are diverted through weirs and into bypass channels designed to prevent flooding of agricultural lands and urban areas. The resulting riparian vegetation is confined to narrow strips along these levees.

### *The Sacramento River Ecosystem*

The major physical factors effecting the development and persistence of riparian habitats along the Sacramento River are geology, hydrology, and the resulting meander of the channel. Flood events erode the river bank and deposit sand and silt on the floodplain. Over time the river channel migrates through unconsolidated alluvium and is slowed or restricted by the less erodible geologic material, constantly modifying the alluvial floodplain. Various ages and types of riparian habitats develop and exist on the floodplain.

Early successional vegetation species are established when germination conditions are triggered by a moist open site, such as a newly created sandbar. Species, such as willows and

cottonwoods, tend to have rapid growth rates that result in quick root establishment to the water table. Eventually, the presence of these early colonizers slows flood flows and encourages the accumulation of silt over time. These finer soils can retain moisture longer than the underlying sand and gravel, and create a favorable environment for the germination of other trees, such as box elder and Oregon ash. As deposits accumulate and increase the level of the river bed, species that are less tolerant of frequent flooding begin to colonize, such as sycamore, black walnut, and finally, valley oak (Figure 9).

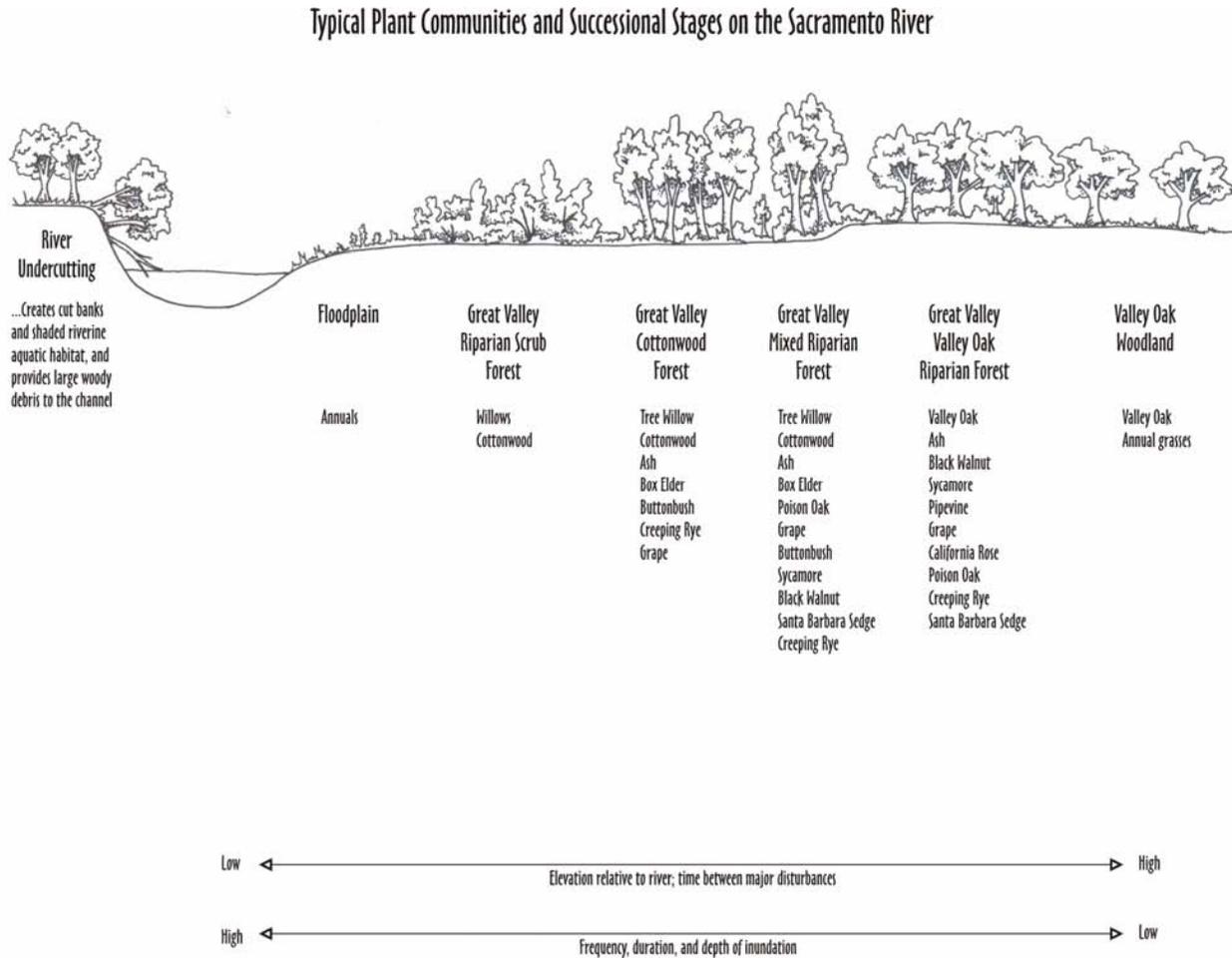
Natural processes such as flood events, erosion, channel migration and fire play an important role in creating various ages and kinds of riparian habitats. The presence of fire in the landscape has been one of the major evolutionary factors determining the composition of flora throughout California. Lightning is the most common natural ignition source. Generated by summer thunderstorms, lightning is responsible for much of the wildland fires that occur throughout western United States each year. Fire, flood, and drought all played an important role in plant succession prior to settlement of the area.



**Phelan Island**

*Photo by Skip Jones*

**Figure 9. Typical Plant Communities and Successional Stages on the Sacramento River.**



These different, yet intertwined plant communities provide important habitat for breeding, migrating, wintering, and local wildlife (Conrad et al. 1977; Gaines 1974, 1977; Roberts et al. 1977). For example, gravel bars are important to nesting killdeer, spotted sandpipers, and lesser nighthawks. Areas of young, dense willow scrub host large numbers of invertebrates, which are an abundant food source for landbirds, such as the nesting blue grosbeak. The cottonwood riparian forest that evolves from riparian scrub provides dense canopy cover and commonly hosts a wide array of local and migrant birds, including the western yellow-billed cuckoo, and nesting eagles, osprey, and Swainson’s hawks. As the cottonwood forest matures and diversifies, it becomes mixed riparian forest. Here, the dense mixture of trees and shrubs are often covered with the vines of wild grape and pipevine, supporting many other bird species. The more mature valley oak riparian forest is drier and has a closed canopy and often, dense understory, which also provides

diversity of avian habitats. Valley oak woodland, found on the higher floodplain terraces, has a much more open understory, and provides excellent foraging and roosting habitat for many avian species, and nesting habitat for owls, woodpeckers, and bluebirds. Newly eroded cut banks are essential to providing nest sites for bank swallows. Heavily shaded banks provide cover and maintain suitable water temperatures for juvenile salmon. Sloughs and side channels provide more static conditions required by northwestern pond turtles. These are just several examples of the diversity and abundance of species that Sacramento River riparian habitats support and illustrate the complexity and importance of the system.

### **Physical Environment**

#### *Climate and Air Quality*

The climate of California's northern Central Valley is classified as Mediterranean, with cool, wet winters and hot, dry summers. Rainfall is fairly well distributed throughout the winter, occurring in steady, but gentle, two- or three-day storms. The annual average precipitation is 16-18 inches. Heavy fog is common during the winter months, while thunderstorms, hail, and snow are rare occurrences. The mean annual temperature is 61.7<sup>o</sup>F with extremes of 118<sup>o</sup>F and 15<sup>o</sup>F. The south winds are associated with storms in the winter and cooling trends in the summer. North winds are usually dry following winter storms, and hot and dry in the summer.

The Refuge is in California's Sacramento Valley Air Basin. The Sacramento Valley Air Basin occupies 15,043 square miles and includes Butte, Colusa, Glenn, Sacramento, Shasta, Sutter, Tehama, Yolo, and Yuba counties, the western urbanized portion of Placer County, and the eastern portion of Solano County. The Tehama County Air Pollution Control District, Butte County Air Quality Management District, Colusa County Air Pollution Control District, and the Glenn County Air Pollution Control District are the agencies responsible for ensuring compliance with Federal and State air quality standards in the basin where the Refuge is located.

The Federal and State governments have each established ambient air quality standards for several pollutants. Most standards have been set to protect public health. However, standards for some pollutants are based on other values, such as protecting crops and materials and avoiding nuisance

conditions. Currently, Butte County is federally classified as a non-attainment area for ground-level ozone. Non-attainment areas are defined as any area that does not meet ambient air quality standards for a pollutant. In addition, Tehama, Butte, and Glenn Counties are classified by the State of California as non-attainment areas for ozone and particulate matter (PM<sub>10</sub>) standards. In fact, only three counties in the entire state are not classified as non-attainment areas for PM<sub>10</sub>. Being classified as a non-attainment area means that the state must develop an implementation plan to outline methods for reaching identified air quality standards. Permitting, scheduling, and restrictions on some activities may be required. Currently, individual counties require smoke management plans and limit acreage burned on prescribed burns conducted by the refuge.

Ozone, the main component of photochemical smog, is formed through a complex series of chemical reactions between reactive organic gasses (ROG) and nitrogen oxides (NO<sub>x</sub>). On-road motor vehicles and other mobile sources are the largest contributors to NO<sub>x</sub> emissions in the Sacramento Valley. On-road motor vehicles, area-wide sources, and stationary sources are significant contributors to ROG emissions. Once formed, ozone remains in the atmosphere for 1 or 2 days. As a result, ozone is a regional pollutant and often impacts a large area. Ozone's main effects include damage to vegetation, chemical deterioration of various materials, and irritation and damage to the human respiratory system.

PM<sub>10</sub> is produced by stationary point sources such as fuel combustion and industrial processes, fugitive sources, such as roadway dust from paved and unpaved roads, wind erosion from open land, and transportation sources, such as automobiles. The primary sources of PM<sub>10</sub> in the Sacramento Valley are fugitive dust from paved and unpaved roads and agricultural operations, and smoke from residential wood combustion and seasonal agricultural burning. Soil type and soil moisture content are important factors in PM<sub>10</sub> emissions. Federal and State PM<sub>10</sub> standards are designed to prevent respiratory disease and protect visibility.

Certain land uses are considered more sensitive to air pollution than others. Locations, such as schools, hospitals, and convalescent homes, are labeled sensitive receptors because their occupants (the young, old, and infirm) are more susceptible to respiratory infections and other air quality-related health problems than the general public. Residential

areas are also considered to be sensitive receptors because residents tend to be home for extended periods of time, resulting in sustained exposure to any pollutants present.

#### *Geology, Hydrology, and Soils*

The area of the Refuge between Red Bluff and Chico Landing is underlain by sedimentary and volcanic deposits associated with the Tehama, Tuscan, and Red Bluff formations (Harwood and Helley 1982; Helley and Harwood 1985). On top of these formations lie terrace deposits, such as Riverbank and Modesto formations, as well as paleochannel deposits, alluvial fans, meanderbelt deposits, and basin and marsh deposits (Department of Water Resources 1994; Robertson 1987). The Modesto and Riverbank deposits flank the river in steps away from the channel, and tend to erode at lower rates than the other young deposits. These areas tend to form higher, more consolidated banks, and have a high proportion of Class I agricultural soils, including the Columbia and Vina loams.

There are many tributaries that enter the Sacramento River through the Refuge properties located north of Chico, including Coyote Creek, Oat Creek, Elder Creek and Hoag Slough. Although this area has a large number of tributaries, the overall hydrology has been greatly changed due to the presence of Shasta Dam. Bank erosion rates have declined, likely due to reduced peak flow and increased bank protection. In the Refuge project area, Red Bluff to Colusa, the Sacramento River is characterized by three general levels of bank protection; however, U.S. Army Corps of Engineers and California Department of Water Resources rip-rap occurs in isolated stretches throughout this area. First, from Red Bluff to Ord Bend, bank protection consists of small private levees discontinuously protecting individual private properties. The Corps of Engineers Sacramento River Bank Protection Program levee system begins at the left bank at Ord Bend and at the right bank about seven miles below. Second, from this point downstream, the Corps of Engineers project levees are continuous. Third, the levees constrict just below Princeton, greatly reducing the formation of point bars and terraces, which in turn affect the regeneration of cottonwood and willow forests.

Refuge properties that lie between Chico Landing and Colusa are bounded on the west by terrace deposits (Modesto Formation) and on the east by paleochannel deposits of a much older river system. This stretch of the river has only one main

tributary, Stony Creek, which enters the river through the Phelan Island Unit. South of Stony Creek, the river has historically overflowed its banks on both sides of the river during floods (Thompson 1961), resulting in clay-lined basins to the west and east of the river. Today, weirs and channels convey floodwaters into the Butte Sink and the Sutter/Yolo bypasses. The natural, loamy levees that have gradually developed along the river separate the main channel from these basins on its sides. Sediment texture is finer, with more silty and sandy banks compared to the more gravelly banks found in the northern reach (US Army Corps of Engineers 1988). This reach of the river meanders, though it has become less sinuous since 1896.

#### *Contaminants and Water Quality*

The Refuge lies within the jurisdiction of the Central Valley Regional Water Quality Control Board, which established beneficial uses and water quality objectives for surface water and groundwater in the Water Quality Control Plan (Basin Plan) for the region (Central Valley Regional Water Quality Control Board 1998). Because the Sacramento River originates as snowmelt, it is of excellent water quality; therefore, it supports all existing beneficial uses of the Basin Plan, including domestic, agricultural, and industrial water supply; recreation; wildlife habitat; cold and warm freshwater fish habitat; and migration and spawning for salmonid fisheries. The water is considered soft, moderately alkaline, and low in dissolved solids, with high turbidity during peak runoff periods. The Sacramento River is listed as impaired on the U.S. Environmental Protection Agency's (EPA) Section 303 (d) list of water bodies for the pesticide diazinon, and trace metals (including mercury, cadmium, copper, and zinc). A contaminants investigation occurring at other refuges of the Sacramento Refuge Complex discovered the following pesticides in Refuge wetlands: atrazine, dieldrin, DDT, heptachlor, heptachlor epoxide, n-butyl phthalate diazinon, n-butyl phthalate trifluralin, trifluralin, trifluralinatrazine, and trifluralindiazinon (USGS 1992). The Refuges do not use these chemicals; however, these preliminary results are not surprising because all of the refuges in the Complex are adjacent to and surrounded by agriculture, where pesticides and herbicides are regularly applied for crop production. These elevated concentrations were only slightly greater than Service guidelines for possible effects on wildlife (USGS 1992).

## Biological Resources

### *Vegetation*

The Refuge currently consists of 10,304 acres (Chapter 1, Table 1) of agricultural, wetland, grassland, and riparian habitats. Agricultural areas include walnut and almond orchards, pasture, and row crops; currently, accounting for 26% of refuge lands. Riparian habitats include open water, oxbow wetlands, gravel and sand bars, herbland cover, blackberry scrub, Great Valley riparian scrub, Great Valley cottonwood riparian forest, Great Valley mixed riparian forest, Valley oak, Valley freshwater marsh, giant reed, disturbed, and restored riparian.



**Eddy Lake on the Sacramento River Refuge**

*Photo by Joe Silveira*

Distribution of these habitats can be seen in Figures 11-23 and a list of plant species occurring on the Refuge is located in Appendix G. Descriptions of agricultural and riparian habitats and their associated plant/wildlife species are as follows.

### *Agricultural*

Walnut orchards account for about 60 percent of the Refuge's agricultural acreage. Almond, row crop, and pasture make up the remaining 40 percent of the agricultural acreage. Walnut and almond orchards are farmed under cooperative agreements with local farmers and land managers, and are maintained using current farming techniques that include mowing, irrigation, pesticide and herbicide use, and mechanical harvest.

Orchards support a limited amount of wildlife, including nesting mourning doves, western bluebirds, scrub jays, northern flickers, lazuli buntings, and non-native such as European starlings and house finches. Black-tailed hares, California voles, and pocket gophers are also present in orchards. Areas of row crop and pasture can support abundant wildlife during brief periods, such as black-tailed hares, house mice, California voles, California ground squirrels, pocket gophers, brewer's blackbirds, house finches, and mourning doves.

### *Riparian Habitats*

In conformance with the descriptions used by the Geographic Information Center at California State University, Chico (2002) for mapping the riparian vegetation of the Sacramento River, Refuge "riparian" habitats are referred to as: open water, oxbow wetlands, gravel and sand bars, herbland cover, blackberry scrub, Great Valley riparian scrub, Great Valley cottonwood riparian forest, Great Valley mixed riparian forest, Valley oak, Valley freshwater marsh, giant reed, disturbed, and restored riparian.

Open water constitutes water, either standing or moving, and does not necessarily include vegetation. These areas support many fish species, including salmon, steelhead, and sturgeon, as well as avian species such as American white pelican, double-crested cormorant, osprey, kingfisher, and common merganser.

Gravel and sand bars appear as open, unvegetated areas in aerial photos, but ground inspection reveals several annual and short-lived perennial species of sun-loving herbs, grasses, and aromatic subshrubs. The vegetation cover is less than 50 percent. Species such as killdeer, spotted sandpiper, and lesser nighthawk commonly use these areas.

Herbland cover is composed of annual and perennial grasses and forbs, and is enclosed by other riparian vegetation or the stream channel. Species such as lazuli bunting, blue grosbeak, and common yellowthroat frequently nest in these areas.

Blackberry scrub is vegetation where 80 percent or more of the coverage is blackberry shrubs. Blackberry shrubs are important escape cover for California quail, and are used for perches by a variety of songbirds.

Great Valley riparian scrub forms from primary succession processes where vegetation becomes established in areas where erosion and sedimentation of deposits have occurred (Holland 1986; Holland and Roye 1989). Vegetation includes streamside thickets dominated by sandbar or gravel bar willows, or by other fast growing shrubs and vines. It is also commonly populated by cottonwood, California rose, Mexican tea, and wild grape. Typical inhabitants include the black-chinned hummingbird, willow flycatcher, Pacific-slope flycatcher, mourning dove, and black phoebe.

Great Valley cottonwood riparian forest consists of cottonwoods that are at least one year old and account for 80 percent or greater of the canopy coverage. Cottonwood forests are an early successional stage riparian vegetation type and consist of primarily of mature Fremont cottonwood trees and sparse understory (Holland 1986; Holland and Roye 1989). They can also include one or more species of willows and have a dense understory of Oregon ash, box elder, wild grape, and various herbs and grasses. Within this habitat type, species such as the bald eagle, western yellow-billed cuckoo, and Pacific-slope flycatcher nest and forage.

Great Valley mixed riparian forest (MRF) is a vegetation type consisting of later successional species, such as valley oak (Holland 1986; Holland and Roye 1989). Valley oak accounts for less than 60 percent of the canopy coverage with black walnut, Oregon ash, and western sycamore also present. Willows and cottonwood may also be present in relatively low abundance. The dense understory often consists of Oregon ash, box elder, poison oak, and wild grape. Due to the dense canopy and understory, a large variety of migratory and resident bird species use this habitat, such as the western yellow-billed cuckoo, yellow-rumped warbler, black-headed grosbeak, and spotted towhee. Since MRF frequently edges oxbows and sloughs, it attracts a large array of species that are “wetland-related”, including the northwestern pond turtle, great blue heron, great egret, double-crested cormorant, wood duck, yellow-breasted chat, common yellowthroat, and song sparrow.

The valley oak riparian forest (VORF) consists of vegetation with at least 60 percent valley oak canopy. Restricted to the highest parts of the floodplain, VORF occurs in areas that are more distant from or higher than the active river channel. This habitat type is a medium-to-tall deciduous, closed-canopy forest dominated by valley oak and may include Oregon ash, black

walnut, and western sycamore. The understory includes California pipevine, virgin's bower, California blackberry, California wildrose, poison oak, and blue wild-rye (Holland 1986). Common species found here include the red-shouldered hawk, great-horned owl, western screech-owl, acorn woodpecker, Bewick's wren, bushtit, and scrub-jay. Historically an extensive habitat, it has been greatly reduced by agriculture and firewood harvesting and is now only limited and scattered in occurrence.



**Valley Oak Woodland**

*Photo by Joe Silveira*

Valley oak woodland (VOW) is found on deep, well-drained alluvial soils, far back from or high above the active river channel (Holland 1986). VOW is an open, winter-deciduous savanna dominated by widely spaced oaks, blue elderberry, and coyote-brush, with an understory of grasses and forbs. VOW often intergrades with VORF. Due to its more open nature, VOW attracts different avian species than VORF, such as the Swainson's hawk, American kestrel, western kingbird, loggerhead shrike, yellow-billed magpie, and western meadowlark. VOW once occupied thousands of acres in the Great Central Valley. It occurred on the best agricultural soils (Columbia and Vina type) that covered thousands of acres in the Great Valley (Bureau of Soils 913; Holland 1986; Holmes et al. 1915; Watson et al. 1929). Consequently, valley oak woodlands are among the most reduced natural habitat type in California.

Valley freshwater marsh is dominated by perennial emergent monocots, a type of marsh vegetation. Cattails or tules usually

are the dominants, often forming monotonous stands that are sparingly populated with additional species, such as rushes and sedges. Coverage may be very high, approaching 100 percent. Typical riparian areas that support freshwater marsh include the main channel, tributaries, sloughs, abandoned channel, oxbow lakes, and ponds. These areas attract an array of wetland-dependent species such as mallard, wood duck, black-crowned night-heron, great egret, great blue heron, American bittern, northwestern-pond turtle and giant garter snake. Giant reed (*Arundo donax*, locally referred to as bamboo) is a grass that is less than 8 meters in height. It is a highly invasive plant that reduces and replaces native species. Giant reed provides a very low quality habitat for wildlife species.

Disturbed habitats include areas that are undergoing major disturbances and are now either completely devoid of riparian vegetation or contain only small remnants of it.

#### *Fish and Wildlife*

Many kinds of birds use the Refuge at various times throughout the year, such as gulls, terns, wading birds, diving birds, waterfowl, shorebirds, raptors, game birds, and a variety of landbirds. Also present are mammalian, amphibian, reptile, fish, and invertebrate species. While many species are common year-round, others are here only during migration, for the winter, or during spring and summer months to breed. Appendix G contains a complete list of fish and wildlife species that occur and potentially occur on the Sacramento River Refuge. An overview of wildlife use of the Refuge follows.

#### Waterfowl

The primary waterfowl use of the Refuge is by wintering birds during the months of August through March. Peak wintering populations in the Sacramento Valley occur during November through January, when several million ducks may be present. A small percentage remains through the spring and summer months to nest. On the Refuge, populations peak during flood events when much of the floodplain is underwater. During these periods, the quantity of habitat is increased, previously unavailable resources become available, and the area can support thousands of ducks. Common wintering duck species include the northern pintail, mallard, American wigeon, green-winged teal, gadwall, northern shoveler, wood duck, ring-necked duck, common goldeneye, and common merganser. Goose species consist mostly of small numbers of the western Canada goose, with occasional white-fronted geese. The

primary summer nesting species include the mallard, wood duck, and common merganser, and lesser numbers of cinnamon teal and western Canada goose.



**Wood duck**  
*USFWS Photo*

### Shorebirds

The greatest numbers of shorebirds use the Refuge during fall and spring migrations, with populations peaking in April when thousands of sandpipers pass through the Refuge on their way to the northern breeding grounds. Common fall and spring migrants include western and least sandpipers, dunlin, long-billed dowitcher, and greater yellowlegs. Killdeer and spotted sandpipers nest on gravel bars along the river's edge.

### Wading/diving birds

Many wading and diving birds use the Refuge year-round, utilizing all wetland and some riparian habitat types for foraging, roosting, and nesting. Great blue heron, great egret, and double-crested cormorant rookeries have been found in mixed riparian forests near the main channel and along oxbows and sloughs. Year-round species include great blue herons, great, snowy and cattle egrets, green herons, American bitterns, black-crowned night-herons, Virginia rails, soras, common moorhens, American coots, pied-billed and western grebes, and double-crested cormorants. Other waterbirds use Refuge wetlands at various times throughout the year, such as Clark's grebes, eared grebes, and American white pelicans.

### Raptors

Many species of raptors (birds of prey) are found along the Sacramento River at the edge of riparian habitat adjacent to agricultural lands. Raptor abundance is greatest in the winter because of the high numbers of red-tailed hawks that winter in the Sacramento Valley. Other common wintering species include barn owl, western screech-owl, and great horned owl, but American bald eagle and turkey vulture are also present in relatively large numbers. White-tailed kite and peregrine falcon are also present during the winter. Local breeding raptors include the American kestrel, turkey vulture, osprey, northern harrier, red-shouldered hawk, Swainson's hawk, red-tailed hawk, barn owl, western screech-owl, and great horned owl.

### Game birds

Game birds occupy various habitats along the Sacramento River. The mourning dove commonly nests in riparian forests and orchards and forages on gravel bars. California quail are common residents in the herbaceous layer of various riparian habitats and blackberry thickets. Wild turkeys use large trees for escape and roost and nest in dense herbaceous vegetation. Non-native ring-necked pheasants nest in dense herbaceous vegetation and feed and roost in various riparian habitats.

### Gulls/terns

Ring-billed and herring gulls are common during fall and into spring. Forster's and Caspian terns are often seen in small numbers in migration during the spring and fall.

### Landbirds

The Refuge provides a variety of habitats for a great diversity of migratory and resident landbirds (Chapter 1, Figure 4). Habitat diversity, structural complexity, and proximity to wetlands are important habitat features. The Sacramento River is an important migration corridor that provides stopover resting and feeding habitat for landbirds that breed in the nearby foothills and mountains. The river is also an important breeding area for migratory and resident songbirds and other landbirds. Species include the western yellow-billed cuckoo, lesser nighthawk, black-chinned and Anna's hummingbirds, belted kingfisher, acorn, Nuttall's and downy woodpeckers, northern flicker, olive-sided, willow, and Pacific-slope flycatchers, western wood-pewee, black phoebe, western kingbird, tree, violet-green, northern rough-winged, bank, and cliff swallows, scrub jay, yellow-billed magpie, oak titmouse, bushtit, white-breasted nuthatch, Bewick's and marsh wrens,

ruby-crowned kinglet, western bluebird, Swainson's and hermit thrushes, northern mockingbird, loggerhead shrike, orange-crowned, Nashville, yellow, yellow-rumped and Wilson's warblers, common yellowthroat, yellow-breasted chat, western tanager, black-headed and blue grosbeaks, lazuli bunting, spotted and California towhee, lark, fox, song, Lincoln's, golden-crowned, and white-crowned sparrows, dark-eyed junco, red-winged, yellow-headed and Brewer's blackbirds, western meadowlark, brown-headed cowbird, northern oriole, purple finch, and lesser and American goldfinches. Many of these species are priority or focal species in conservation plans or on Federal or State priority species lists (Table 5). Non-native European starling, rock pigeon, and house sparrow are common.



**Willow flycatcher**

*Photo by Steve Emmons*

### Mammals

Many mammalian species are year-round residents of the Refuge. Native beavers, mink, and river otters and non-native muskrats occur along the riparian zone and associated wetlands and waterways. Other native species occurring in riparian habitat along the Sacramento River include the broad-footed mole, ornate shrew, big brown bat, Brazilian free-tailed bat, California myotis, Townsend's big-eared bat, black-tailed hare, desert cottontail, California vole, deer mouse, porcupine, Botta's pocket gopher, western gray squirrel, beechy ground

squirrel, western harvest mouse, coyote, gray fox, long-tailed weasel, mountain lion, raccoon, ringtail, striped skunk, and black-tailed deer. Occasionally, black bear are observed along the northern end of middle Sacramento River. Non-native species include the Virginia opossum, black rat, Norway rat, house mouse, and feral house cat.

### Amphibians and Reptiles

Reptiles are common residents in riparian and adjacent areas. They include the western rattlesnake, common garter snake, gopher snake, western yellowbelly racer, common kingsnake, western fence lizard, and alligator lizard. A few species, such as giant garter snake and northwestern pond turtle, are wetland-dependent residents. The western toad and Pacific tree frog are the only amphibians known to occur on the Refuge. Non-native species include the American bullfrog and red-eared slider.



**Western pond turtle**

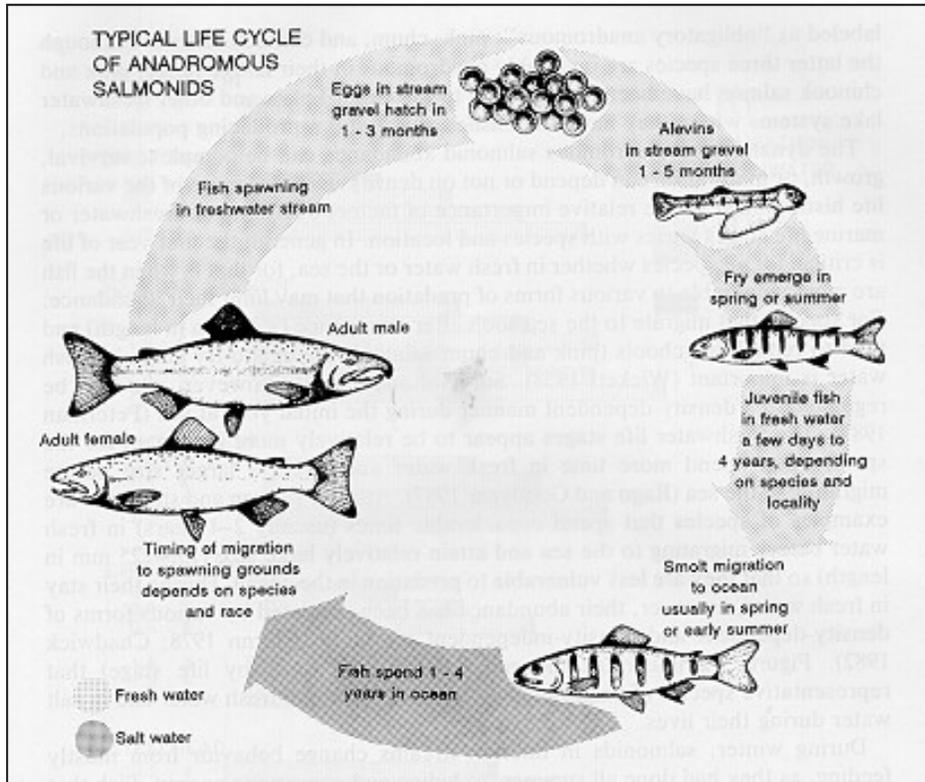
*USFWS Photo*

### Fish

Fish species occur at the Refuge in the main channel, sloughs, oxbow lakes, and on the inundated floodplain. The Sacramento River is important to native anadromous fish, including green and white sturgeon, pacific and river lamprey, steelhead, and four distinct runs of Chinook salmon (Moyle 2002), (Chapter 1, Figure 3). Three of the four Chinook salmon runs are considered unique Evolutionary Significant Units (ESU). These include the Sacramento River winter-run ESU, Central Valley spring-run ESU, and Central Valley fall-run and late-fall-run ESU Chinook salmon (Moyle 2002). The Central Valley ESU steelhead is also a unique race (Moyle 2002). Anadromous fish are migratory, using the open ocean, bays, estuaries, deltas, main river channels, floodplains, and tributaries. Anadromous fish

spawn in freshwater environments and spend their adult life in marine environments. The typical life cycle for Sacramento River Chinook salmon is illustrated in Figure 10.

**Figure 10. Typical Life Cycle of Anadromous Salmonids.**



Other native fish include blackfish, California roach, hardhead, hitch, the endemic Sacramento splittail, Sacramento squawfish, speckled dace, Sacramento sucker, threespine stickleback, redear sunfish, Sacramento perch, prickly sculpin, riffle sculpin, and staghorn sculpin (Moyle 2002). Non-native species include anadromous American shad, threadfin shad, and striped bass (Moyle 2002). Non-native warm-water species include carp, golden shiner, channel and white catfish, black, brown and yellow bullhead, mosquito fish, Mississippi silverfish, black and white crappie, bluegill, green sunfish, largemouth, smallmouth and spotted bass, and bigscale logperch (Moyle 2002).

### Invertebrates

Invertebrate populations are greatest and most diverse in aquatic habitats, and provide an important food base for many fish and wildlife species both aquatic and terrestrial. Common aquatic invertebrates include water fleas, snails, clams, dragonflies, damselflies, water boatmen, backswimmers, beetles, midges, mosquitoes, worms, clams, snails, and crayfish.

Terrestrial invertebrates are an important food base for many migratory and resident bird species, and include species such as grasshoppers, beetles, butterflies, moths, and ants.

#### Threatened and Endangered Species

The Sacramento River Refuge provides breeding, rearing, migratory staging, and wintering habitat for Federal and State threatened and endangered species and species of special status. A list of these species is presented in Table 5.

Chinook salmon, Sacramento River winter-run ESU (Federal and State-listed endangered species) only occurs in the Sacramento River watershed in California and most spawning is limited to the main stem of the Sacramento River. Adult salmon leave the ocean and migrate through the Sacramento-San Joaquin Delta and upstream into the Sacramento River from December through July. Downstream migration of juvenile winter-run Chinook salmon occurs from November through May. They rear as fry along the entire Refuge and also migrate past the Refuge as smolts. Winter-run Chinook salmon can rear in the following areas on the Sacramento River: above Red Bluff Diversion Dam (moving downstream as smolts), and probably in the lower river between river mile 70 and 164 (moving downstream as fry). Water temperatures determine juvenile rearing locations and river conditions strongly influence movement. Critical Habitat for the Sacramento River winter-run Chinook salmon was designated June 16, 1993 (58 CFR 33212, June 16, 1993). Critical habitat includes the river bottom and riparian zone, which are those terrestrial areas that directly affect a freshwater aquatic ecosystem. Critical Habitat for this ESU includes the Sacramento River from Keswick Dam to Chipps Island, all the waters westward from Chipps Island to the Carquinez Strait Bridge, all the waters of San Pablo Bay, and all the waters of the San Francisco Bay north of the San Francisco Bay–Oakland.

**Table 5. Special status wildlife species occurring or potentially occurring at Sacramento River Refuge.**

Species		Status		
		CNPS	State	Federal
<b>Plants</b>				
Silky cryptantha	<i>Cryptantha crinita</i>	CNPS 1		FSC
Sanford's arrowhead	<i>Sagittaria sanfordii</i>	CNPS 1		FSC
Rose mallow	<i>Hibiscus lasiocarpus</i>	CNPS 2		
Fox sedge	<i>Carex vulpinoidea</i>	CNPS 2		
Four-angled spikerush	<i>Eleocharis quadrangulata</i>	CNPS 2		
Columbian watermeal	<i>Wolffia brasiliensis</i>	CNPS 2		
<b>Insects</b>				
Valley elderberry longhorn beetle	<i>Desmocerus californicus dimorphus</i>			FT
<b>Fish</b>				
River lamprey	<i>Lamprreta ayresi</i>		CSC	FSC
Pacific lamprey	<i>Lampetra tridentate</i>			FSC
Green sturgeon	<i>Ascipenser medirostris</i>		CSC	CS
Chinook salmon, Central Valley Spring-run	<i>Oncorhynchus tshawytscha</i>		CT	FT
Chinook salmon, Sacramento River Winter-run	<i>Oncorhynchus tshawytscha</i>		CE	FE
Chinook salmon, Central Valley Fall/late Fall-run	<i>Oncorhynchus tshawytscha</i>		CSC	CS
Central Valley steelhead	<i>Oncorhynchus mykiss</i>			FT
Pink salmon	<i>Oncorhynchus gorbuscha</i>		CSC	
Chum salmon	<i>Oncorhynchus keta</i>		CSC	
Coho salmon	<i>Oncorhynchus kisutch</i>		CSC	
Sacramento splittail	<i>Pogonichthys macrolepidotus</i>		CSC	FSC
Hardhead	<i>Mylopharadon conocephalus</i>		CSC	
Sacramento perch	<i>Archoplites interruptus</i>		CSC	FSC
<b>Amphibians &amp; Reptiles</b>				
Giant garter snake	<i>Thamnophis gigas</i>		CT	FT
Northwestern pond turtle	<i>Clemmys marmorata marmorata</i>		CSC	FSC
<b>Birds</b>				
American white pelican	<i>Pelecanus erythrorhynchos</i>		CSC	
Double-crested cormorant	<i>Phalacrocorax auritus</i>		CSC	
American bittern	<i>Botaurus lentiginosus</i>			FSC
Least bittern	<i>Ixobrychus exilis</i>		CSC	
Barrow's goldeneye	<i>Bucephala islandica</i>		CSC	
Bald eagle	<i>Haliaeetus leuccephalus</i>		CE	FT
Golden eagle	<i>Aquila chrysaetos</i>		CSC	PR
Osprey	<i>Pandion haliaetus</i>		CSC	

Species		Status		
		CNPS	State	Federal
Northern harrier	<i>Circus cyaneus</i>		CSC	
Cooper's Hawk	<i>Accipiter cooperii</i>		CSC	
American Peregrine Falcon	<i>Falco peregrinus anatum</i>		SFP, CE	FSC, BCC
Merlin	<i>Falco columbarius</i>		CSC	
Sharp-shinned hawk	<i>Accipiter striatus</i>		CSC	
Swainson's hawk	<i>Buteo swainsoni</i>		CT	FSC, BCC
White-tailed kite	<i>Elanus leucurus</i>			FSC
Western yellow-billed cuckoo	<i>Coccyzus americanus occidentalis</i>		CE	CS, BCC
Long-eared owl	<i>Asio otus</i>		CSC	
Vaux's swift	<i>Chaetura vauxi</i>		CSC	FSC
Lewis' woodpecker	<i>Melanerpes lewis</i>			FSC
Nuttall's woodpecker	<i>Picooides nuttallii</i>			FSC
Red-breasted sapsucker	<i>Sphyrapicus ruber</i>			FSC
Willow flycatcher	<i>Empidonax traillii</i>		CE	FSC
Bank swallow	<i>Riparia riparia</i>		CT	FSC
Oak titmouse	<i>Parus inornatus</i>			FSC
Loggerhead shrike	<i>Lanius ludovicianus</i>		CSC	FSC, BCC
Least Bell's Vireo (extirpated)	<i>Vireo bellii pusillus</i>		CE	FE
Yellow warbler	<i>Dendroica petechia bewersterii</i>		CSC	
Yellow-breasted chat	<i>Icteria virens</i>		CSC	
Tricolored blackbird	<i>Agelaius tricolor</i>		CSC	FSC, BCC
Lawrence's goldfinch	<i>Carduelis lawrencei</i>			FSC, BCC
<b>Mammals</b>				
Townsend's big-eared bat	<i>Corynorhinus townsendii pallescens</i>		CSC	FSC
Western mastiff bat	<i>Eumops perotis californicus</i>		CSC	FSC
Pallid bat	<i>Antrozous pallidus</i>		CSC	
Yuma bat	<i>Myotis yumanensis</i>			FSC
Ringtail	<i>Bassariscus astutus</i>		SFP	

Status Key:

California Native Plant Society:

CSP 1 - Plants rare, threatened, or endangered in California and elsewhere;

CSP 2 - Plants rare, threatened, or endangered in California but more common elsewhere

State of California:

CE - State-listed, Endangered, CT - State-listed, Threatened, CSC - State

Species of Special Concern, SFP - State Fully Protected

Federal:

FE - Federally-listed, Endangered, FT - Federally-listed, Threatened, CS -

Candidate Species, FSC - Federal Species of Concern, PR - Protected under Golden Eagle Protection Act, BCC - Birds of Conservation Concern

Chinook salmon, Central Valley spring-run ESU (Federal and State-listed threatened species) occurs in the main stem of the Sacramento River, and the Mill Creek, Deer Creek, Big Chico Creek, and Butte Creek tributaries. Adult salmon leave the ocean and migrate through the Sacramento-San Joaquin Delta, upstream into the Sacramento River from March through September. Downstream migration of juvenile spring-run Chinook salmon occurs from March through June, while yearlings move downstream from November through April. Most spawning occurs in headwater tributary streams. Critical habitat for this ESU is under development.



**Chinook Salmon**

*Photo by USFWS*

Chinook salmon, Central Valley fall-run ESU and late-fall-run ESU (Federal candidate species and State species of concern) occur in the main stem and tributaries of the Sacramento River. Adult salmon leave the ocean and migrate through the Sacramento-San Joaquin Delta, upstream into the Sacramento River from July through December and spawn from October through December. Spawning occurs on the mainstem of the Sacramento River, including below the Red Bluff Diversion Dam. Late-fall-run Chinook salmon occur on the main stem of the Sacramento River. Adult salmon leave the ocean and migrate through the Sacramento-San Joaquin Delta, upstream into the Sacramento River from October through April and spawn from January through April. Spawning occurs above the Red Bluff Diversion Dam and lower tributaries of the middle and upper Sacramento River.

Steelhead, Central Valley ESU (federally listed threatened species) is an anadromous form of rainbow trout, which has traditionally supported a major sport fishery in the Sacramento

River system. The historical range of steelhead in the Central Valley has been reduced by dams and water diversions that now restrict the species to the lower portions of major rivers where habitat is less favorable for steelhead spawning and rearing. They use the Sacramento River as a migration corridor to and from spawning grounds in the mainstem of the river above the Red Bluff Diversion Dam, the tributary streams, and the Coleman National Fish Hatchery. They are present in the Sacramento River year-round, either as smolts migrating downstream or adults migrating upstream or downstream. Upstream migration begins in July, peaks in the fall, and continues through February or March. Most spawning occurs from January through March. Juvenile migration generally occurs during the spring and early summer after at least one year of rearing in upstream areas. Populations have greatly declined over much of the species' range, including the Sacramento River basin, due to blockage of upstream migration by dams and flood control projects, agricultural and municipal diversions, harmful temperatures in the Sacramento River, reduced availability of spawning gravels, and toxic discharges. Designation of river reaches as Critical Habitat is being considered for this ESU.



**Valley Elderberry Longhorn Beetle**

*USFWS Photo*

The Valley elderberry longhorn beetle (federally listed threatened species) is found only in association with its host plant, the blue elderberry. These beetles are endemic to riparian habitat of the Sacramento and San Joaquin valleys. Adults feed on foliage from March through June, during which time they mate and the females lay their eggs. Eggs are laid on leaves, branches, bark crevices, and trunks and hatch within a few days. Larvae bore through the stem pith, creating a pupation gallery. After one to two years, the larva chews a hole

to the stem surface and returns to the chamber to pupate (Halstead and Oldham 1990). When the host plant begins to flower, the pupa emerges as an adult and exits the chamber through a characteristic exit hole. Upon emergence, the adults occupy foliage, flowers, and stems of the host plant.

The bald eagle (federally listed threatened species and State-listed endangered species) nests in Lake, Mendocino, Trinity, Siskiyou, Modoc, Shasta, Tehama, Lassen, Plumas and Butte counties, and in the Lake Tahoe Basin. The bald eagle occurs throughout the year at and in the vicinity of Sacramento River Refuge, and is known to breed here. Individuals forage and roost throughout the northern Sacramento Valley in locations supporting various permanent and temporary wetlands. Eagles occur in areas that have relatively large, open roost trees. Suitable perch trees occur along the Sacramento River throughout the project sites and vicinity. Bald eagles are most common on the Refuge in winter.

The western yellow-billed cuckoo (Federal candidate species, State-listed threatened species, and FWS Bird of Conservation Concern) breeding range in California includes lower Colorado, Kern and Sacramento rivers. Surveys for the western yellow-billed cuckoo identified a breeding range on the middle Sacramento River between Red Bluff and Meridian, just southeast of Colusa. The cuckoo was located on the Sacramento River Refuge during recent surveys. The cuckoo nests in larger trees, such as Fremont's cottonwood, located in close proximity to foraging habitat (mixed riparian forest and willow and herbaceous scrublands).

The least Bell's vireo (Federal and State-listed endangered species) and willow flycatcher (State-listed endangered species) nests and forages in willow scrub vegetation. The vireo has been extirpated (eliminated) from northern California and the willow flycatcher no longer breeds on the Sacramento River.

The bank swallow (State-listed threatened species) is a colonial nesting species which makes nest burrows in the steep cut banks of the Sacramento River. Annual erosion of mid and high floodplain elevation banks of Columbia silty-loam and Columbia sandy-loam is necessary for colony establishment. The largest populations occur along the middle Sacramento River, from Red Bluff to Colusa, and survey results have shown the importance of Sacramento River Refuge to the bank swallow. The largest Sacramento River bank swallow colony occurs at

the Flynn Unit, where a Refuge levee was removed leading to the formation of a large cut bank.



### **Bank Swallows**

*Photo by Steve Emmons*

Swainson's hawk (State-listed threatened species) breeds in North America and winters in Mexico, Central America, and South America. They nest in trees along riparian corridors or in isolated trees or small groves near suitable foraging habitat. Foraging habitat consists of grassland vegetation and short herbaceous croplands. Swainson's hawks have been observed perched in valley oak trees and flying in broad circles along the Sacramento River between Red Bluff and Colusa. They are known to nest in the vicinity of the Llano Seco Unit and the Sul Norte Unit. Large numbers have been observed at Llano Seco Ranch during fall migration (early to mid-October).

The giant garter snake (federally listed endangered species and State-listed threatened species) historically ranged from the Sacramento/San Joaquin Delta to the south end of the Tulare Lake Basin. The present distribution is from Chico to central Fresno County. The giant garter snake requires freshwater wetlands, such as marshes and low gradient streams. Permanent wetlands are of particular importance, as they provide habitat over the summer and early fall, when seasonal wetlands are dry. The giant garter snake is not associated with swift streams and rivers, such as the Sacramento River. They have adapted to drainage and irrigation systems, especially those associated with rice cultivation; therefore, they may occur in agricultural areas at the Refuge, along the river below Chico.

Species have become threatened and endangered on the Sacramento River largely due to habitat loss and degradation. Fisheries habitat includes sufficient water flows and temperatures for fish to complete life history stages. It includes a meandering river that recruits spawning gravels and large woody debris and provides shaded riverine aquatic habitat and a topographically-connected main channel/floodplain system. Avian habitat also includes all of the various riparian vegetation and habitat types, such as gravel bars, sand bars, erodible vertical river banks, willow scrub, herbland, tall mature cottonwood forests, mixed riparian forests, valley oak riparian forests, and valley oak and elderberry savannas. These vegetation types occur in various aged stands and in various sized patches of various densities. The combination of riparian vegetation types and their structure create a rich mosaic of habitat for resident and migratory breeding and wintering birds.

### **Social and Economic Environment**

#### *Transportation*

Major transportation routes in the vicinity of the Refuge include Interstate 5, State highways 99, 45, 162, 32, 20, and county routes 99W, A8 (Tyler Road), A9 (South Avenue), and A11 (Style Road). Bridges cross the Sacramento River at Red Bluff (Highway 99), Tehama – Los Molinos (A8), Woodson Bridge (A9), Hamilton City (Highway 32), Ord Bend (Ord Ferry Road), Butte City (Highway 162) – Codora Four Corners, and Colusa. Many small paved county roads provide for local transportation, offering service access to local agricultural activities. These, and the large interstate and highways, provide access to Refuge visitor contact stations, parking lots, and public and private boat launches. There are no alternative transportation systems that provide access to the Refuge units.

The Sacramento River is a navigable water within California and boating has been a traditional use. The jurisdiction of the Service regarding navigable waters within the Refuge is discussed in Chapter 1. Boating activities within the river are subject to existing State and Federal laws. No changes are proposed.

#### *Employment*

The employment base of the agricultural heartland is diversifying in Colusa, Glenn, and Tehama counties, but real

wages are decreasing in almost every sector (Collaborative Economics for New Valley Connexions 2001).

The following is an excerpt from *The State of the Great Central Valley of California – Assessing the Region via Indicators* (Munroe and Jackman 1999).

“Unemployment rates have persistently been higher in the Central Valley than in the state, typically by at least 3 percentage points. This is mainly attributable to the Central Valley’s large share of jobs in agriculture, construction, and other sectors that have marked seasonal fluctuations.

In 1997, the Central Valley unemployment rate rose to almost 4 percentage points above the State’s. The main reason for this was that the rate of job growth in the state in the period 1996-1997 was almost twice that of the Central Valley.

Unemployment rates in the Sacramento Region are markedly lower than in the San Joaquin Region and North Valley and are even decidedly lower than those of the state.”

#### *Local Economy*

Agriculture is the dominant economic enterprise in the northern Sacramento Valley. The diversity of crops grown in the Sacramento Valley reflects the diversity of soils, climate, cultural and economic factors. Butte County’s major crops include rice, almonds, prunes, and walnuts; Glenn County’s include rice, almonds, prunes, alfalfa, and corn; Tehama County’s include prunes, walnuts, olives, and pasture; and Colusa County’s include rice, tomatoes, and almonds. Areas in proximity to the river mainly support tree crops. Countywide agricultural production values are \$291.3 million for Butte; \$280.9 million for Glenn; \$110.7 million for Tehama; and \$346 million for Colusa (California Department of Finance 2000).

As diverse as the crops they grow, these four counties also vary greatly in their demographics. Butte County has a population of more than 205,400 (year 2000), with the largest employment sectors being trade, services, and state/local government. Agriculture employs 3,000 people in Butte County. Glenn County has a population of 26,900, with State/local government as its largest employment sector, and agriculture its second (employing 1,520 people). Tehama County’s population is 56,700, and its major employment sectors are trade services

and State/local government. Agriculture employs 1,440 people in Tehama County. Colusa County has a population of 19,150, with agriculture as its largest employment sector (employing about 2,540 people), and State/local government its second.

### *Land Use and Zoning*

The Refuge is bordered by private lands, as well as Federal and State owned public lands. Private lands are mostly agricultural land (orchards, row crops, rice), with some private duck-hunting clubs, farmsteads, businesses, trailer parks, and isolated homes.

Each of the four counties in which the Refuge acquisition boundary is located has its own General Plan that outlines land use policies. The portions of Butte, Glenn, Tehama, and Colusa Counties' General Plans that relate to Refuge management are summarized in Appendix M.

### *Demographics*

Until recently, demographic data had not been analyzed to depict the profile of potential visitors to the Sacramento River Refuge by county. In January 2002, TNC facilitated The Sacramento River Public Recreation Access Study (EDAW 2003). The primary purpose of the study was to "...assess existing and potential public recreation uses, access, needs, and opportunities along the Sacramento River between Red Bluff and Colusa." The goals of the study were to 1) identify and characterize existing public access opportunities and needs associated with public recreation facilities and infrastructure... and 2) to identify and make recommendations for future public recreation access opportunities and management programs..." The study areas were developed so that data would be meaningful and useful to the partners that are developing management plans.

The tables that are the most applicable to the CCP are included in Appendix N. Two study areas are portrayed (EDAW Table 4.1-1): 1) the local study area comprising Tehama, Butte, Glenn, and Colusa counties and 2) the regional study area encompassing 20 adjacent counties where there is reasonable likelihood of recreational visitation.

EDAW Tables 4.1-3,-4,-5 and-6 (Appendix N) depict a profile of the potential local refuge visitor as predominately Caucasian, 31-50 years of age, some college education/trade school education with a household income under \$20,000 to \$40,000

(median income \$31-35,000). The current population in the local four counties is expected to grow by 55 percent, in contrast to the adjacent 20 counties, which are expected to grow by 25 percent (Appendix N EDAW Table 4.1-2). There is a significant Hispanic population, including one-half of the residents of Colusa County, and about one-third of the residents of Glenn County. The local area residents tended to have lower household income brackets than their regional counterparts.

The U.S. Department of Housing and Urban Development (HUD) defines low income as 80% of the median family income for the area, subject to adjustment for areas with unusually high or low incomes or housing costs. The 1999 estimated median family income was \$31,206 in Tehama County, \$31,924 in Butte County, \$32,107 in Glenn County, and \$35,062 in Colusa County (California Employment Development Department 2000).



**Osprey**

*Photo by Steve Emmons*

### **Cultural Resources**

From the late Pleistocene, more than 10,000 years ago, through the late Holocene, to present time humans have occupied northern California and utilized its generous natural resources. Many diverse and complex cultures developed during this time, culminating in the Native American Tribes recorded by early ethnographers.

Wintun (Nomlaki) occupied both banks of the Sacramento River and the valley and foothills west of the River. The northwest Maidu lived in the valley, east of the River, along Butte and Big Chico Creeks, and had territories extending into

the eastern foothills and mountains. The southern-most Yana tribe (Yahi) occupied lands east of the River, north of the Big Chico Creek. The territories of these tribes overlapped seasonally. For example, during the summer months the Nomlaki moved from the alluvial plain of the Sacramento River onto the alluvial fan of adjacent eastern foothills, while Yahi and northwest Maidu moved east, into the southern Cascade and northern Sierra Nevada Mountains, respectively. These people fished for Chinook salmon and hunted for tule elk, pronghorn antelope, black-tailed deer, rabbits, California quail, and waterfowl. They also harvested acorns and a variety of seeds, roots, tubers, and bulbs from native plants (Goldschmidt 1978; Johnson 1978; Riddell 1978).

Euro-American contact with native tribes in the region began with the Spanish Moraga expedition of 1808. In the 1820's fur trappers, such as Jedediah Smith, were working in the area. By the 1830's smallpox and malaria had decimated the native population. The following decades brought increasing colonization of the area and the beginnings of the modern agricultural pattern.

American colonization of the Sacramento Valley began during the Mexican Rancho era. John Bidwell, Peter Lassen, and John Parrot were among those awarded a Mexican Land Grant, which included Rancho del Arroyo Chico, Rancho Bosquejo, and Rancho Llano Seco, respectively. Statehood came soon after gold was discovered by James Marshall at Sutter's Mill on the American River. Thousands of fortune seekers immigrated to California and those supplying goods and services to the miners realized economic success. The early ranches and farms provided vital agricultural commodities which helped expand settlement. People and freight were transported by wagon and steamboat. Thirteen ferries were located at the Sacramento River between Red Bluff and Colusa. River travel by steamboat was a practical mode of transportation because river boats could efficiently transport agricultural freight and the valley oak forests and woodlands supplied an abundance of fuel to power these paddle-wheeled steam boats. Ferries, river boat landings, and bridges all played a key role in the locations of towns and the development of a system of roads. Improved roads and the railroad system eventually replaced river boat travel.

Agriculture was first and foremost the central economic force in the Sacramento Valley. Dry land grain farming was the earliest

agricultural practice. Row crops, orchards, rice, and irrigated pasture flourished when abundant water from the Sacramento River and its tributaries irrigated the fertile alluvial soils of the floodplain and basins. Water was distributed to farms through a system of river and stream diversions and water delivery canals. The development of the centrifugal pump in the early 20<sup>th</sup> century facilitated the expansion of irrigated lands through ground water pumping. Finally, State and Federal water projects for land reclamation, irrigation and urban water supply, and flood control allowed for further agricultural and urban expansion and the industries which followed.

Information obtained from Service Region 1 cultural resources division staff and the Northeast Information Center of the California Historical Information System at California State University (CSU) Chico verified that the areas bordering the Sacramento River are considered sensitive for both prehistoric and historic cultural resources. Additionally, these areas may be used as traditional cultural properties (USFWS 2002b). The cultural resources investigations conducted to date include three narrow surveys that examined small portions of the Ohm, Pine Creek, and Phelan Island units. Two cultural resource sites have been formally recorded within Refuge boundaries, and the site locations are being protected in conformance with Federal law.

The CSU Chico Research Foundation Archaeological Research Program (ARP) conducted an archeological study of the middle Sacramento River floodplain in 2002, leading to the comprehensive Cultural Resource Overview and Management Plan – Sacramento River Conservation Area (White et al. 2003). The project consisted of five tasks: 1) Intensive Archaeological Survey of selected portions of the Refuge; 2) compilation of a Geoarchaeological Model and Field Test of the model; 3) completion of a Final Archaeological Overview, Assessment, and Management Plan; 4) completion of a Public Report of Findings; and 5) administration and management. The project area consisted of a series of parcels totaling about 11,500 acres adjoining the Sacramento River, spanning Tehama, Glenn, Butte, and Colusa counties between Red Bluff and Colusa, California. The study completed an archaeological survey, assisting the Service in meeting cultural resource inventory mandates as specified in Sections 106 and 110 of the National Historic Preservation Act. The final overview, assessment, and management plan provides a summary of the status of known cultural resources, a sensitivity study for

resources yet- to-be identified, and general plans for future scientific investigations, public interpretation of archaeological and paleo-environmental findings, and administration and coordination for future actions which may affect cultural resources. The Public Report of Findings will assist the Service to address the Department of Interior recommendations for public outreach and dissemination of scientific results.

Research conducted for the project was performed at a level sufficient to understand the cultural resources found on individual parcels within the context of broader regional patterns. A goal of the project was to accurately predict the nature, extent, and distribution of resources within the parcels that formed the focus of the study. To achieve this goal we assessed the nature, extent, and distribution of archaeological resources across a broader area. This was accomplished by conducting an inventory and summarizing available records of archaeological resources in the Sacramento River corridor in the vicinity of the project area (White et al. 2003).

## **Public Use**

### *Trends*

The ability to compare the population and social trends with existing recreation facilities using the Sacramento River Public Recreation Access Study (SRPRAS) is invaluable in making projections about future recreational needs on the Sacramento River Refuge. SRPRAS reviewed three studies that provided significant information about recreation use, needs, and trends analysis: Sacramento River Recreation Survey (DWR 1980), Public Opinions and Attitudes on Recreation in California (California DPR 1998), and Outdoor Recreation in American Life: A National Assessment of Demand and Supply (Cordell et al. 1999). Appendix N contains table summaries that represent a cross section of applicable information available in the study.

The DWR report indicated that users of the Sacramento River were generally local and that 77 percent of the study sample resided in eight counties: Shasta, Tehama, Glenn, Butte, Glenn, Colusa, Sutter, Yolo, and Sacramento. The types of activities reported by visitors using the upper Sacramento River were: relaxing (49 percent), fishing (47 percent), power-boating (34 percent), camping (30 percent), canoeing (23 percent), tubing (22 percent), swimming/beach use (22 percent), picnicking (15 percent), and special events (8 percent) (Appendix N, EDAW Table 4.2-1). Visitors used the sections from the Red Bluff

Diversion Dam to Hamilton City Bridge and Chico Landing to Meridian Bridge, rather than Hamilton City Bridge to Chico Landing section (Appendix N, EDAW Table 4.2-2). Generally, day and overnight use were evenly split (Appendix N, EDAW Table 4.2-3); day use visitors stayed 3-4 hours while overnight visitors stayed 3-4 days (Appendix N, EDAW Table 4.2-4).

The California DPR report (1998) covers a broader 24-county area and assesses 43 recreational activities. Three priority wildlife-dependent activities were surveyed and ranked, although the nature study category could include educational/interpretive activities (Table 6).

**Table 6. Ranks of three wildlife dependent activities (EDAW Table 4.2-5).**

	<b>Rank</b>	<b>Participation</b>	<b>Average days</b>
<b>Nature study, wildlife viewing</b>	12	59%	19.35
<b>Fishing</b>	16	39.8%	6.43
<b>Hunting</b>	39	8%	1.35

Walking was ranked number one with 90 percent participating 83.56 days per year (Appendix N, EDAW Table 4.2-6). When comparing geographic sub-areas, power boating and hunting were more prevalent in the local counties and general nature study and fishing were relatively the same across the areas (Appendix N, EDAW Table 4.2-7). At least 67 percent of the respondents visited natural and undeveloped area several times a year or more (Appendix N, EDAW Table 4.2-8). The most important factors influencing enjoyment of recreational activities were being in the outdoors (87.4 percent), relaxing (77.3 percent), and beauty of the area (76.7 percent); meeting new people (16 percent) ranked last (Appendix N, EDAW Table 4.2-9).

Recreation trends in the U.S. are found in *Outdoor Recreation in American Life: A National Assessment of Demand and Supply Trends* (Cordell et al. 1999). Projections were made nationally for four U.S. regions, with California included in the Pacific coast region. Trends for the Pacific region indicate wildlife viewing and nature study are expected to increase by 65 percent and double the number of days per year per person in

the next 40 years. Fishing is expected to increase, while hunting is expected to decrease (Appendix N, EDAW Table 4.2-11).

EDAW's Table 2.1, Facilities Amenities Matrix by River Mile (Appendix N), and Table 2.2, Facilities Amenities Matrix by Agency (Appendix N), provide valuable information about facilities location and ownership. These matrices are valuable to coordinate public access and activities with the appropriate agency and help determine the visitor use needs.

The 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation – California (Survey) is as also a very valuable resource to help predict recreation trends (USDOJ et al. 2001). This comprehensive publication provides information about the numbers of U.S. anglers, hunters, and wildlife-watchers by state. The Survey has been completed since 1955, yet over time, the methodology has changed making only the 1991, 1996, and 2001 Surveys directly comparable. Appendix N contains tables and charts that represent some California summary survey comparison highlights. For more detailed information, refer to the U.S. Census data that can be found at: <http://www.census.gov/prod/2002pubs/fhw01-ca.pdf>.



### **Kayaking on the Sacramento River**

*Photo by Joe Silveira*

#### *Environmental Education*

Environmental education is comprised of teacher or leader-conducted activities that are intended to actively involve students or others in hands-on activities. These activities are designed to promote discovery and fact-finding, develop problem-solving skills, and lead to personal involvement and action. The Fish and Wildlife Service Manual states,

“Environmental education should be curriculum based and can provide interdisciplinary opportunities, linking the natural world with subject areas such as math, science, social studies, and language arts.” The Service focuses on kindergarten through twelfth grade students. See Chapter 4 for the current environmental education activities that occur on the Refuge.

#### *Interpretation*

Interpretation involves participants of all ages who learn about the complex issues confronting fish and wildlife resource management as they voluntarily engage in stimulating and enjoyable activities. First-hand experience with the environment is emphasized although presentations, audiovisual media, and exhibits are often necessary components of the interpretive program. See Chapter 4 for the current interpretive activities that occur on Refuge.

#### **Refuge Unit Descriptions**

The Refuge is comprised of 26 different units (Table 1, Chapter 1), each having its own specific projects, goals, and management needs. A brief summary of size, location, and land use/composition of each unit follows, beginning with the northern-most unit (La BARRANCA) and ending with the southern-most unit (Drumheller Slough). Llano Seco Ranch Riparian Easement, a conservation easement on private property, is also described.

#### *La BARRANCA*

The La BARRANCA Unit is 1,066 acres and is located between river miles 240.5 and 236.5. The first 247 acres were acquired in 1989, and the remaining 819 acres in 1991.

The unit’s 399 acres of walnut and 84 fallow acres are managed via an agreement with a local farmer. Approximately 200 acres of the walnuts will be removed in 2005, in order to prepare for potential riparian restoration efforts in 2005. Of the current 193 restored riparian acres, 36 were planted in 1997 and 96 were planted in 2001. In winter 2002/03, 61 acres were planted and will receive irrigation, and chemical/physical treatments until 2006. The 367 acres of pre-existing riparian habitats consist mostly of mixed riparian forest, cottonwood riparian forest, herbland cover, riparian scrub, and gravel bar (Figure 11).

A feasibility study, funded through the Anadromous Fish Restoration Program (AFRP) and Central Valley Project Improvement Act (CVPIA), was conducted between 2001 and

2002. The purpose of the study was to focus on the potential impacts of fish entrapment on native fishes and alternatives for floodplain restoration in areas of past gravel mining operations. The Refuge, Red Bluff Fish and Wildlife Office, and River Partners received funding through AFRP in 2003 to conduct environmental compliance for analysis of restoration alternatives identified in the study including levee removal, gravel pit re-grading and riparian restoration of existing farm lands. This site is subject to further site-specific NEPA processes outside of this document.

PRBO (PRBO Conservation Science) monitors portions of the unit for avian use. Special wildlife use includes nesting osprey, bank swallow colonies, and bald eagle roosts. Special vegetation profiles include sand/gravel terrace with naked buckwheat, Kellogg's tarplant, telegraph plant, and Oregon tarweed and Valley elderberry-oak savanna.

#### *Blackberry Island*

Acquired in 2002, the Blackberry Island Unit is 52 acres and is located between river miles 240 and 239.5.

The unit's 52 acres of pre-existing riparian habitats consist mostly of herbland cover, gravel/sandbars, and mixed riparian forest with some riparian scrub (Figure 11).

Special wildlife use includes neo-tropical migratory birds. Special vegetation profiles include a mature sycamore forest.

#### *Todd Island*

Todd Island, located between river miles 238 and 236, is currently owned and managed by the Bureau of Land Management (BLM). The Island's 185 acres of pre-existing riparian habitats consist of a mixture of cottonwood riparian forest, mixed riparian forest, non-native herb lands and gravel bar habitat (Figure 11).

Special wildlife use includes western yellow-billed cuckoo and salmonid spawning habitat in the main channel. Public use via boat access is currently allowed on the Island. The Service is currently in discussion with BLM to incorporate this property as part of the Refuge. If this occurs, the proposed uses will be consistent with current BLM public use activities, including hunting, fishing, wildlife observation and photography, and interpretation and environmental education.

*Mooney*

Acquired in 1994, the Mooney Unit is 342 acres and is located between river miles 236.5 and 235.

The unit's 342 acres of pre-existing riparian habitats consist mostly of mixed riparian forest (dominated by invasive black walnut), cottonwood riparian forest, and herbland cover (Figure 11).

Special vegetation profiles include mid-terrace mixed riparian forest and large western sycamores.

Public use on this unit is currently limited to an existing "life-use reservation" granted to two individuals as part of the property deed, which includes hunting and picnicking rights.

Current management activities include a Cooperative Land Management Agreement (CLMA) with a local rancher for seasonal cattle grazing to control nonnative annual grasses and forbs. A portion of the unit is cooperatively monitored by PRBO for avian use.

*Ohm*

The Ohm Unit is 757 acres and is located between river miles 235 and 233. The first 504 acres were acquired in 1989, and the remaining 253 acres in 1991. Approximately 155 of the original 757 acres are now located on the east bank after the river changed course and cut through the northeast portion of the unit. As of June 2005, the ownership of the eastern portion of the unit (lands east of the Sacramento River) is currently under ownership dispute with an adjacent landowner. That portion is identified on the maps in Chapter 5.

The unit's 201 restored riparian acres were planted to mixed riparian forest in 2004, and will receive irrigation and chemical/physical treatments until 2007. The 556 acres of pre-existing riparian habitats consist mostly of mixed riparian forest, cottonwood riparian forest, herbland cover, gravel bar, and non-native grassland (Figure 12).

Some portions of the unit are cooperatively monitored by PRBO for avian use. Current management activities include seasonal cattle grazing to control nonnative annual grasses and forbs through a CLMA with a local cattle ranch. In 2003, a permanent gravel fire break 2,300 feet in length was

constructed as part of the Wildland Urban Interface (WUI) fire prevention program.

Special wildlife use includes fall-migrant yellow warbler and willow flycatcher, bank swallow colonies, and river otters. Special vegetation profiles include low-terrace sandbar willow, and mid-terrace mixed riparian forest.

### *Flynn*

The Flynn Unit is 630 acres and is located between river miles 233 and 230.5. The first 545 acres were acquired in 1990, and the remaining 85 acres in 1998.

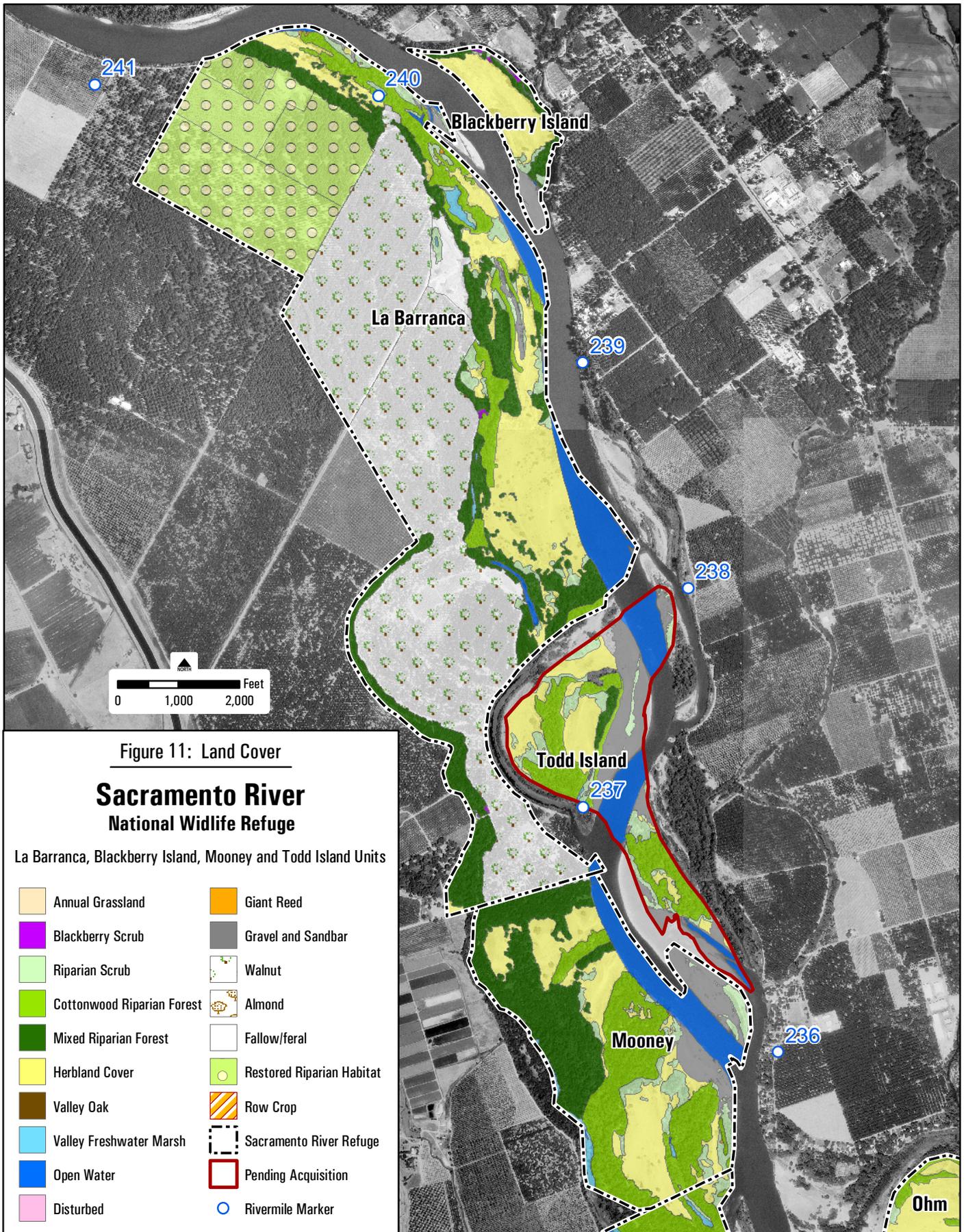
Of the unit's 401 restored riparian acres, 70 were planted in 1996, 82 in 1997, 164 in 1998, and 85 in 2000. The 229 acres of pre-existing riparian habitats consist mostly of mixed riparian forest, cottonwood riparian forest, riparian scrub, and gravel bar (Figure 12).

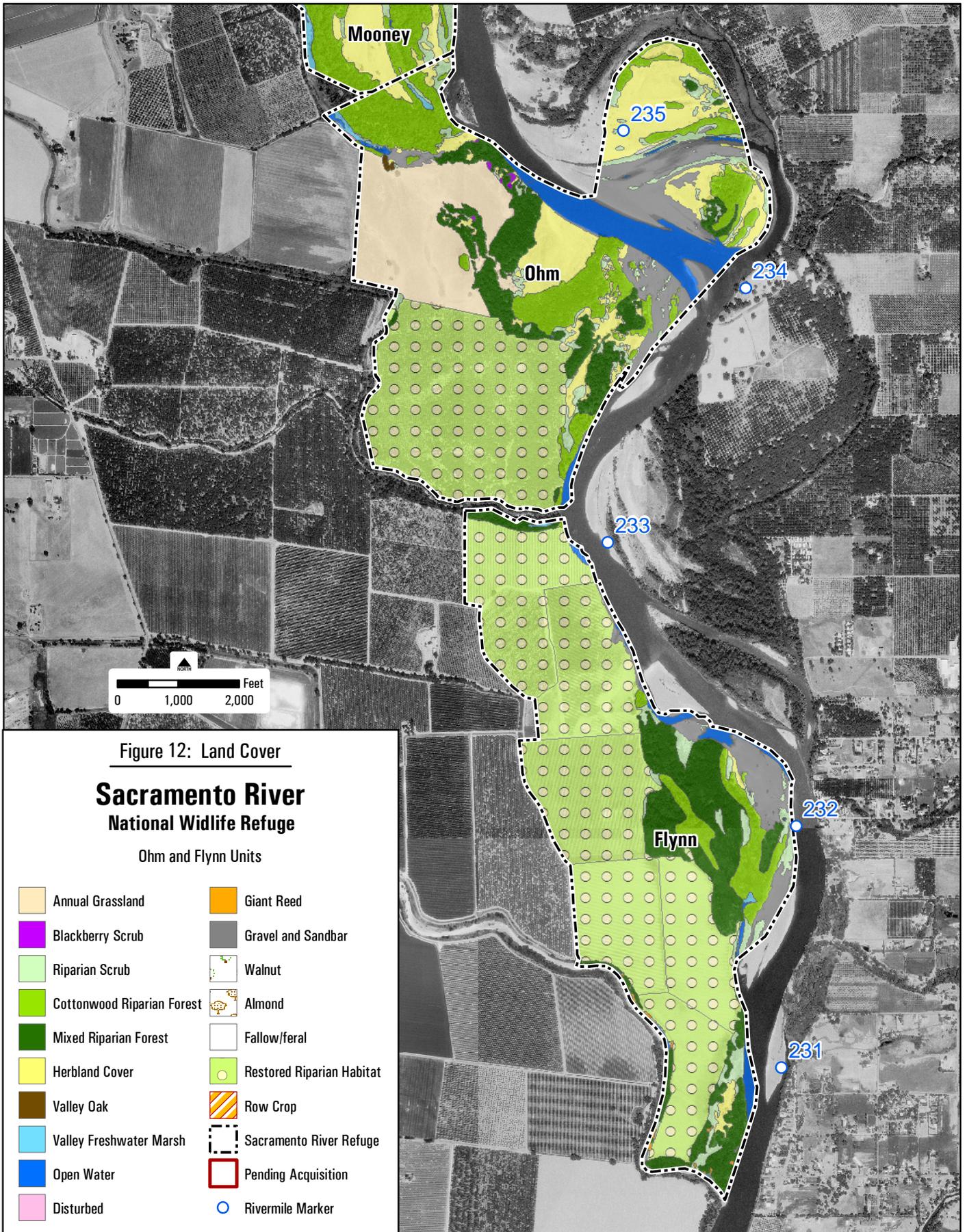


Some portions of the unit are cooperatively monitored by PRBO for avian use. Special wildlife use includes breeding lazuli buntings, common yellowthroats, a heron/egret rookery, western yellow-billed cuckoos, California quail, and the largest known bank swallow colony on the Sacramento River. Special vegetation profile includes mid-terrace mixed riparian forest.

### **California Quail**

*Photo by Steve Emmons*





### *Heron Island*

Acquired in 1990, the Heron Island Unit is 126 acres and is located between river miles 228.5 and 228.3.

The majority of the unit is abandoned English walnut, and the remaining 60 acres is a mixture of mixed riparian forest, cottonwood riparian forest, riparian scrub, and open water (Figure 13). The walnut acreage is unmanaged and is being allowed to undergo natural recruitment, letting natural vegetation restore the site.

This unit is accessible to Refuge personnel by boat only. Special wildlife use includes a bank swallow colony. Special vegetation profiles include very large valley oak and western sycamore specimens. Small patches of perennial pepperweed were identified in 2002, posing significant management challenges due to the difficulty of access for vegetation control.

### *Rio Vista*

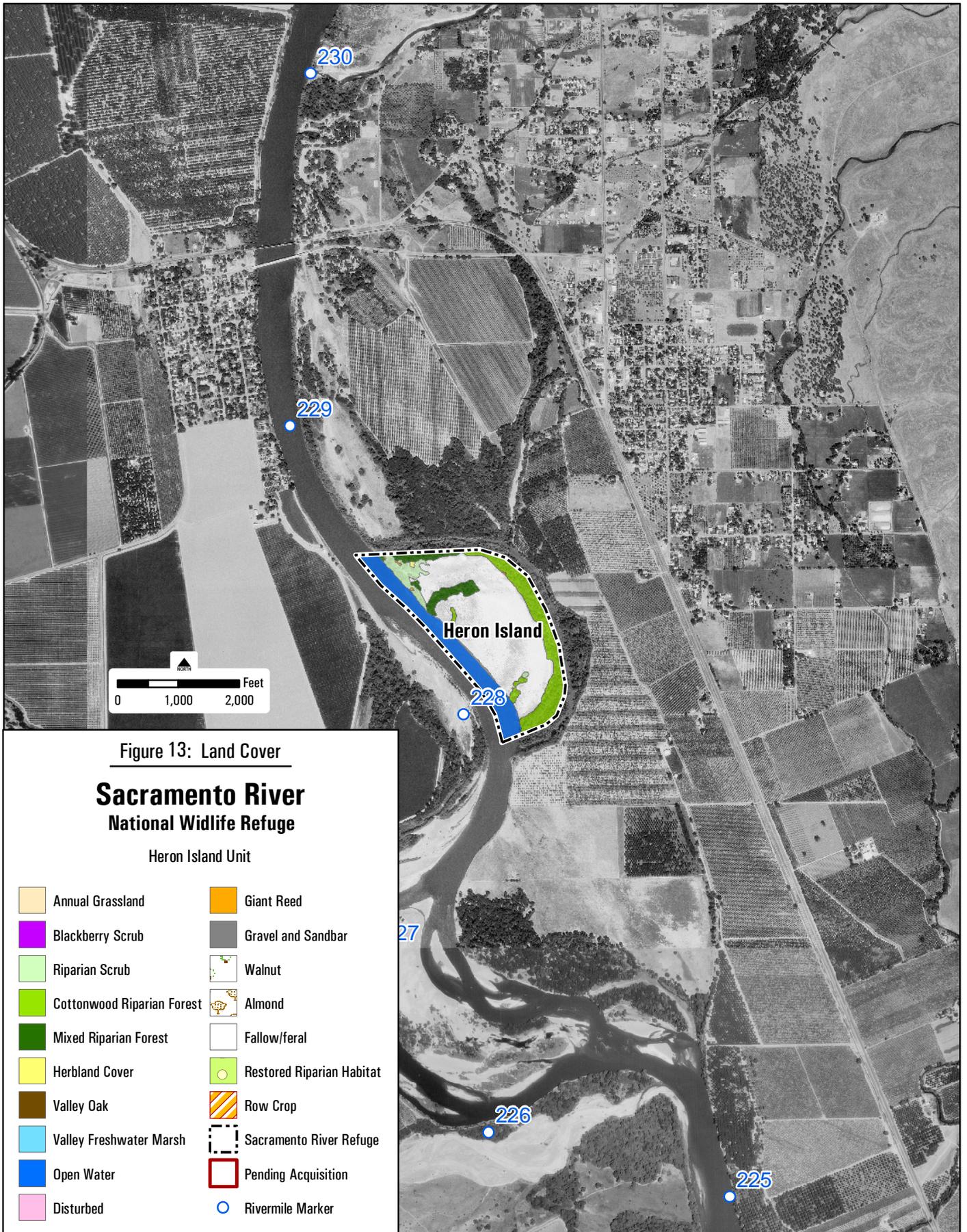
Acquired in 1991, the Rio Vista Unit (Figure 14) is 1,149 acres and is located between river miles 218 and 215.5. This unit is bordered on the north by South Ave (A-9) and on the south by the Merrill's Landing Unit of the CDFG Sacramento River Wildlife Area.

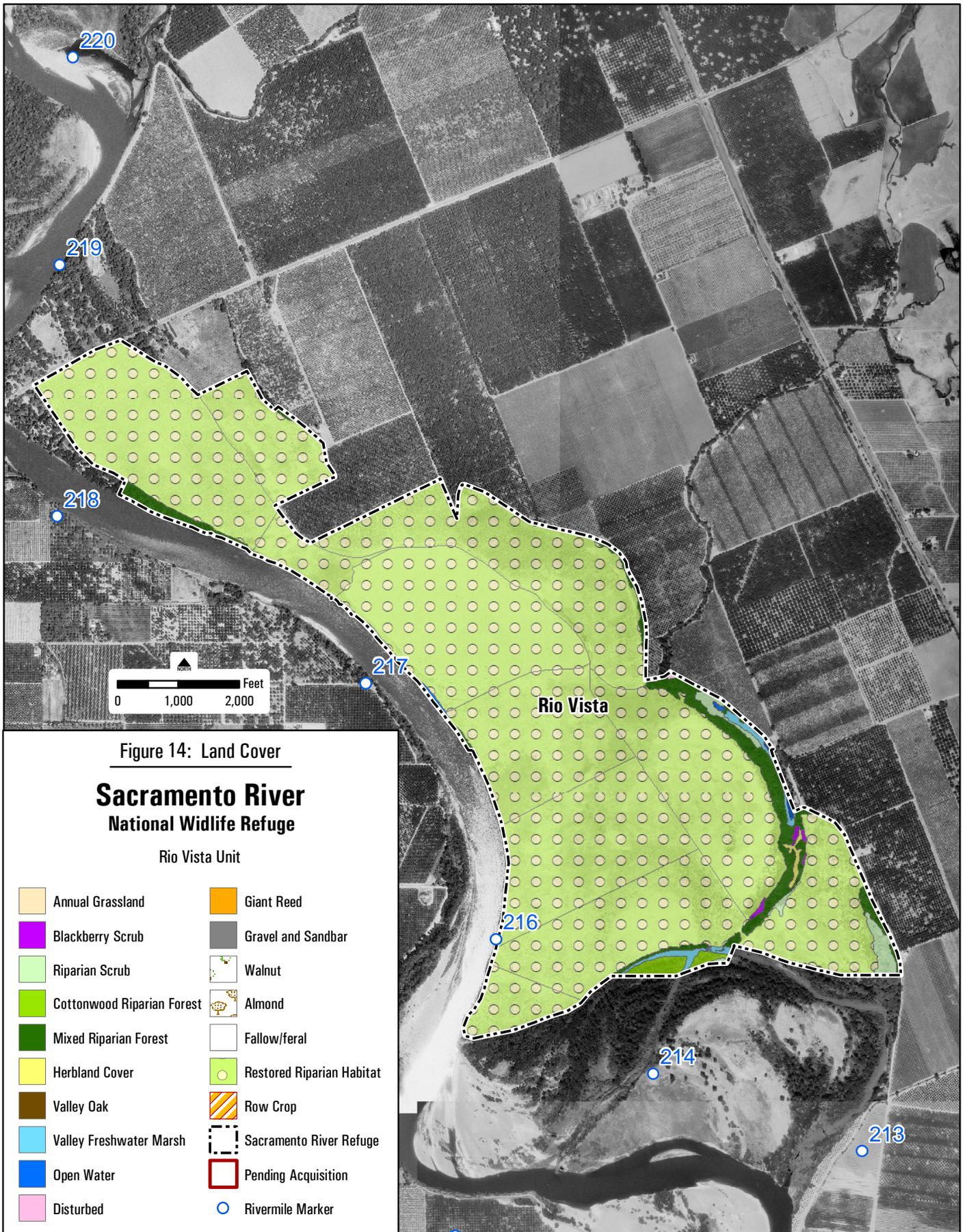
The unit's 86 acres of pre-existing riparian habitats consist mainly of mixed riparian forest, with some cottonwood riparian forest and riparian scrub.

Restoration of mixed riparian forest began in 1993 with 27 acres, and continued with 108 acres in 1994, 122 acres in 1995, 139 acres in 1996, 146 acres in 1997, 146 acres in 1998, 228 acres in 1999, and 75 acres in 2000. In 2001, 72 acres were restored to valley oak and elderberry savanna.

Some portions of the unit are cooperatively monitored by PRBO for avian use. Special wildlife use includes nesting blue grosbeaks. Special vegetation profiles include natural regeneration of valley oaks and blue elderberry.

In 2003, 14,250 feet of permanent gravel fire breaks were constructed as part of the WUI fire prevention program to protect adjacent residences and a RV park.





In 2003, at the request of Tehama County Public Works, the Refuge and TNC hired a private environmental engineering consultant to conduct a feasibility study evaluating the potential for floodplain topography restoration and localized flood reduction near South Ave (A-9). The feasibility study was completed in 2004 and the swale restoration will be completed in 2005.

#### *Foster Island*

Foster Island, located between river miles 211.5 and 210, is currently owned and managed by BLM. The Island's approximately 174 acres of pre-existing riparian habitats consist of mixed riparian forest, nonnative herblands and gravel bar (Figure 15).

This property is accessible by boat only. The Service and BLM are currently discussing incorporation of this property as part of the Refuge. If this occurs, the proposed uses will be consistent with current BLM public use activities including hunting, fishing, wildlife observation and photography, and interpretation and environmental education.

#### *McIntosh Landing North*

Acquired in 1994, the McIntosh Landing North Unit is 63 acres and is located between river miles 202.5 and 201.8.

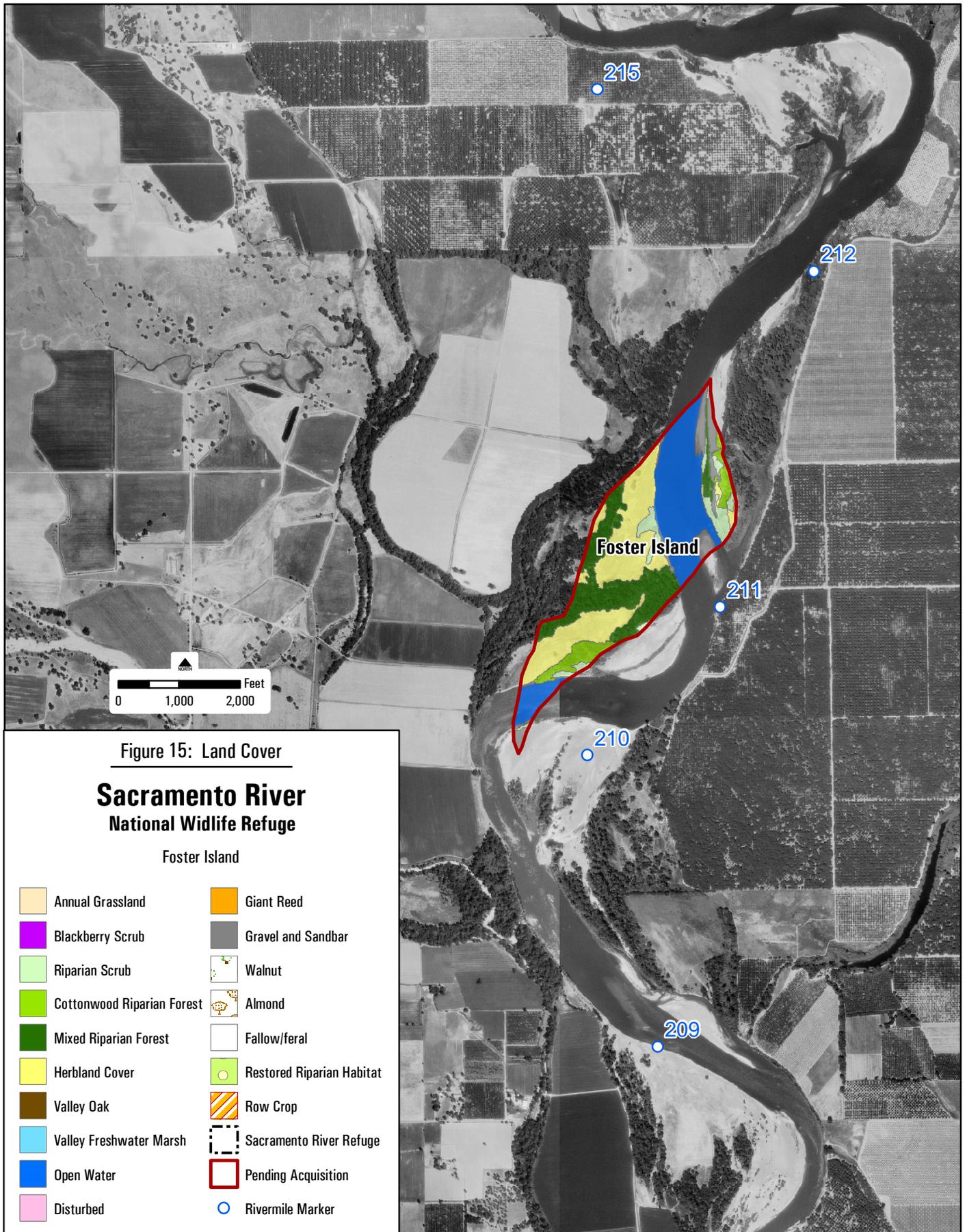
The unit originally consisted of 63 acres of pre-existing riparian habitats, but has lost about 11 of these acres to erosion (Figure 16). The remaining 52 acres is not actively managed.

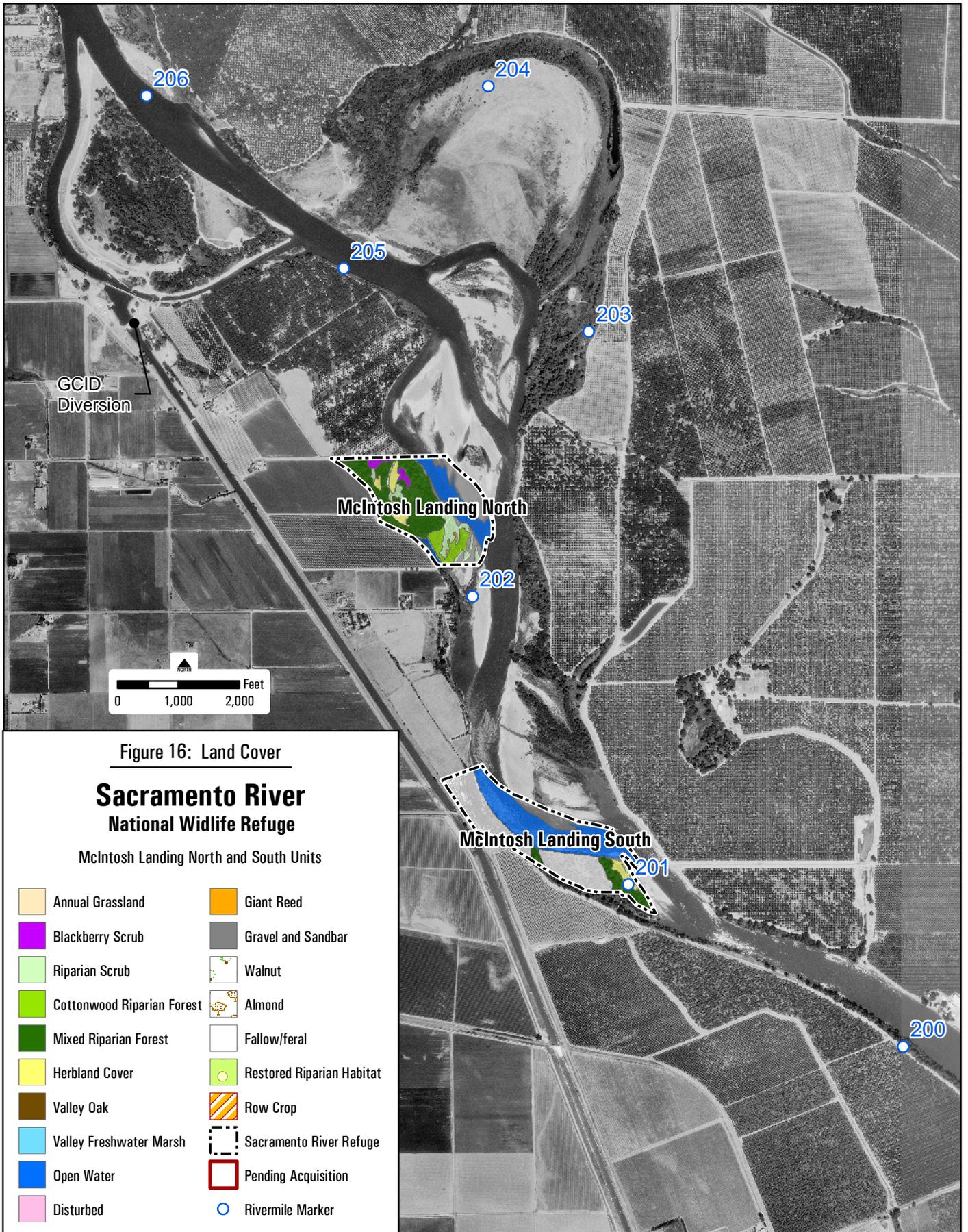
#### *McIntosh Landing South*

Acquired in 1994, the McIntosh Landing South Unit is 67 acres and is located between river miles 201.5 and 201.

The unit originally consisted of 50 acres of walnut orchard and 17 acres of pre-existing mixed riparian forest, but has lost about half of these acres to erosion (Figure 16). A CLMA to manage the abandoned orchard was developed in 2002 with the River Partners. Due to its proximity to the J-levee upstream of Hamilton City, land use changes are not currently being considered for this unit.

Special wildlife use includes multiple bank swallow colonies.





### *Pine Creek*

The Pine Creek Unit is 564 acres and is located between river miles 198.5 and 198. The first 404 acres were acquired in 1995, and the remaining 160 acres in 2003. This unit is bordered on the north by Highway 32 and on the south by the Pine Creek Unit of the CDFG Sacramento River Wildlife Area.

Restoration of mixed riparian forest began in 1998 with 80 acres, and continued with 211 acres in 1999 and 68 acres in 2004. Only those planted in 2004 still receive irrigation or chemical/physical treatments, which will discontinue in 2007. In 2004, 141 acres were restored to native grass and receive no irrigation, but will receive chemical/physical treatments until 2007. Eighteen acres remain fallow. The 34 acres of pre-existing riparian habitats consist of cottonwood riparian forest and riparian scrub (Figure 17).

A swale restoration project was completed in 2004 to assist movement of flood flows across the unit and protect Highway 32. Restoration of these swale banks and island deposit zones to valley oak woodland will occur fall 2005 (4 acres) and will receive irrigation and chemical/physical treatments until 2007.

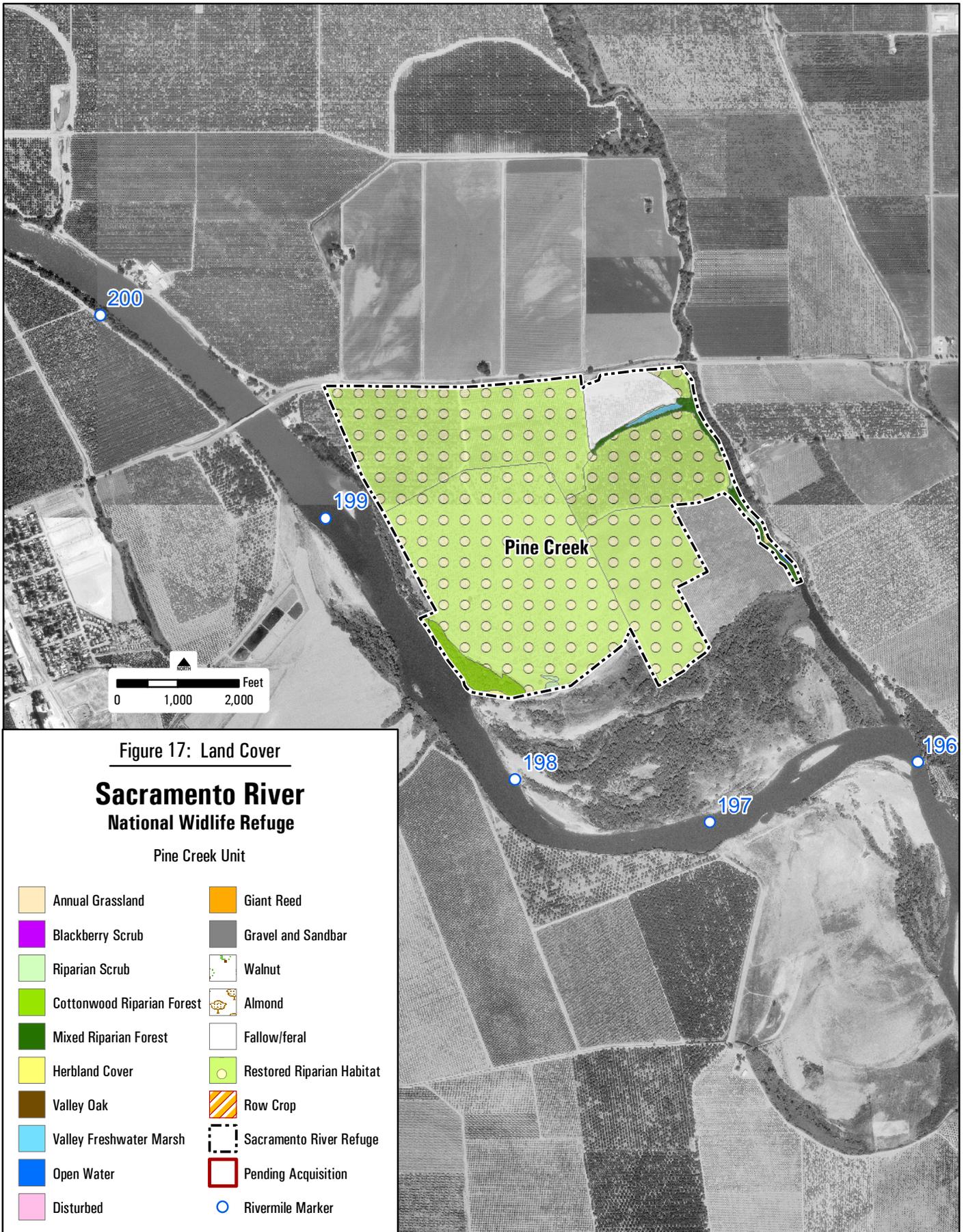
WUI fuel reduction projects to remove old orchard stumps discarded along the levee, understory vegetation south of the private residences, and an abandoned barn were completed in 2003.

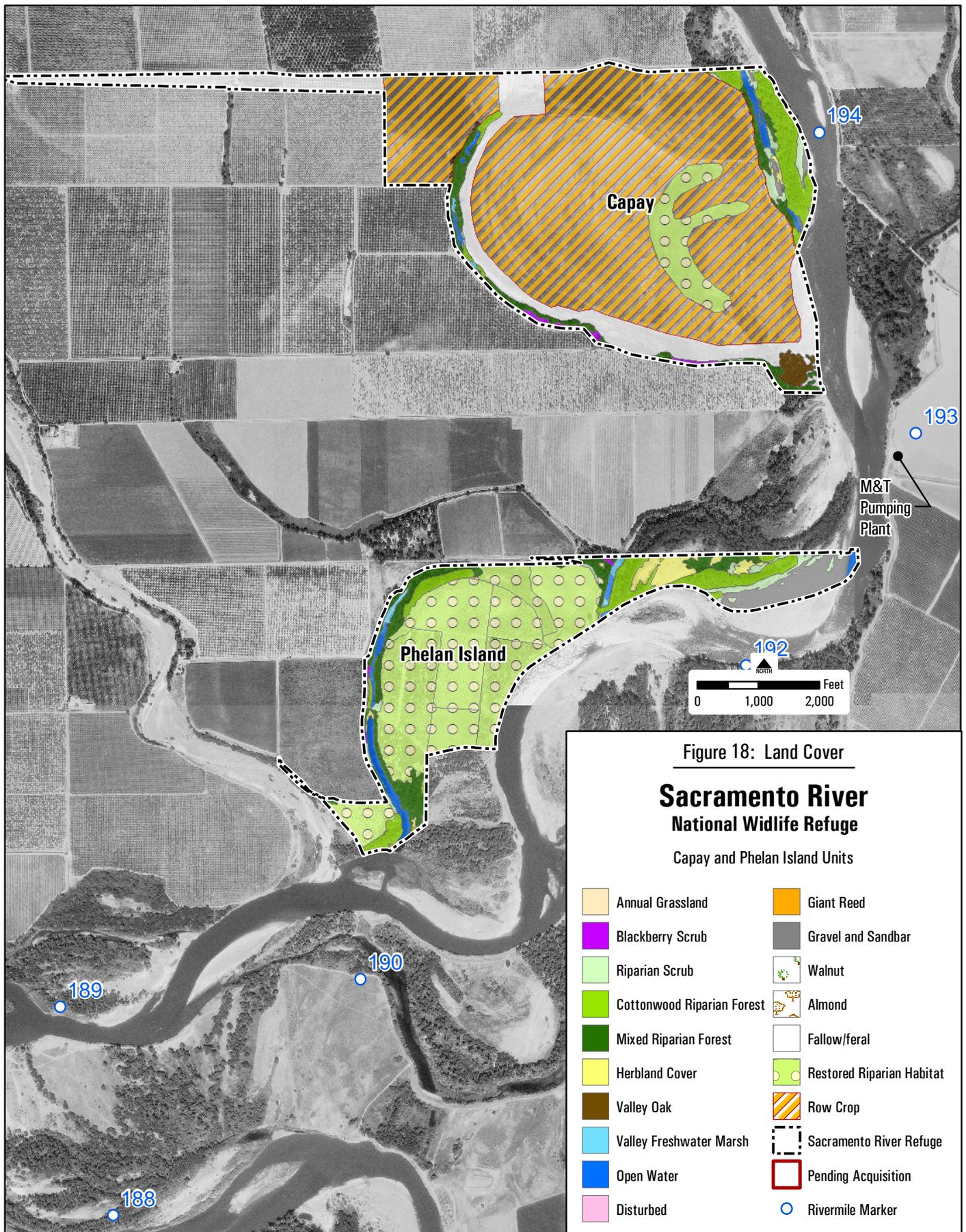
Special wildlife use includes juvenile salmonid rearing habitat in adjacent Pine Creek.

### *Capay*

Acquired in 1999, the Capay Unit is 666 acres and is located between river miles 194 and 193. This unit is bordered on the north by County Road 23 and the Pine Creek Unit of the CDFG Sacramento River Wildlife Area.

The unit's 575 acres of agricultural lands are currently managed as both irrigated and dry land row crops under a CLMA with TNC. The 91 acres of pre-existing riparian habitat is mostly cottonwood riparian forest (Figure 18).





Special wildlife use includes breeding yellow warblers and a bank swallow colony. Special vegetation profiles include a high diversity of herbaceous plant species.

#### *Phelan Island*

Acquired in 1991, the Phelan Island Unit is 308 acres and is located between river miles 191.5 and 190.5.

Restoration of mixed riparian forest began in 1995 with 11 acres, and continued with 12 acres in 1997, 24 acres in 1998, 57 acres in 1999, and 82 acres in 2001. The 122 acres of pre-existing riparian habitats consist mostly of mixed riparian forest, cottonwood riparian forest, herbland cover, and open water (Sam Slough) (Figure 18).

Some portions of the unit are cooperatively monitored by PRBO for avian use. Special wildlife use includes northwestern pond turtles in Sam Slough, breeding lazuli buntings, western yellow-billed cuckoos, and blue and black-headed grosbeaks. Special vegetation profiles adjacent to the Refuge include DWR mitigation plantings of mixed riparian forest at River Unit planted in 1991, and valley oak/elderberry forest at Sam Slough Unit planted in 1992.

#### *Jacinto*

Acquired in 1996, the Jacinto Unit is 69 acres and is located between river miles 186.5 and 186.

The unit's 10 acres of walnut are managed through a CLMA with River Partners and a tenant farmer. The 59 acres of pre-existing riparian habitats consist mostly of mixed riparian forest, cottonwood riparian forest, riparian scrub, and gravel/sand bar (Figure 19).

Special vegetation profiles include an old growth cottonwood stand and giant reed (*Arundo*).

#### *Dead Man's Reach*

Acquired in 1999, the Dead Man's Reach Unit is 637 acres and is located between river miles 186.5 and 185.

The unit's 323 acres of walnut, 243 acres of almond, and 4 fallow acres are managed through a CLMA by a tenant farmer. Almond management will be discontinued in 2005 in order to prepare for riparian restoration efforts. The 67 acres of pre-

existing riparian habitats consist mostly of mixed riparian forest, riparian scrub, and gravel bar (Figure 19).

*North Ord*

Acquired in 2002, the North Ord Unit is 29 acres and is located between river miles 185 and 185.5.

The unit's 26 fallow/feral acres consist mostly of abandoned walnut orchard. The 3 acres of pre-existing riparian habitats consist mostly of mixed riparian forest and riparian scrub (Figure 19).

*Ord Bend*

Acquired in 1995, the Ord Bend Unit is 111 acres and is located between river miles 184 and 183.7. This unit is bordered by Ord Ferry Road on the north and is directly south of the Ord Bend County Park.

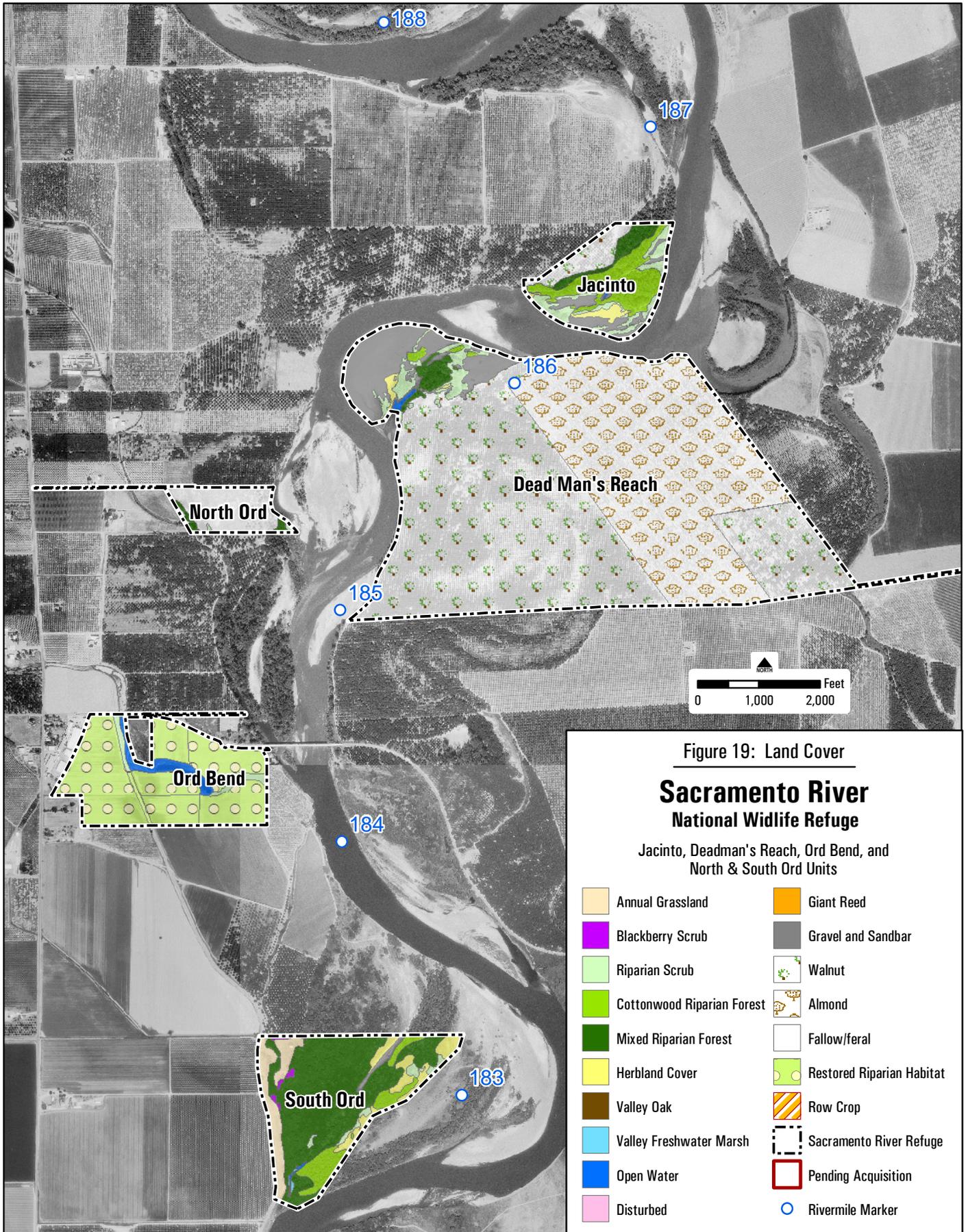
The unit's 96 restored riparian acres were planted in 1999. Most of these acres were restored to valley oak savanna, with some areas of mixed riparian forest and native grassland. The 15 acres of pre-existing riparian habitats consist mostly of riparian scrub, open water and blackberry (Figure 19).

Special wildlife use includes waterbird use on the Army Corps of Engineer's (ACOE) borrow site on Stony Creek tributary, and a Valley elderberry longhorn beetle exit hole sighting (first fresh exit hole observed on the Refuge). Special vegetation profiles include a high terrace, most of which is outside of the 100-year flood plain.

In 2003, 5,150 feet of permanent gravel fire breaks were constructed as part of the WUI fire prevention program to protect adjacent residences, agricultural structures and a wood treatment plant. These fires breaks also serve as buffers to reduce the impacts of depredation on agriculture and pesticide drift. The Refuge also coordinates with the local fire and levee district on annual levee maintenance projects.

*South Ord*

Acquired in 1999, the South Ord Unit is 122 acres and is located between river miles 183.5 and 183. The South Ord Unit is bordered to the north by the Oxbow Unit of the CDFG Sacramento River Wildlife Area.



The unit's 122 acres of pre-existing riparian habitats consist mostly of mixed riparian forest, cottonwood riparian forest, and herbland cover (Figure 19). Some chemical and physical manipulations may be required on about 10 acres to maintain flow through a drain (part of deed requirements).

Some portions of the unit are cooperatively monitored by PRBO for avian use.

*Llano Seco Riparian Sanctuary and Islands 1 and 2*

Acquired in 1991, the Llano Seco Riparian Sanctuary and Llano Seco Islands 1 and 2 consist of 906 acres and are located between river miles 183.5 and 175.5. Llano Seco Island 1 is bordered to the north by the Oxbow Unit of the CDFG Sacramento River Wildlife Area.

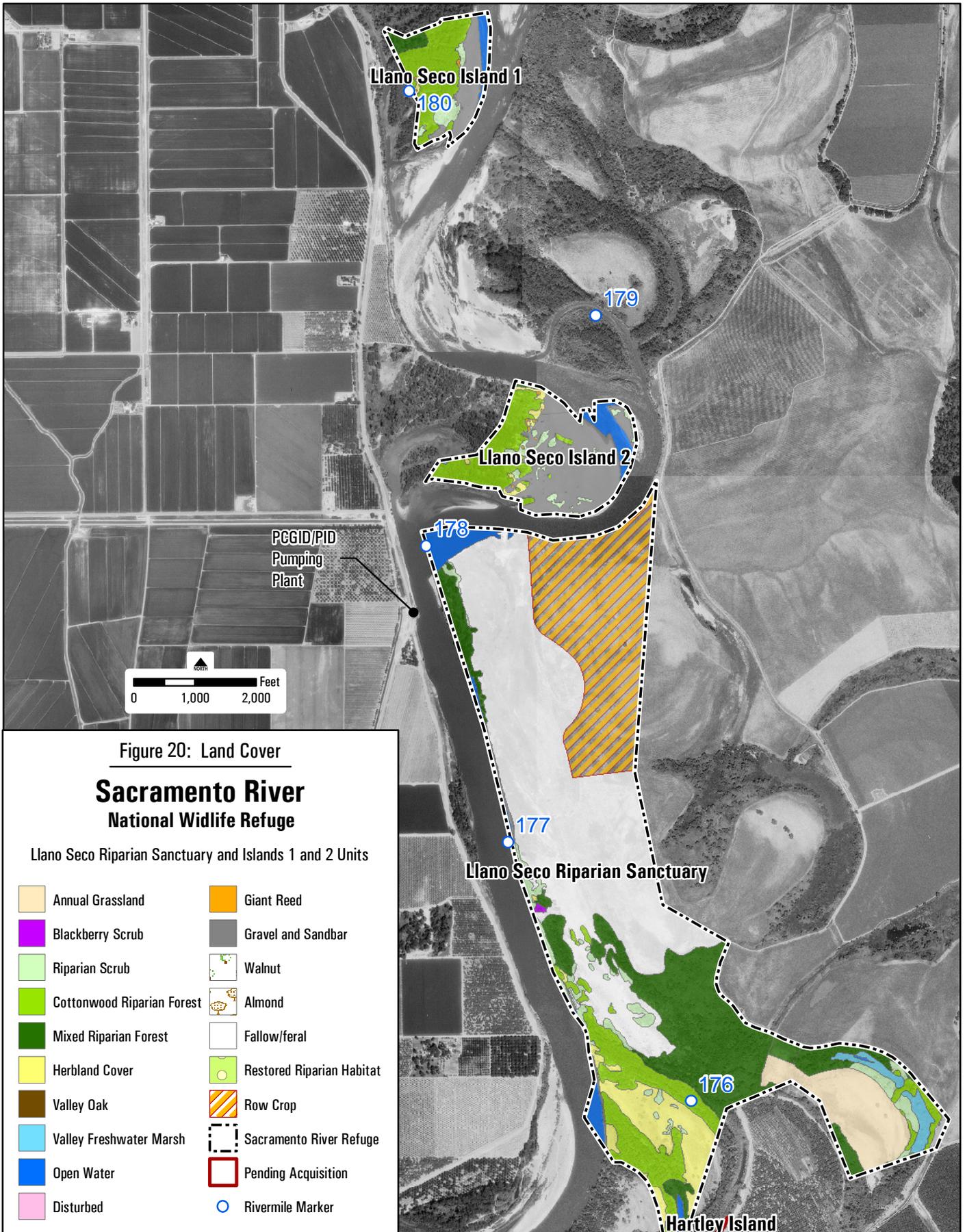
The unit's 520 acres of pre-existing riparian habitats consist mostly of mixed riparian forest, cottonwood riparian forest, herbland cover, riparian scrub, and gravel bar. The unit's remaining 386 acres are composed of 206 fallow acres and 180 acres of row crop; this area is being evaluated for riparian restoration through a feasibility study funded by CalFed (Figure 20).

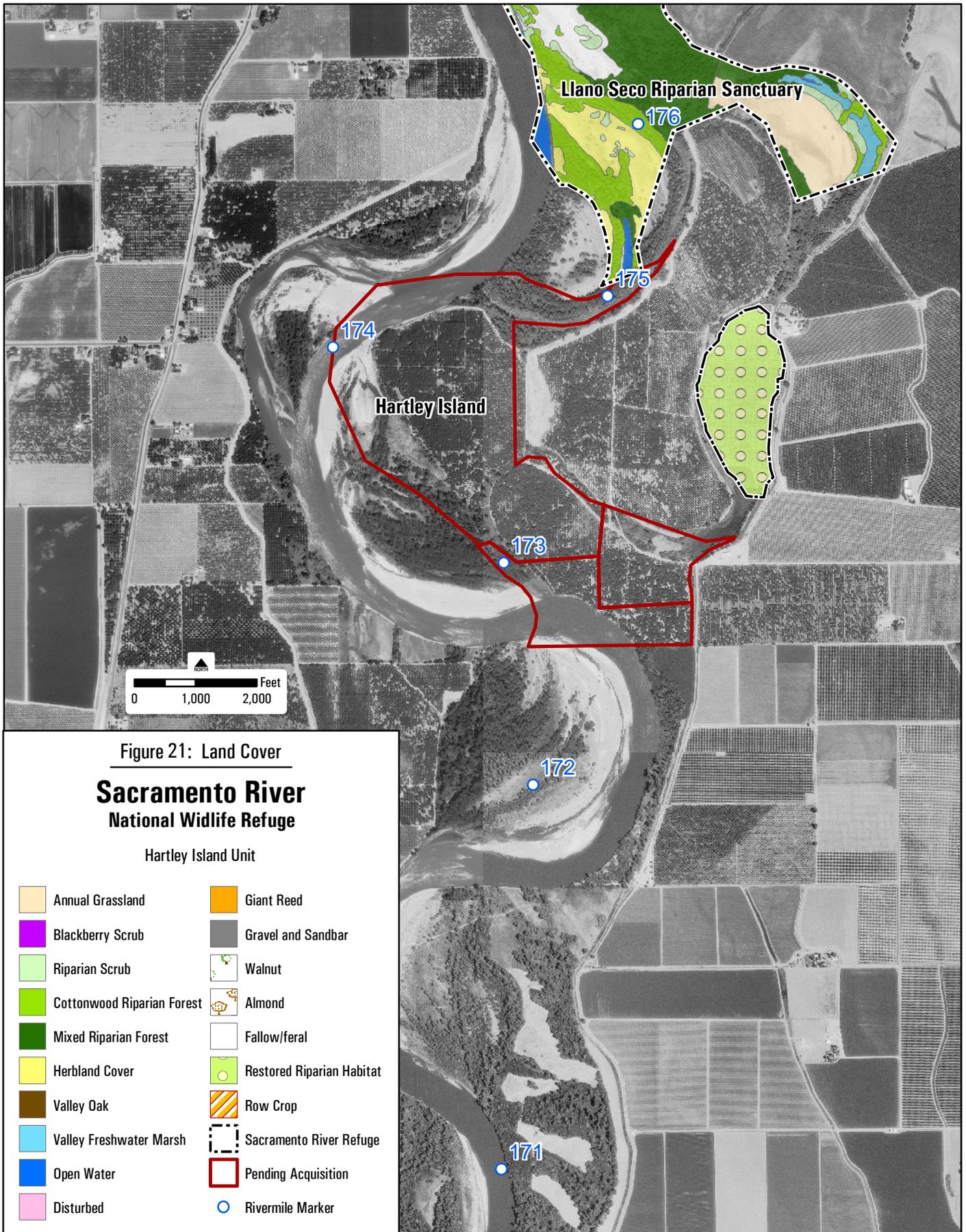
Special wildlife use includes California quail in mixed riparian forest at Goodman opening, multiple bank swallow colonies, and yellow-billed cuckoo sightings. Special vegetation profiles include a natural succession from wheat cropping at Goodman opening into blue elderberry, coyote bush, creeping wild-rye grasses, mugwort, and box elder.

*Hartley Island*

The Hartley Island Unit is 487 acres and is located between river miles 174.5 and 172.5 (Figure 21). Hartley Island is bordered to the north by the Oxbow Unit of the CDFG Sacramento River Wildlife Area. Sixty-seven acres of this property were acquired in 2003. The remaining 420 acres are privately owned and are currently in the acquisition process.

Of the 420 acres currently under private ownership, 237 are walnut that are managed by a contracted farmer, and the remaining 183 acres are pre-existing riparian habitats composed mostly of mixed riparian forest, cottonwood riparian forest, herbland cover, and gravel bar





Of the 67 acres that are currently owned by the Refuge, 63 were restored to mixed riparian forest in 2004, and 4 are pre-existing riparian habitats.

### *Sul Norte*

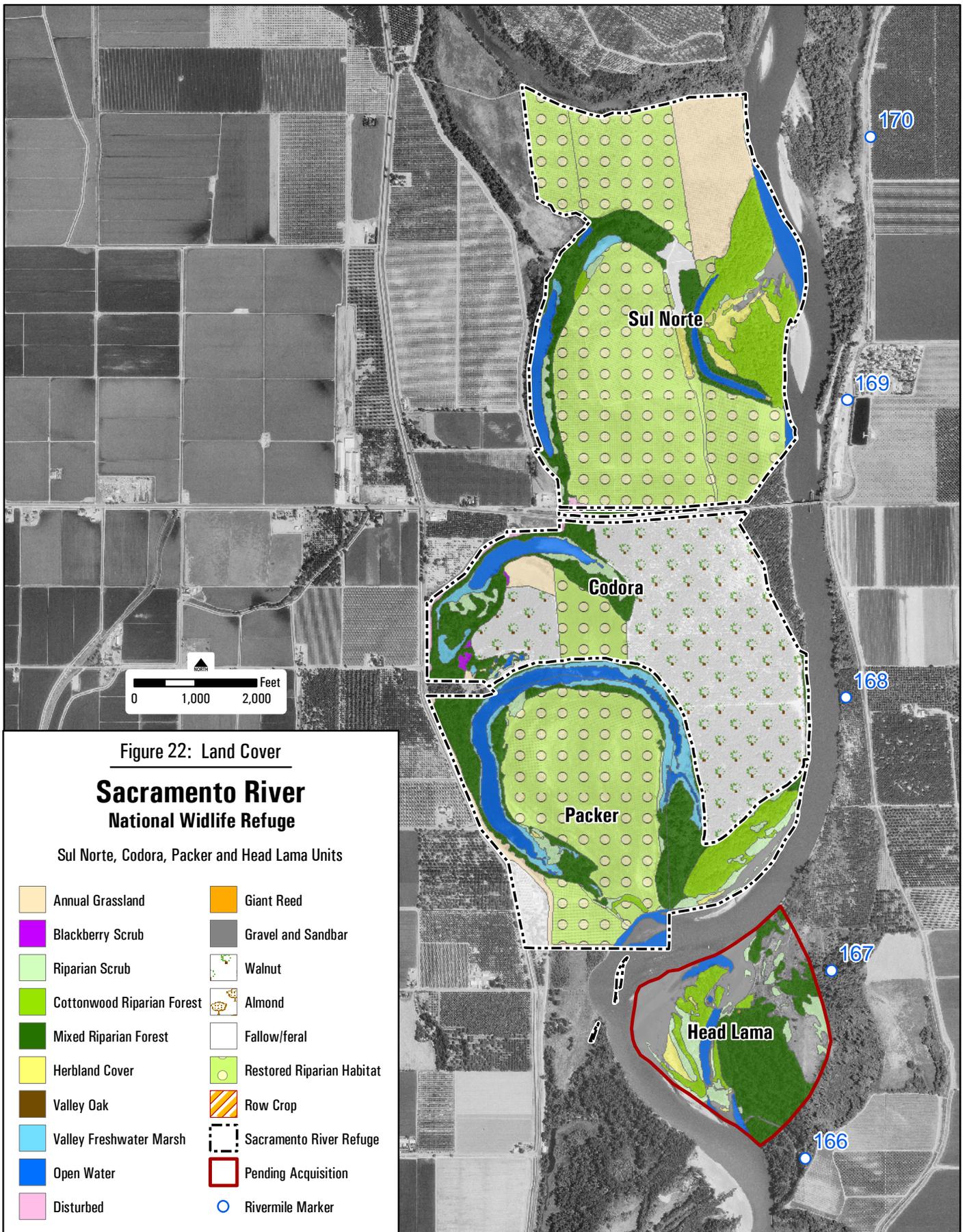
The Sul Norte Unit, acquired in 1990/91, is 590 acres and is located between river miles 170 and 168.5. This unit is bordered on the north by the Beehive Bend Unit of the CDFG Sacramento River Wildlife Area and on the south by the Highway 162 viaduct.

In 1998, 241 restored riparian acres were planted into mixed riparian forest and savanna. This was replanted again in 2000. In 1999, a research project to determine the feasibility of natural recruitment on mid-terrace floodplain soils was conducted on 20 acres (Peterson 2002). This restoration technique proved to be unsuccessful due to competition with nonnative invasive weeds and human-made changes in the hydrograph; in 2003 these acres (in addition to 49 acres in 2002) were restored to riparian habitat as described in the report “Hydraulic Analysis of Riparian Habitat Conservation on the Sacramento River from Princeton to Beehive Bend” (Ayres Associates 2001). In 2002, 86 acres were restored to native grass. Restoration completed in 2002 and 2003 will receive irrigation and/or chemical/physical treatments until 2006 and 2007, respectively. The 192 acres of pre-existing riparian habitats consist mostly of mixed riparian forest, cottonwood riparian forest, herbland cover, and gravel bar (Figure 22).

Some portions of the unit are cooperatively monitored by PRBO for avian use. Special wildlife use includes ring-tailed cats, river otters, breeding yellow warblers, western yellow-billed cuckoos, and a bank swallow colony. Special vegetation profiles include low-mid and high terrace forest types, as well as natural regeneration of valley oak in former prune orchard (2000 restoration site).

### *Codora*

Acquired in 1994, the Codora Unit is 399 acres and is located between river miles 168 and 167. This unit is bordered on the west by Highway 45 and to the north by the Highway 162 viaduct.



The unit's 269 acres of walnut acres are managed under a CLMA with TNC and leased to a tenant farmer. The current 28 restored riparian acres were allowed to undergo natural recruitment in 1996, and receive no irrigation or chemical/physical treatments. The 102 acres of pre-existing riparian habitats consist mostly of mixed riparian forest and open water (Figure 22).

Some portions of the unit are cooperatively monitored by PRBO for avian use. Special vegetation profiles include the natural regeneration of 28 acres of arroyo willow, cottonwood, and box elder, which germinated in 1996, after last being row cropped in 1995.

#### *Packer*

Acquired in 1997, the Packer Unit is 404 acres and is located between river miles 168 and 167. This unit is bordered on the west by Highway 45 and to the south by Princeton Unit of the CDFG Sacramento River Wildlife Area.

In 1999, 174 acres were restored to mixed riparian forest. The 215 acres of pre-existing riparian habitats consists mostly of mixed riparian forest, open water (Packer Lake), cottonwood riparian forest, and riparian scrub (Figure 22).

Some portions of the unit are cooperatively monitored by PRBO for avian use. Special wildlife use includes black-crowned night-heron roosts and wood ducks on Packer Lake. Special vegetation profiles include valley oak regeneration on low bench on the southwest side of Packer Lake.

A WUI project was implemented in 2002 to reduce the threat of wildfire on neighboring properties. The project included physical manipulation (fuels reduction) and construction of a permanent fire break.

Packer Lake was opened to public fishing in 2001 (U.S. Fish and Wildlife Service 2001). The Refuge plans to work with the State of California, Department of Boating & Waterways to modify the boat launch area at the Packer Unit to improve safety for anglers and other visitors.

#### *Head Lama*

The Head Lama Unit is 177 acres and is located between river miles 167 and 166. This unit is privately owned and is currently in the acquisition process.

The unit's 177 acres of pre-existing riparian habitats consist mostly of mixed riparian forest, cottonwood riparian forest, riparian scrub, gravel bar, and some herbland cover (Figure 22).

#### *Drumheller Slough*

The Drumheller Slough Unit is 224 acres and is located between river miles 165 and 164.5. The first 72 acres were acquired in 1998, and the remaining 152 acres in 1999. This unit is bisected by County Road 60 and bordered by the Princeton Unit of the CDFG Sacramento River Wildlife Area to the south.

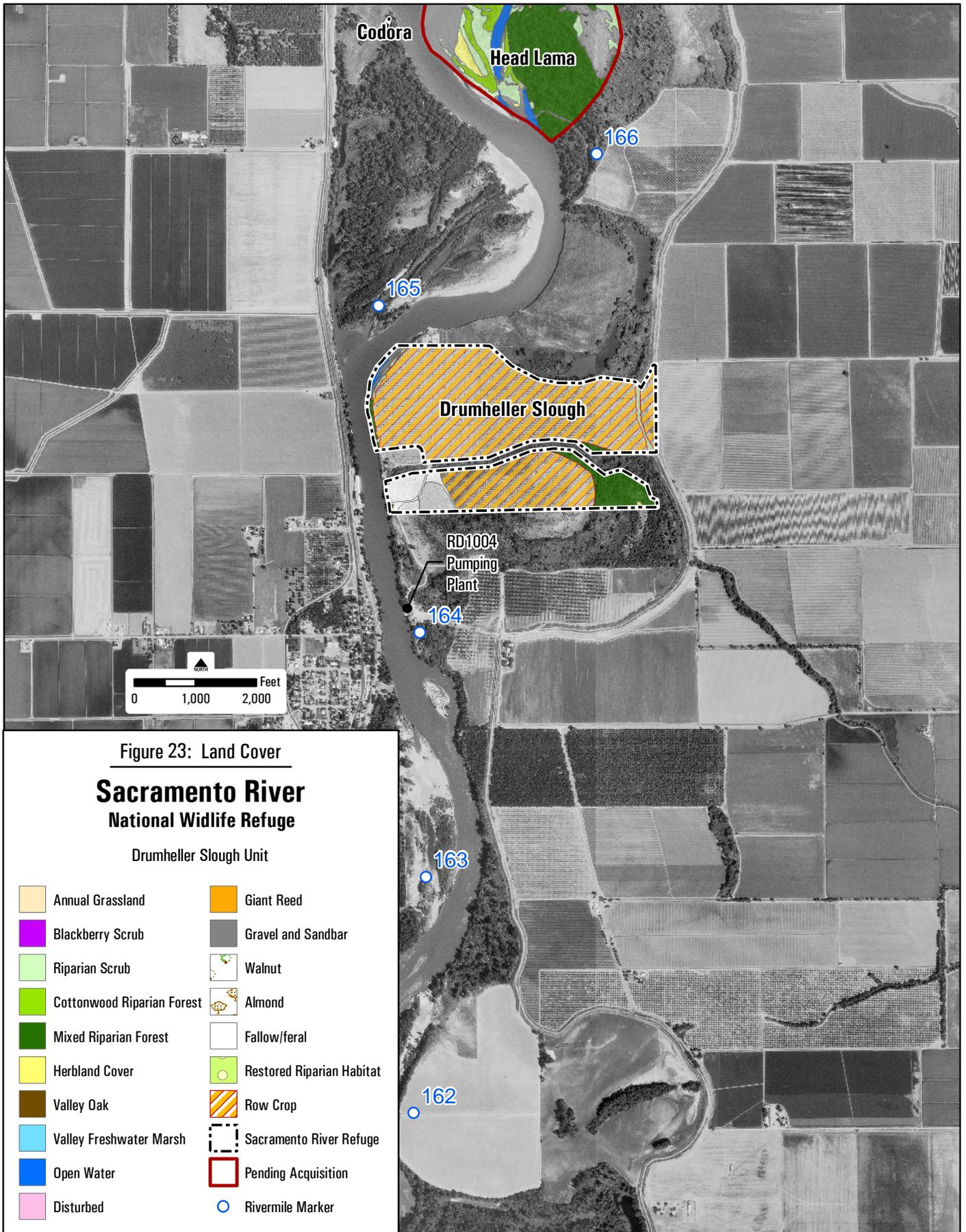
The 24 acres of pre-existing riparian habitats consist mostly of mixed riparian forest (Figure 23). The unit's remaining 200 acres are currently being managed under a CLMA with River Partners and leased to local growers for dry land row crops.

Special vegetation profiles include blue elderberry bushes planted as a Valley elderberry longhorn beetle mitigation site and Drumheller slough giant garter snake mitigation site.



**Sacramento River**

*Photo by Perry Grissom*



*Llano Seco Riparian Easement*

Acquired in 1991, the Llano Seco Ranch Riparian Easement consists of 1,281 acres located between river miles 183 and 178 (Figure 24). This conservation easement is located on private property and is bordered to the north by the Ord Ferry Bridge and to the south by the Llano Seco Unit, Riparian Sanctuary.

The 1,281 acres of pre-existing riparian habitats and fallow grain lands consist of non-native grassland, mixed riparian forest, cottonwood riparian forest, elderberry savanna, herbland cover, riparian scrub, and sand and gravel bar. There are three oxbow lakes here: The Lagoon, Duck Lake, and Goose Lake.

Special wildlife use includes California quail at the edge of oxbow lakes and seasonal winter waterfowl use, primarily mallard and wood duck, of the oxbow lakes. A relatively large bank swallow colony occurs at Ryan' Island, nesting yellow-billed cuckoo have been observed at the Lagoon, Goose Lake, and at least two points in between, and Swainson's hawk have also been observed at Goose Lake. Special vegetation profiles includes minor natural succession of cottonwood, box elder, and elderberry at Ryan's Island, three locations of mature elderberry savanna, and old-growth sandbar willow scrub at mid-elevation floodplain.

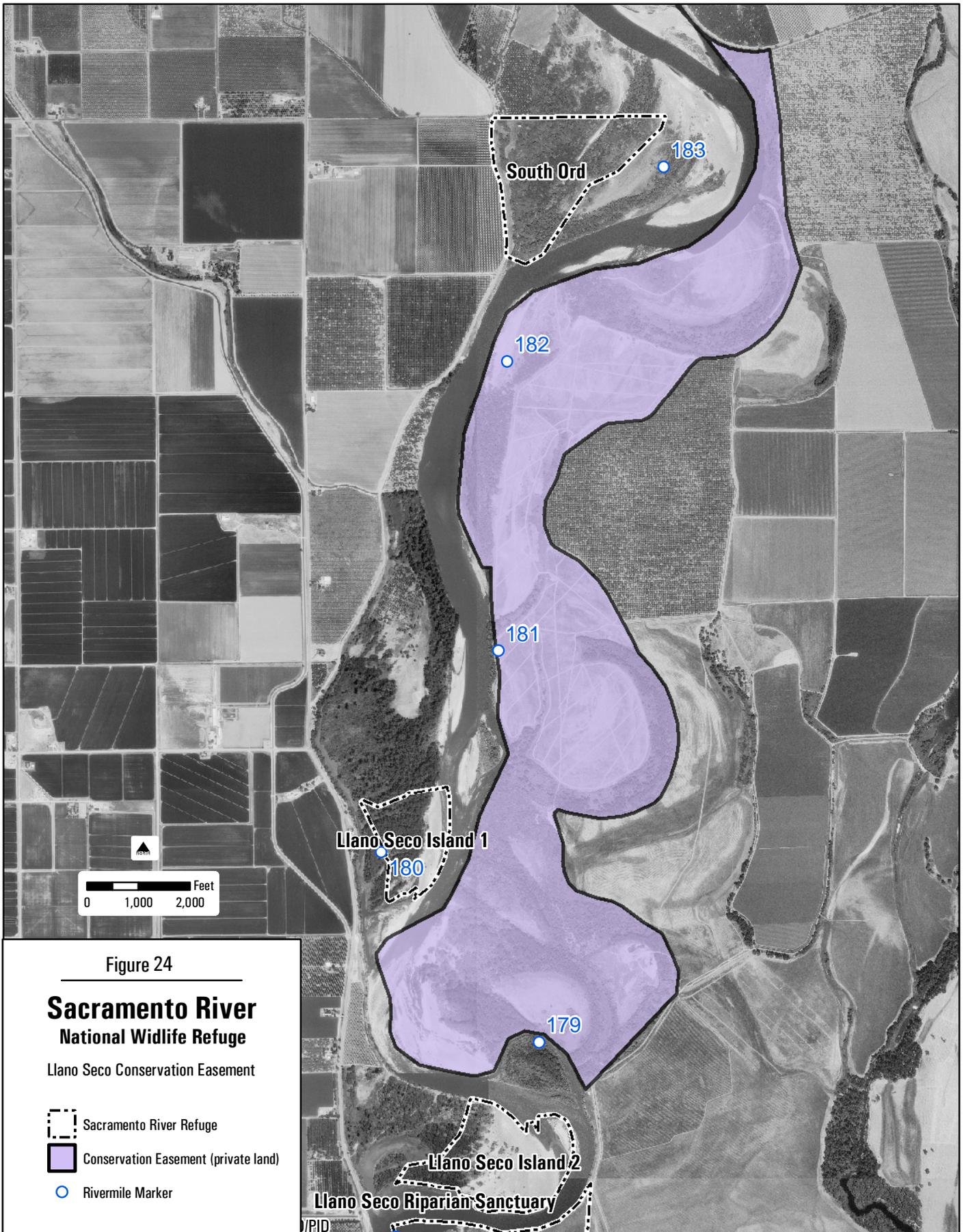


Figure 24

### Sacramento River National Wildlife Refuge

Llano Seco Conservation Easement

- Sacramento River Refuge
- Conservation Easement (private land)
- Rivermile Marker

