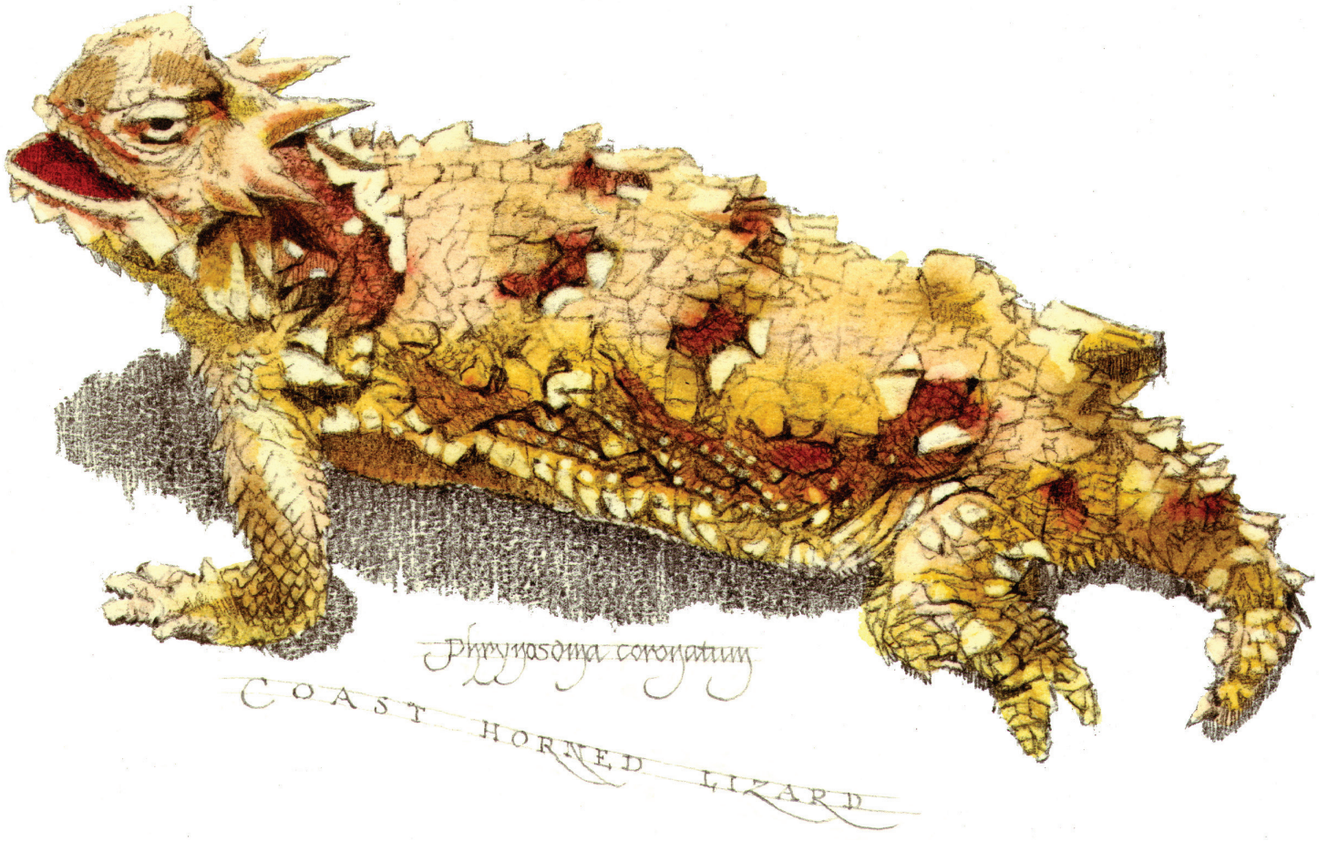
Examples of Biodiversity



California supports resources of national and even international significance for biodiversity. From the rich kelp forests off the coast, to the unique populations of fishes in rivers, streams, and mountain lakes, to the isolated pupfishes of the deserts, California's aquatic communities rival some of the most diverse. Yet California is best known for its terrestrial diversity, including iconic coastal redwoods found nowhere else on earth, characteristic oak woodlands of the coastal mountains and Sierra Nevada foothills, and seemingly hostile deserts that support an incredible diversity of life. The Central Valley features sweeping grasslands, colorful flower fields, and one of the most extensive distributions of vernal pools in the world.

Kelp Forests

California's nearshore kelp forests are dominated by two types of brown algae, Giant Kelp (*Macrocystis pyrifera*) and Bull Kelp (*Nereocystis luetkeana*).

Giant Kelp can be found worldwide in nearshore temperate oceans. On the Pacific coast of North America, Giant Kelp ranges from Baja California to southeast Alaska. In its California range, Giant Kelp is most abundant south of San Francisco. A perennial, Giant Kelp individuals can live for up to nine years, although the fronds usually die within nine months.

Giant Kelp forest
Photo: Chad King, MBNMS/NOAA

Bull Kelp resides along the Pacific coasts of North America and Asia. In North America, Bull Kelp ranges from Point Conception north to the Aleutian Islands. Offshore of California, this annual kelp becomes the dominate kelp species north of Santa Cruz County.

Kelp forests play an important ecological role. Marine life take refuge in kelp forests or rely on kelp for food. Marine mammals forage for invertebrates that live in the kelp forest such as crabs, urchins, and abalone (which feed on kelp). Birds hunt fish which in turn feed on invertebrates and kelp in the forest. Even kelp that has perished is utilized, providing food for invertebrates both at sea and on the beach.

Bull Kelp wrack
Photo: Rebecca Flores Miller

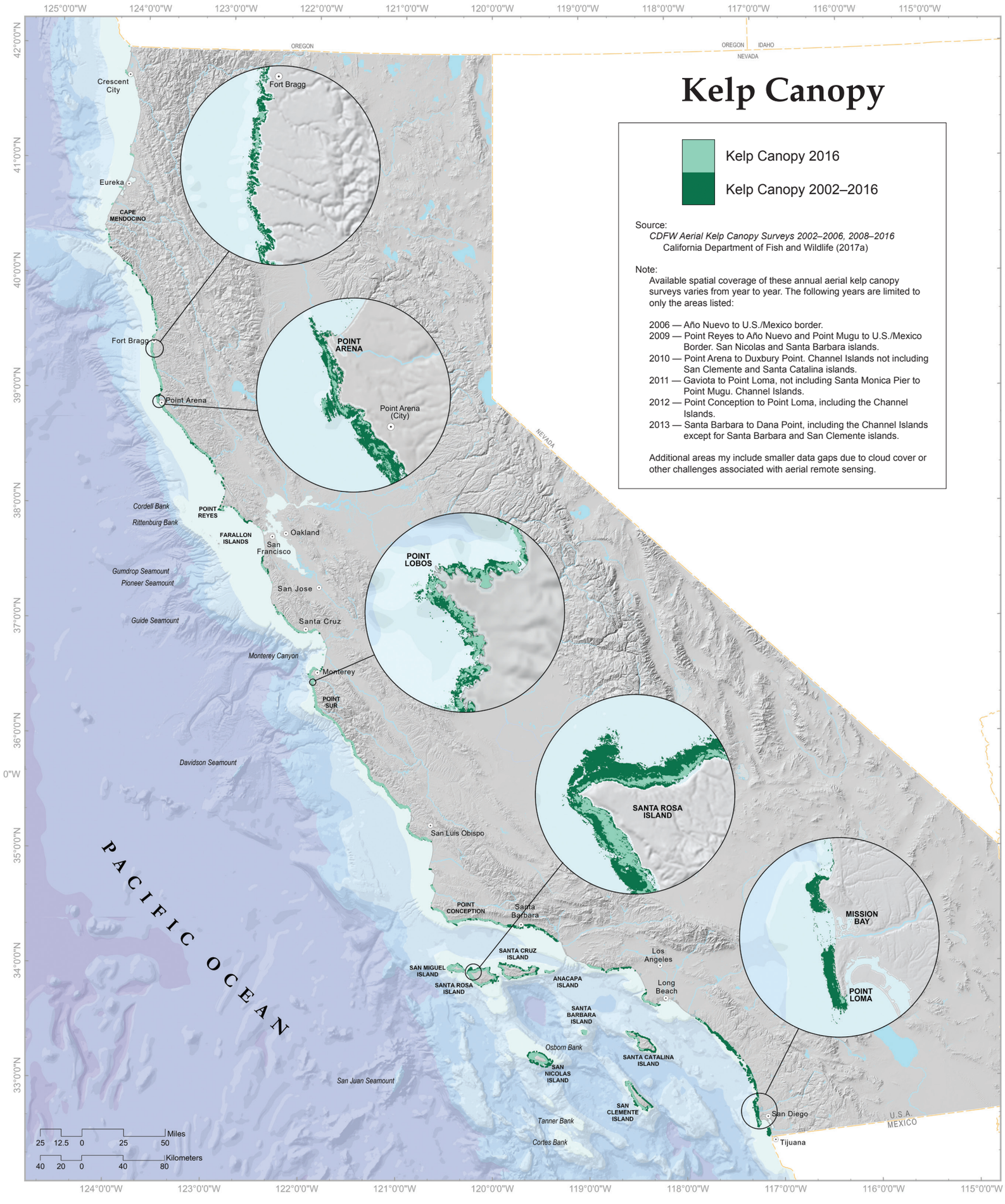
Humans also utilize kelp forests for recreation, including scuba diving, fishing, and the direct harvest of kelp itself. Commercial harvest of Giant Kelp began in the early 1900s to extract acetone and potash to use in explosive manufacturing. Currently, Giant Kelp is harvested to feed cultured abalone while the Bull Kelp harvest is for human food. The kelp fishery is managed by the California Department of Fish and Wildlife under regulations adopted by the California Fish and Game Commission.

Bull Kelp at low tide with Great Blue Heron (*Ardea herodias*)
Photo © Kevin Joe

Ocean conditions naturally ebb and flow over time. Kelp thrives in cool, nutrient-rich water and is reduced by nutrient-poor water and the large ocean swells associated with warm water conditions. Human impacts, including soil erosion, wastewater discharges, power plant warm water outflows, and fishing of urchin predators or competitors, have negatively impacted kelp.

Many of California's kelp forests were greatly reduced in a cascade of events that began in 2013 (Rogers-Bennett and Catton 2019). While researchers examine how these events have shaped marine communities, changing ocean conditions will likely continue to impact kelp forests and complicate conservation efforts. The Department continues to work with partners to adaptively manage kelp forests to protect this important ecosystem.

Low kelp populations, changes in urchin feeding behavior, and urchin population increases can result in the formation of "urchin barrens."
CDFW photo: Paulo Serpa


Kelp Canopy
Kelp Canopy 2016
Kelp Canopy 2002–2016
Source:
CDFW Aerial Kelp Canopy Surveys 2002–2006, 2008–2016
California Department of Fish and Wildlife (2017a)
Note:
Available spatial coverage of these annual aerial kelp canopy surveys varies from year to year. The following years are limited to only the areas listed:
2006 — Año Nuevo to U.S./Mexico border.
2009 — Point Reyes to Año Nuevo and Point Mugu to U.S./Mexico Border. San Nicolas and Santa Barbara islands.
2010 — Point Arena to Duxbury Point. Channel Islands not including San Clemente and Santa Catalina islands.
2011 — Gaviota to Point Loma, not including Santa Monica Pier to Point Mugu. Channel Islands.
2012 — Point Conception to Point Loma, including the Channel Islands.
2013 — Santa Barbara to Dana Point, including the Channel Islands except for Santa Barbara and San Clemente islands.
Additional areas my include smaller data gaps due to cloud cover or other challenges associated with aerial remote sensing.
OREGON
IDAHO
NEVADA
Crescent City
Fort Bragg
Eureka
CAPE MENDOCINO
Point Arena
POINT ARENA
Point Arena (City)
POINT REYES
Cordell Bank
Rittenburg Bank
FARALLON ISLANDS
Oakland
San Francisco
POINT LOBOS
Gumdrop Seamount
Pioneer Seamount
San Jose
Guide Seamount
Santa Cruz
Monterey Canyon
Monterey
POINT SUR
Davidson Seamount
SANTA ROSA ISLAND
San Luis Obispo
PACIFIC OCEAN
POINT CONCEPTION
Santa Barbara
SANTA CRUZ ISLAND
SAN MIGUEL ISLAND
SANTA ROSA ISLAND
ANACAPA ISLAND
Los Angeles
Long Beach
MISSION BAY
POINT LOMA
SANTA BARBARA ISLAND
Osborn Bank
SAN NICOLAS ISLAND
SANTA CATALINA ISLAND
San Juan Seamount
SAN CLEMENTE ISLAND
Tanner Bank
Cortes Bank
San Diego
U.S.A.
MEXICO
Tijuana
Miles
25 12.5 0 25 50
Kilometers
40 20 0 40 80

Anadromous Fishes

Adult White Sturgeon (*Acipenser transmontanus*)
CDFW photo: Mike Healey

Anadromous fishes are an important biological resource of California. The best known of these are salmon and trout species including Chinook Salmon (*Oncorhynchus tshawytscha*), Coho Salmon (*O. kisutch*), Coastal Rainbow Trout/Steelhead (*O. mykiss irideus*), Coastal Cutthroat Trout (*O. clarkii clarkii*), and the ancient fishes White Sturgeon (*Acipenser transmontanus*) and Green Sturgeon (*A. medirostris*). Other native anadromous fishes include Pacific Lamprey (*Entosphenus tridentata*), Western River Lamprey (*Lampetra ayresii*), Longfin Smelt (*Spirinchus thaleichthys*), Eulachon (*Thaleichthys pacificus*), and Threespine Stickleback (*Gasterosteus aculeatus*). Long before European settlers arrived, some Native American cultures depended upon these abundant resources. Since the 1850s, major commercial and sport fisheries have existed for some of these fish, leading to high public interest in their conservation.

Threespine Stickleback (*Gasterosteus aculeatus*)

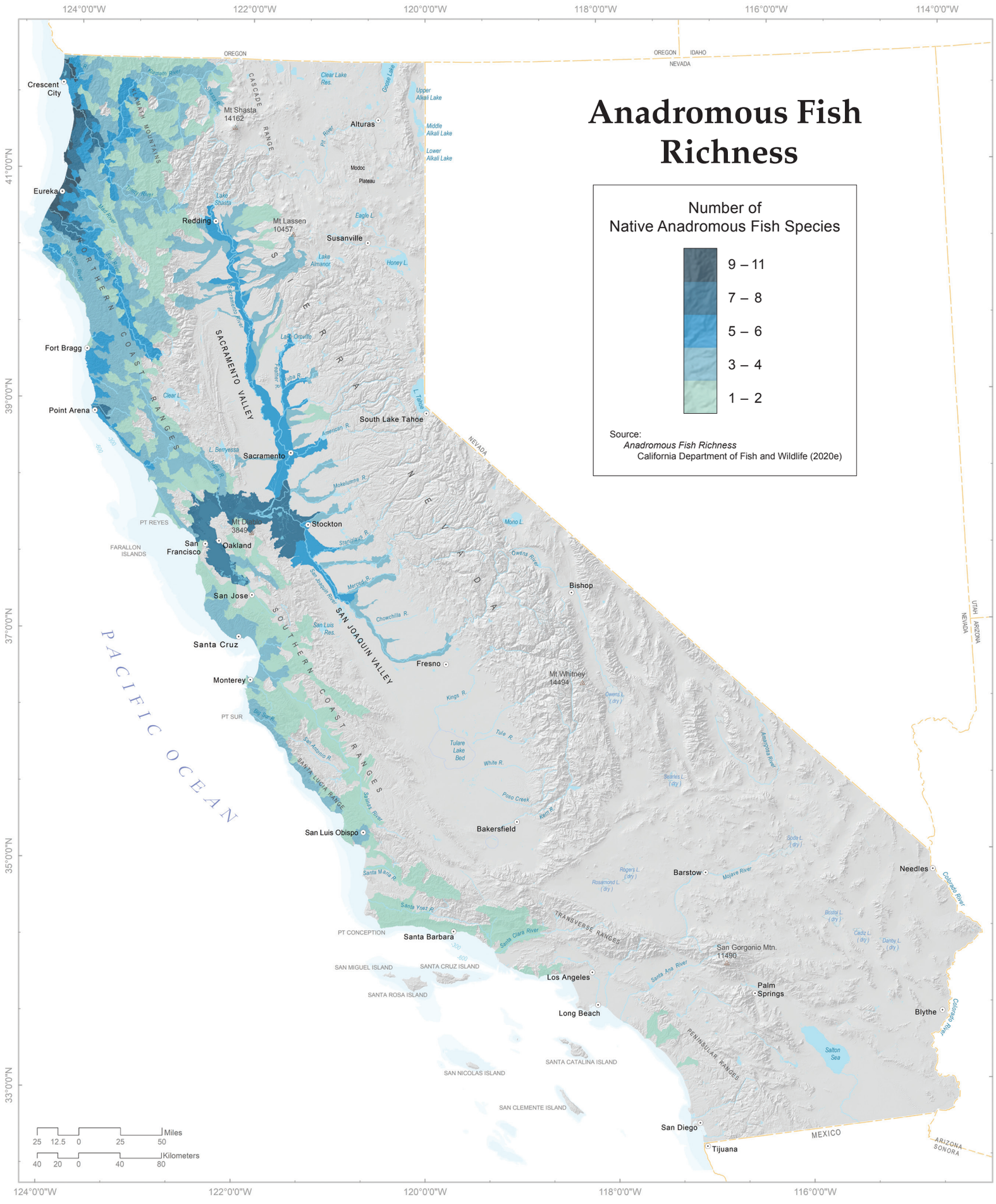
Anadromous fishes hatch in freshwater streams and live there for a few weeks to several years before migrating to the ocean. These fishes typically mature in the ocean and then return to their home streams to reproduce. Life spans range from the Threespine Stickleback, at only one year, to the White Sturgeon, with recorded ages over 100 years. Anadromous fishes spawn in streams with rock or gravel bottoms. Most salmonids and lampreys die after spawning, but steelhead and sturgeon may live to repeat the cycle. All California fish species need clean water and temperatures within their tolerance limits. Juveniles need an adequate food supply in the form of detritus, algae, invertebrates, or small fish; suitable spawning and rearing habitat; and cover to protect them from predators.

Eulachon and Coastal Cutthroat Trout are only found along the upper northern coast in California, at the southern end of their range. Coho Salmon, Chinook Salmon, White and Green Sturgeon, and Longfin Smelt migrate from the Pacific Ocean along the coast of California as far south as the San Francisco Estuary and the coastal streams around Santa Cruz. Steelhead Trout, Pacific Lamprey, River Lamprey, and Threespine Stickleback are found along the length of coastal California and migrate up many rivers and streams throughout the state. Some anadromous species ranges, like that of Steelhead Trout, extend hundreds of miles inland, using the longer rivers in the Sacramento and San Joaquin valleys for spawning and rearing. The map on the opposite page reflects the various ranges of these fishes.

Since the late 19th century, native fish populations have significantly declined due to overfishing and destruction of habitat. Extensive water and power projects have placed dams on all the major rivers of the state, blocking fish migration. Major water diversions, watershed erosion, and pollution have destroyed or degraded habitat. Even with fish hatcheries, salmon and steelhead numbers have continued to decline and certain major runs have been eliminated or are nearing extinction. Lamprey and sturgeon species have difficulty passing fish ladders designed for salmon, so access to additional historic spawning grounds is blocked (Docker 2015, Moyle 2002).

Maintaining water flows and water quality and continuing to manage fishing activities remain important to the conservation of anadromous species. In the long term, managing genetic diversity is just as important. This includes restoring both the habitat and the local genetic stocks of fish uniquely adapted to occupy that habitat. Small, isolated fish populations must also be protected because they are genetically unique and thus contribute to diversity. Government agencies working cooperatively with private citizens and organizations can help preserve the anadromous fishes of California, contributing to the biodiversity of the state.

Male Chinook Salmon (*Oncorhynchus tshawytscha*) during spawning season


Anadromous Fish Richness
Number of Native Anadromous Fish Species
9 – 11
7 – 8
5 – 6
3 – 4
1 – 2
Source:
Anadromous Fish Richness
California Department of Fish and Wildlife (2020e)
124°0'0"W
122°0'0"W
120°0'0"W
118°0'0"W
116°0'0"W
114°0'0"W
41°0'0"N
39°0'0"N
37°0'0"N
35°0'0"N
33°0'0"N
OREGON
IDAHO
NEVADA
UTAH
ARIZONA
MEXICO
SONORA
Crescent City
Eureka
Redding
Mt Shasta 14162
Mt Lassen 10457
Alturas
Susanville
Fort Bragg
Point Arena
Sacramento
South Lake Tahoe
Stockton
Mt Diablo 3849
San Francisco
Oakland
San Jose
Santa Cruz
Monterey
Fresno
Bishop
Mt Whitney 14494
San Luis Obispo
Bakersfield
Santa Barbara
Los Angeles
Long Beach
Barstow
Needles
Palm Springs
Blythe
San Gorgonio Mtn. 11490
San Diego
Tijuana
Salton Sea
PACIFIC OCEAN
KLAMATH MOUNTAINS
CASCADE RANGE
NORTHERN COAST RANGES
SACRAMENTO VALLEY
SIERRA NEVADA
SOUTHERN COAST RANGES
SAN JOAQUIN VALLEY
TRANSVERSE RANGES
PENINSULAR RANGES
SANTA LUCIA RANGE
PT REYES
FARALLON ISLANDS
PT SUR
PT CONCEPTION
SAN MIGUEL ISLAND
SANTA ROSA ISLAND
SANTA CRUZ ISLAND
SANTA CATALINA ISLAND
SAN NICOLAS ISLAND
SAN CLEMENTE ISLAND
Klamath River
Trinity River
Eel River
Mad River
Clear Lake Res.
Goose Lake
Upper Alkali Lake
Middle Alkali Lake
Lower Alkali Lake
Pit River
Lake Shasta
Eagle L.
Lake Almanor
Honey L.
Sacramento River
Lake Oroville
Feather R.
Yuba R.
American R.
L. Tahoe
L. Berryessa
Napa R.
Mokelumne R.
Stanislaus R.
Merced R.
San Joaquin River
San Luis Res.
Chowchilla R.
Mono L.
Owens River
Owens L. (dry)
Kings R.
Tulare Lake Bed
Tule R.
White R.
Kern R.
Poso Creek
Big Sur R.
San Antonio R.
Salinas River
Santa Maria R.
Santa Ynez R.
Santa Clara River
Rogers L. (dry)
Rosamond L. (dry)
Mojave River
Soda L. (dry)
Bristol L. (dry)
Cadiz L. (dry)
Danby L. (dry)
Santa Ana River
Colorado River
Amargosa River
Seeleys L. (dry)
Miles
25 12.5 0 25 50
Kilometers
40 20 0 40 80

Coast Redwoods

Del Norte Coast Redwoods State Park
Photo: California State Parks, 2020

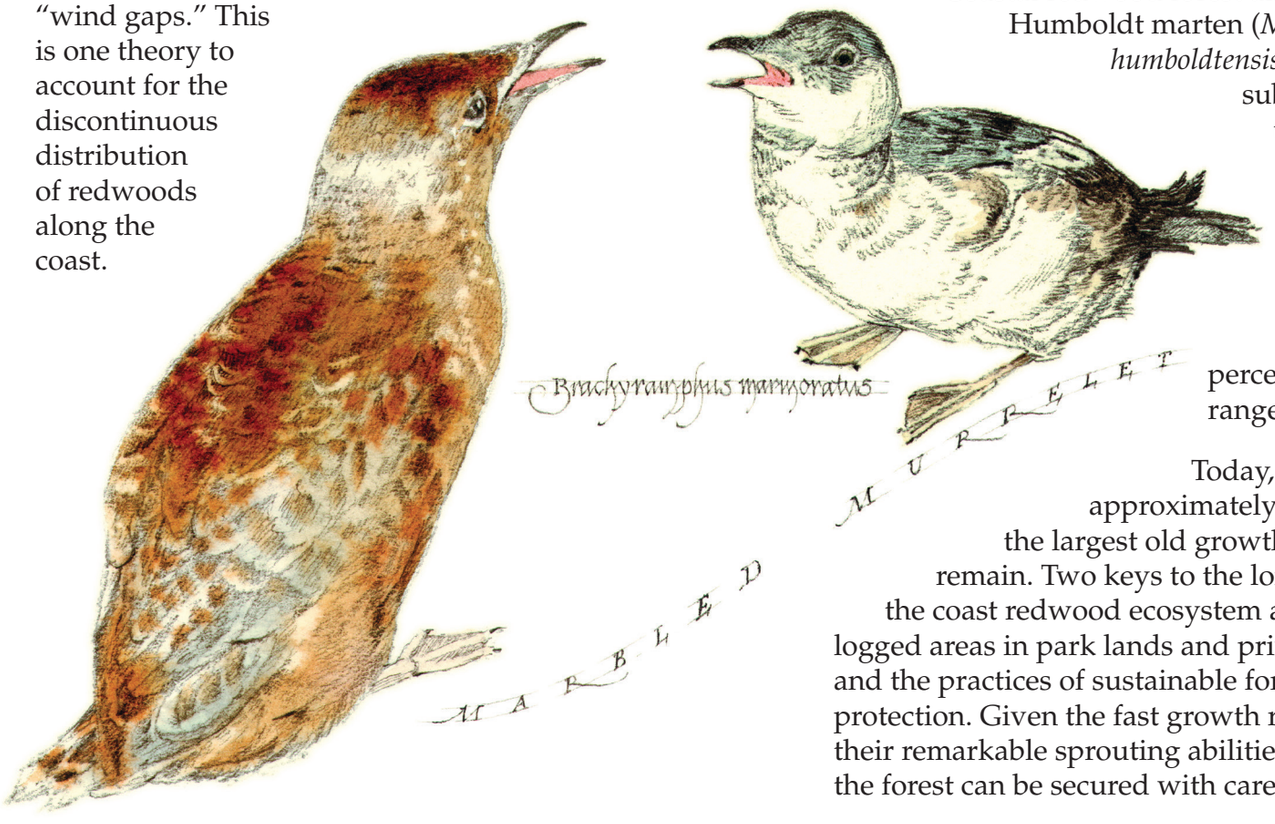
A magnificent contribution to the biodiversity of California is the coast redwood (*Sequoia sempervirens*), known as the world's tallest living tree. Many visitors are awestruck when standing amid old growth giants towering well over 300 feet skyward, with huge bases ranging in diameter from 10 to 25 feet.

Redwoods are remarkably adapted to sprouting new growth after falling, burning, or being cut. Fallen trees even serve as "nursery logs" where seedlings begin their growth in the deep, moist furrows of the long-lasting bark. Redwoods are also extremely long lived. In old growth forests, the average age is about 600 years, with a few trees exceeding 1,500 years.

Coast redwood forest is found only along the coast from southern Oregon to Monterey County. Coastal fog helps provide critical moisture during the drier summer months. Strong winds off major points such as Cape Mendocino and Point Reyes disperse the fog, causing "wind gaps." This is one theory to account for the discontinuous distribution of redwoods along the coast.

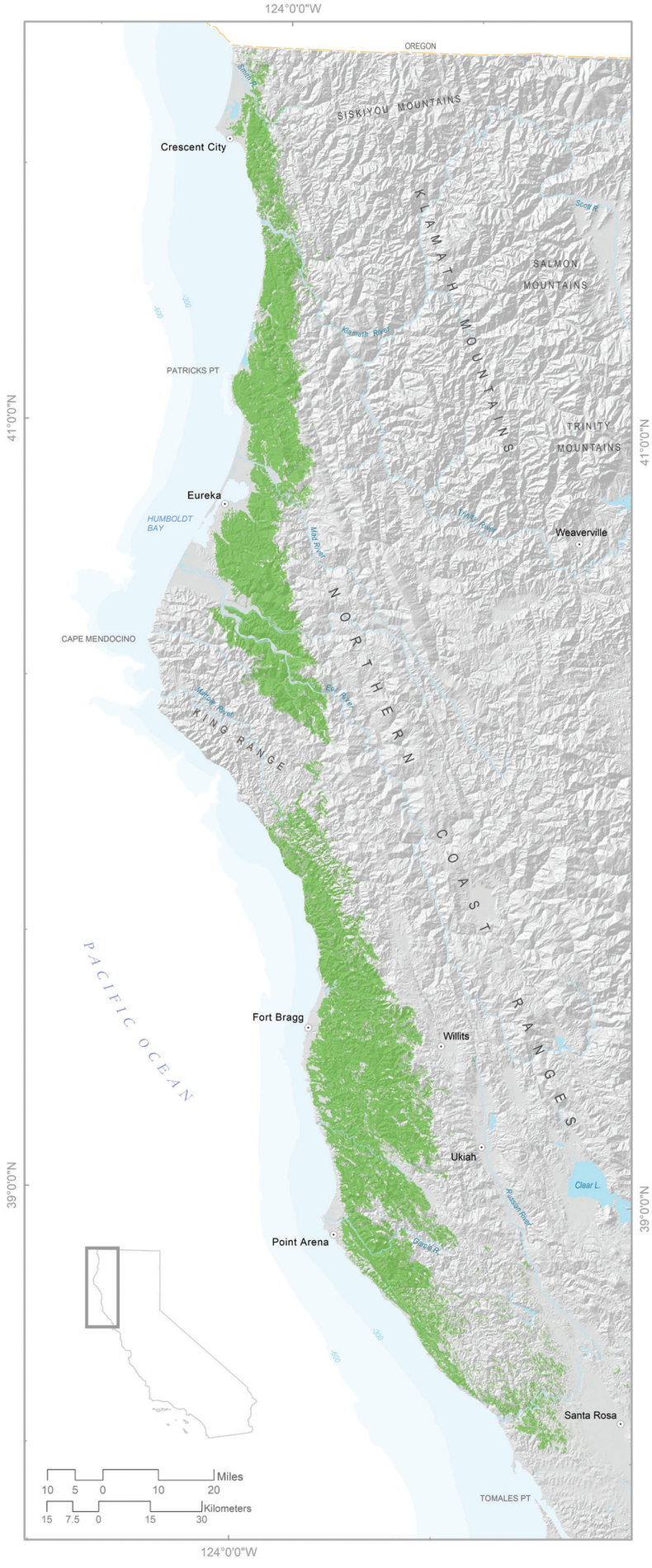
Summer fog is expected to decrease in the future as climate change alters sea surface temperatures (see the Climate Change chapter). This may also impact the distribution of coastal redwood forests.

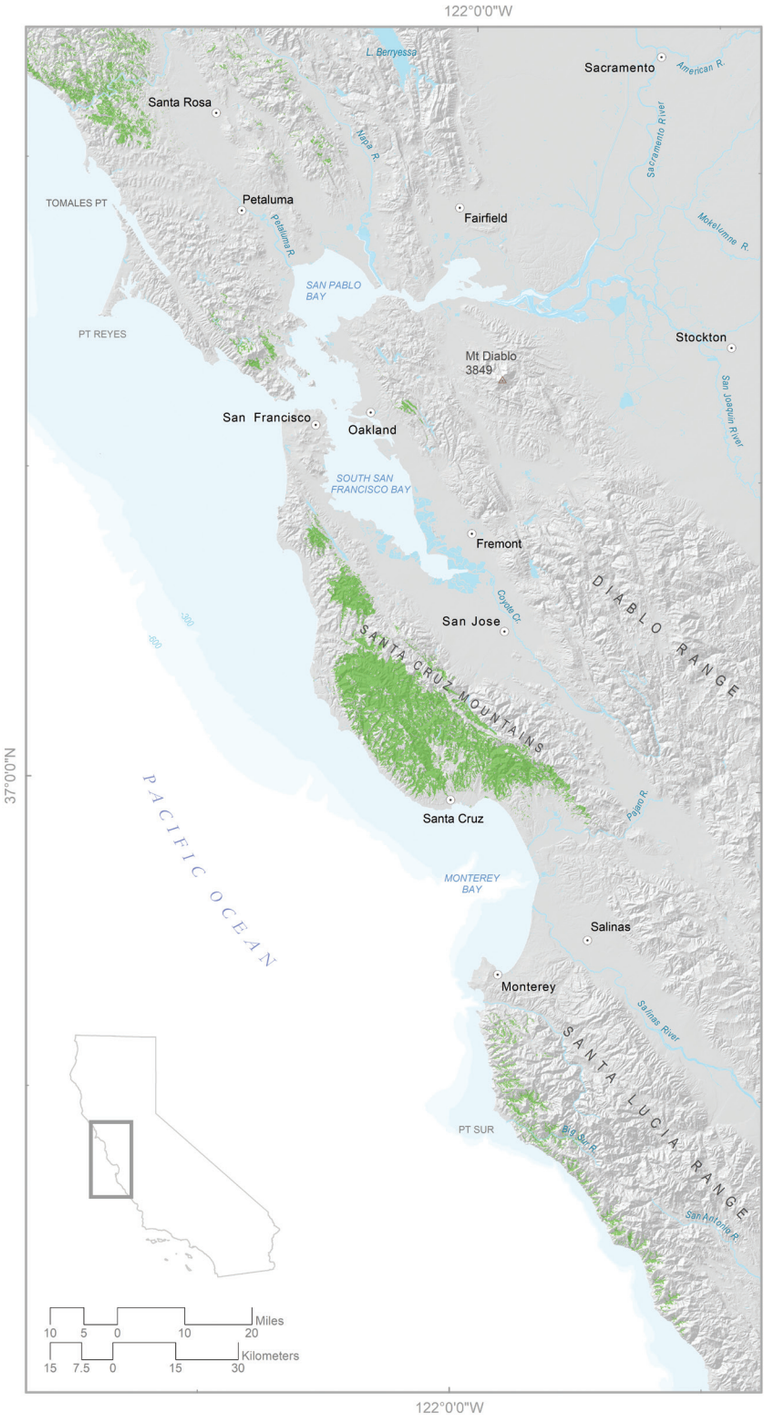
Some animals occur in higher densities in old growth redwoods than in harvested redwood forests. Examples include Marbled Murrelet (*Brachyramphus marmoratus*), an endangered seabird that nests in redwoods; Southern Torrent Salamander (*Rhyacotriton variegatus*); and Tailed Frog (*Ascaphus truei*). Coastal redwood forest also supports the Humboldt marten (*Martes caurina humboldtensis*). Only two subpopulations of this endangered marten have been observed in the northwest corner of the state, occupying less than seven percent of their historic range within California.



Today, it is estimated that approximately five percent of the largest old growth redwood forests remain. Two keys to the long-term viability of the coast redwood ecosystem are the regrowth of logged areas in park lands and private timber lands, and the practices of sustainable forestry and stream protection. Given the fast growth rate of redwoods and their remarkable sprouting abilities, the biodiversity of the forest can be secured with careful management.

Coast Redwoods





Coastal Redwood Distribution

Sources:
Vegetation – Sonoma County [ds2691]
California Department of Fish and Wildlife (2018a)
Classification and Assessment with Landsat of Visible Ecological Groupings (CALVEG)
U.S. Forest Service (2019)

Note:
Coastal Redwood data for Sonoma County extracted from *Vegetation – Sonoma County*, with the remainder of the state represented by CALVEG.

Oak Woodlands

Valley oak (*Quercus lobata*) woodland with lupines and grasses in Monterey County
Photo © Todd Keeler-Wolf

Oak woodlands are among California's most characteristic wildlife habitats. Scattered oak trees over green or golden brown grass, ranch houses and barns on gently rolling hills, and grazing cattle are typical scenes for many Californians traveling the state's country roads and highways.

Twenty-two species of oaks are found in California (Jepson 2019). They have adapted to fill many niches—from majestic woodlands of widely spreading trees in fertile valleys to tall narrow trees of shady northwestern coastal forests, and from low montane shrubs blanketed by winter snow to highly drought-tolerant shrubs growing adjacent to the hottest and driest of our deserts. Oak-dominated vegetation covers more than eight million acres of the state, ranging in elevation from sea level to over 9,000 feet. Although oaks occupy many important and varied habitats in California, it is our oak woodlands that are iconic.

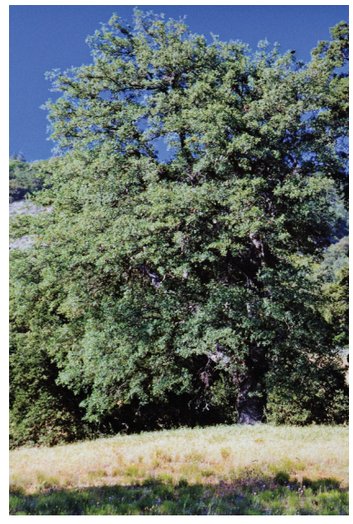
The Acorn Woodpecker (*Melanerpes formicivorus*) derives its name from its acorn collecting habits.
Photo © Timothy Floyd

Woodlands are mostly a mixture of widely spaced trees over grasses and other types of herbaceous vegetation. They are distinguished from forests based on the number of trees and the amount of canopy. Forests are dense, but woodlands have relatively open canopies. The most extensive oak woodlands in California are composed of mixtures of blue oak (*Quercus douglasii*) and interior live oak (*Q. wislizeni*); they occupy the foothills of the Inner Coast Range and the Sierra Nevada. The mixed oak woodlands of the Coast Ranges support among the highest diversity of oaks and resident animals.

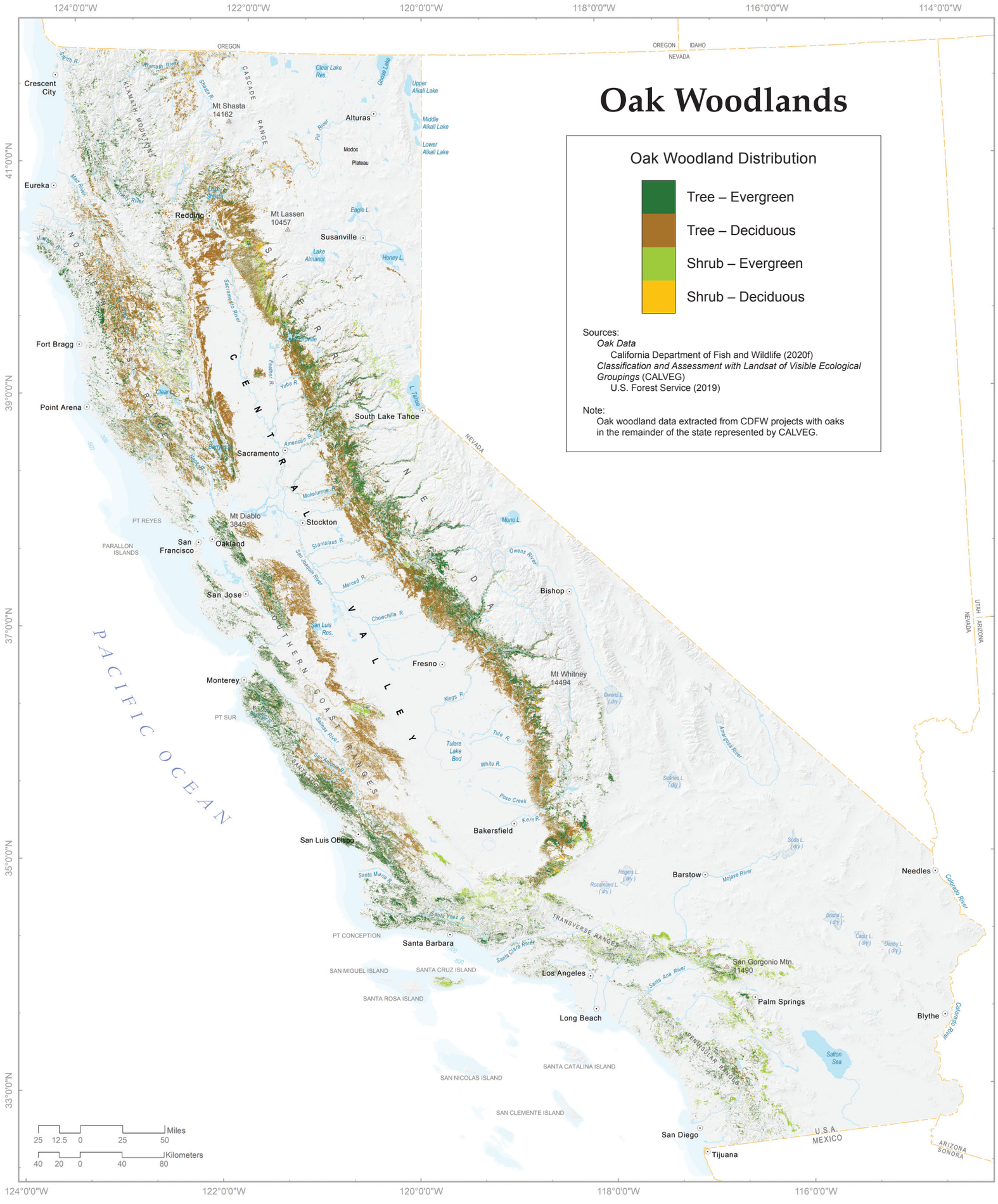
California's oak woodlands are home to more than 5,000 species of insects and over 330 species of amphibians, reptiles, birds, and mammals. All oaks produce acorns, often in massive amounts, a rich source of food for many species of animals. Island and California Scrub-Jays (*Aphelocoma insularis*, *A. californica*), the Acorn Woodpecker (*Melanerpes formicivorus*), and other birds depend upon oaks for food. Bears, mule deer, gray squirrels, and other mammals supplement their diets with acorns. Oak woodlands also support more than 1,500 species of plants, nearly 500 of which are rare or of limited distribution.

The map on the right shows the ranges of different types of oak-dominated vegetation communities. Iconic winter-deciduous oak woodlands, which drop their leaves in the fall, ring the Central Valley in the low foothills of the Sierra Nevada and Coast Ranges. Evergreen oak trees occupy higher foothills and mountain valleys. Shrub oaks are found adjacent to the deserts and at the highest elevations.

Canyon live oak (*Quercus chrysolepis*) forms a dense woodland on steep slopes above the Yuba River, Placer County.
Photo © Todd Keeler-Wolf



Engelmann oak (*Quercus engelmannii*) from the inland parts of San Diego County and adjacent counties of Southern California
Photo © Todd Keeler-Wolf


Oak Woodlands
Oak Woodland Distribution
Tree – Evergreen
Tree – Deciduous
Shrub – Evergreen
Shrub – Deciduous
Sources:
Oak Data
California Department of Fish and Wildlife (2020f)
Classification and Assessment with Landsat of Visible Ecological Groupings (CALVEG)
U.S. Forest Service (2019)
Note:
Oak woodland data extracted from CDFW projects with oaks in the remainder of the state represented by CALVEG.
124°0'0"W
122°0'0"W
120°0'0"W
118°0'0"W
116°0'0"W
114°0'0"W
41°0'0"N
39°0'0"N
37°0'0"N
35°0'0"N
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OREGON
IDAHO
NEVADA
UTAH
ARIZONA
Crescent City
Eureka
Redding
Fort Bragg
Point Arena
Mt Shasta 14162
Mt Lassen 10457
Alturas
Susanville
South Lake Tahoe
Sacramento
Mt Diablo 3849
Stockton
San Francisco
Oakland
San Jose
Monterey
Fresno
Bishop
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Bakersfield
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Santa Barbara
Los Angeles
Long Beach
Barstow
Palm Springs
San Gorgonio Mtn. 11490
Needles
Blythe
San Diego
Tijuana
U.S.A.
MEXICO
PACIFIC OCEAN
KLAMATH MOUNTAINS
CASCADE RANGE
SIERRA NEVADA
CENTRAL VALLEY
SOUTHERN COAST RANGES
TRANSVERSE RANGES
PENINSULAR RANGES
PT REYES
FARALLON ISLANDS
PT SUR
PT CONCEPTION
SAN MIGUEL ISLAND
SANTA CRUZ ISLAND
SANTA ROSA ISLAND
SANTA CATALINA ISLAND
SAN NICOLAS ISLAND
SAN CLEMENTE ISLAND
Miles
25 12.5 0 25 50
Kilometers
40 20 0 40 80

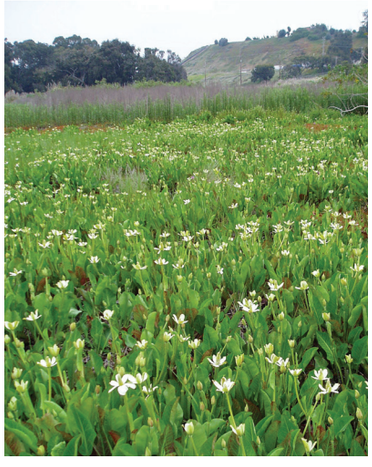
Wetlands and Riparian Habitats

Riparian woodland of California sycamore (*Platanus racemosa*) contrasts with drier upland oak woodland, Arroyo Seco, Santa Lucia Mountains. Photo © Todd Keeler-Wolf

Broadly characterized, California is a dry state. This condition is most noticeable during the seasonal drought of late spring to mid fall when the hills of grass are straw colored and many of the streambeds are without surface water. Notable exceptions to the "summer gold" of the hills and valleys are the riparian zones of the larger streams and rivers and the perennial wetlands associated with springs, lakes, and ponds.

Californian wetlands vary enormously in wetness. Many are flooded throughout the growing season and consist of lush green cattails, tules, and rushes. Others are only seasonally wet (see the Vernal Pools chapter), and some, such as desert playas, are ephemerally watered in rare precipitation events. Some wetlands appear dry but are kept moist below the surface for much of the year by groundwater. California's riparian forests and thickets are made up of water-dependent alders, cottonwoods, sycamores, and willows. Riparian and wetland habitats are frequently juxtaposed in California.

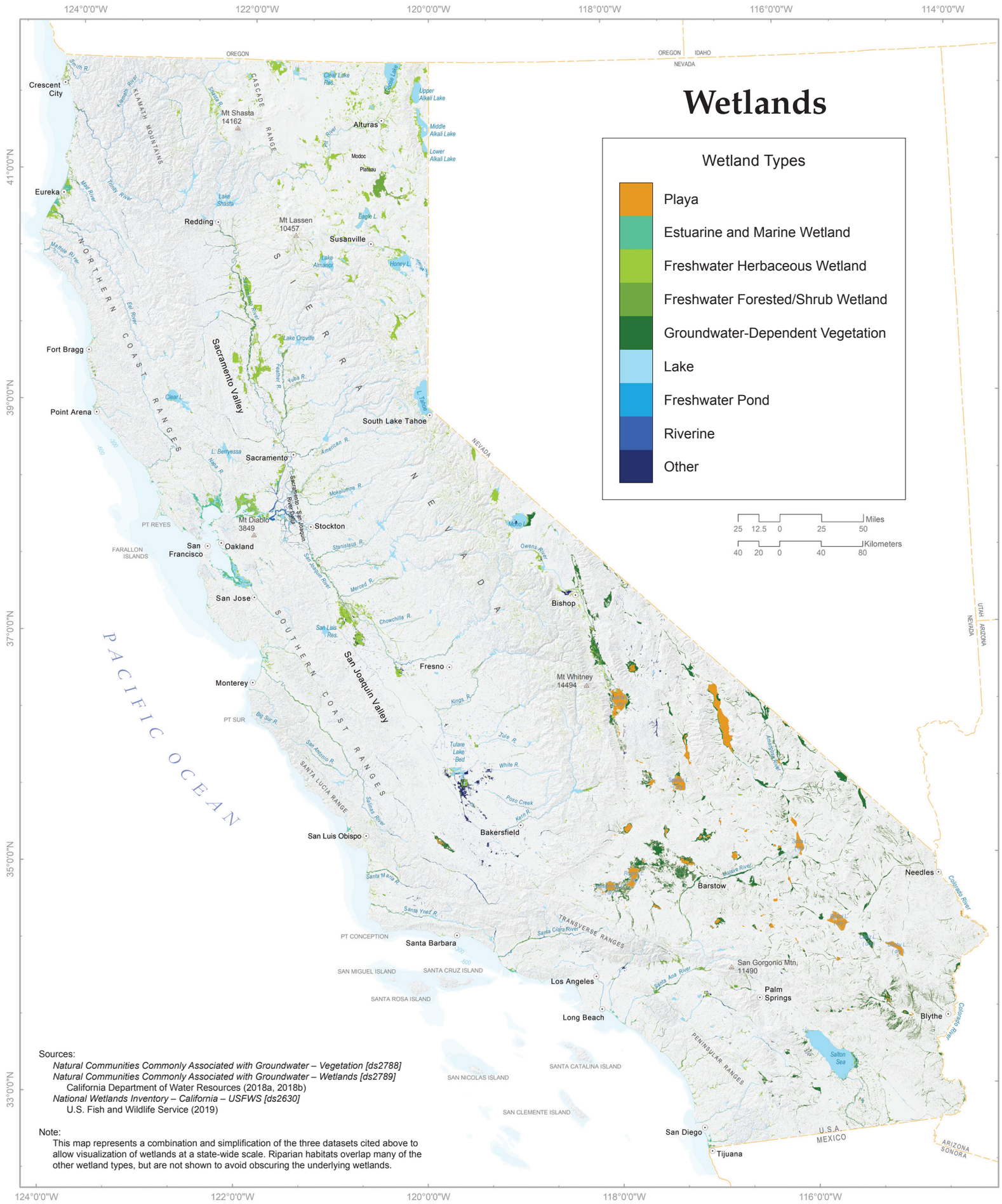
Wetland conditions vary greatly, from chemically harsh springs and ponds of desert basins to lush, flowery alpine meadows and fens. Wetlands of the coastal and interior salt marshes are inhabited by specially adapted plant species that tolerate salts by concentrating them, like pickleweed (*Salicornia pacifica*), or extruding them, like saltgrass (*Distichlis spicata*). Some animal species, such as Ridgeway's Rail (*Rallus obsoletus*) and the salt-marsh harvest mouse (*Reithrodontomys raviventris*), are only found in these environments. Riparian and wetland vegetation provide a rich source of food for many animal species. Yellow-billed Cuckoo (*Coccyzus americanus*), Least Bell's Vireo (*Vireo bellii pusillus*), and Willow Flycatcher (*Empidonax traillii*) are among the California birds highly restricted to riparian and freshwater wetland vegetation. The shade cast by riparian vegetation helps maintain cool temperature of streams and rivers, important to the health and productivity of aquatic animals from caddisflies to Chinook Salmon (*Oncorhynchus tshawytscha*). Riparian areas and wetlands also provide buffers to the catastrophic effects of flooding by retaining soil, encouraging the deposition of sediment, forming natural protective levees, and acting as chemical filters.



Yerba mansa (*Anemopsis californica*) at Ballona wetlands, Los Angeles County CDFW Photo: Todd Keeler-Wolf

Our wetlands and riparian habitats are highly limited, as shown on the map, but they are also highly diverse and productive ecosystems. Although the acreage is small, the diversity of species within these habitats is disproportionately high.

As a result of water's importance to our thirsty society, California's riparian and wetland vegetation have been decimated. Dams have reduced or eliminated the natural flooding cycles important to the regeneration of many kinds of riparian and wetland plants. Riparian vegetation has been physically removed and replaced by concrete embankments and levees maintained for flood control. Former natural channels have been replaced by tunnels and culverts. Groundwater pumping has reduced or eliminated groundwater-dependent ecosystems. Huge areas of the southern San Joaquin Valley and the Sacramento-San Joaquin River Delta that were once seasonally flooded and covered with a patchwork of tule marshes, swamps, vernal pools, riparian forests, and woodlands are now converted to agriculture. Loss of wetland and riparian habitat since European colonization of California is estimated to be 90 percent.



Sources:

Natural Communities Commonly Associated with Groundwater – Vegetation [ds2788]
Natural Communities Commonly Associated with Groundwater – Wetlands [ds2789]
California Department of Water Resources (2018a, 2018b)
National Wetlands Inventory – California – USFWS [ds2630]
U.S. Fish and Wildlife Service (2019)

Note:

This map represents a combination and simplification of the three datasets cited above to allow visualization of wetlands at a state-wide scale. Riparian habitats overlap many of the other wetland types, but are not shown to avoid obscuring the underlying wetlands.

Vernal Pools

Sonoma sunshine (*Blennosperma bakeri*)
CDFW photo: Annie Chang

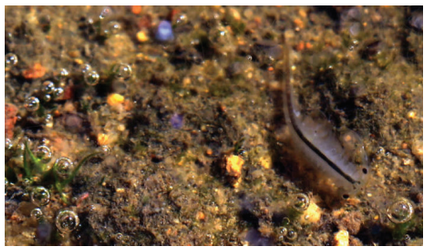
Vernal pools are seasonal wetlands that form in depressions in the soil surface. Because these depressions occur over an impermeable soil or rock layer, they hold rainwater longer than the surrounding terrain—long enough for unique plants and animals to thrive there. Vernal pools are known to occur in parts of the world that, like California, have a Mediterranean climate and areas of impermeable subsurface layers. Other parts of the world where vernal pools are known to occur include Chile and Western Australia.

California has one of the most extensive distributions of vernal pools known in the world. They are found throughout the state, from the Modoc Plateau in the northeast to the mesas of the south coast near San Diego. The map at right shows the distribution of vernal pool complexes in California. While vernal pool complexes of the valley and foothill grasslands of Central California are well known, vernal pools are also embedded in a variety of other natural communities, including shrublands and forests. For example, on the Modoc Plateau, the Devil's Garden vernal pool complex is surrounded by sagebrush scrub and juniper woodland. Many San Diego vernal pools are in chamise chaparral and coastal sage scrub habitats (Keeler-Wolf et al. 1998).

Vernal pools support plants and animals adapted to unique living conditions, which range from very wet to very dry each year. In the winter, pools become the watery home of shrimp, toads, and aquatic plants. In the spring, as the water begins to recede, colorful wildflowers bloom in concentric rings and attract ground-dwelling pollinator bees from the uplands nearby. As summer approaches, the pools begin to dry out. Plants tolerant of drier conditions emerge, dried eggs of fairy and tadpole shrimp fall into cracks in the mud, and spadefoot toads take to their burrows to await the next winter rains.

Golden flowers bloom in a vernal pool located at Flying M Ranch in Merced County. Mima mounds can be spotted in the back.
Photo © Kristi Lazar

Del Mar Mesa in San Diego County
CDFW photo: Jason Price

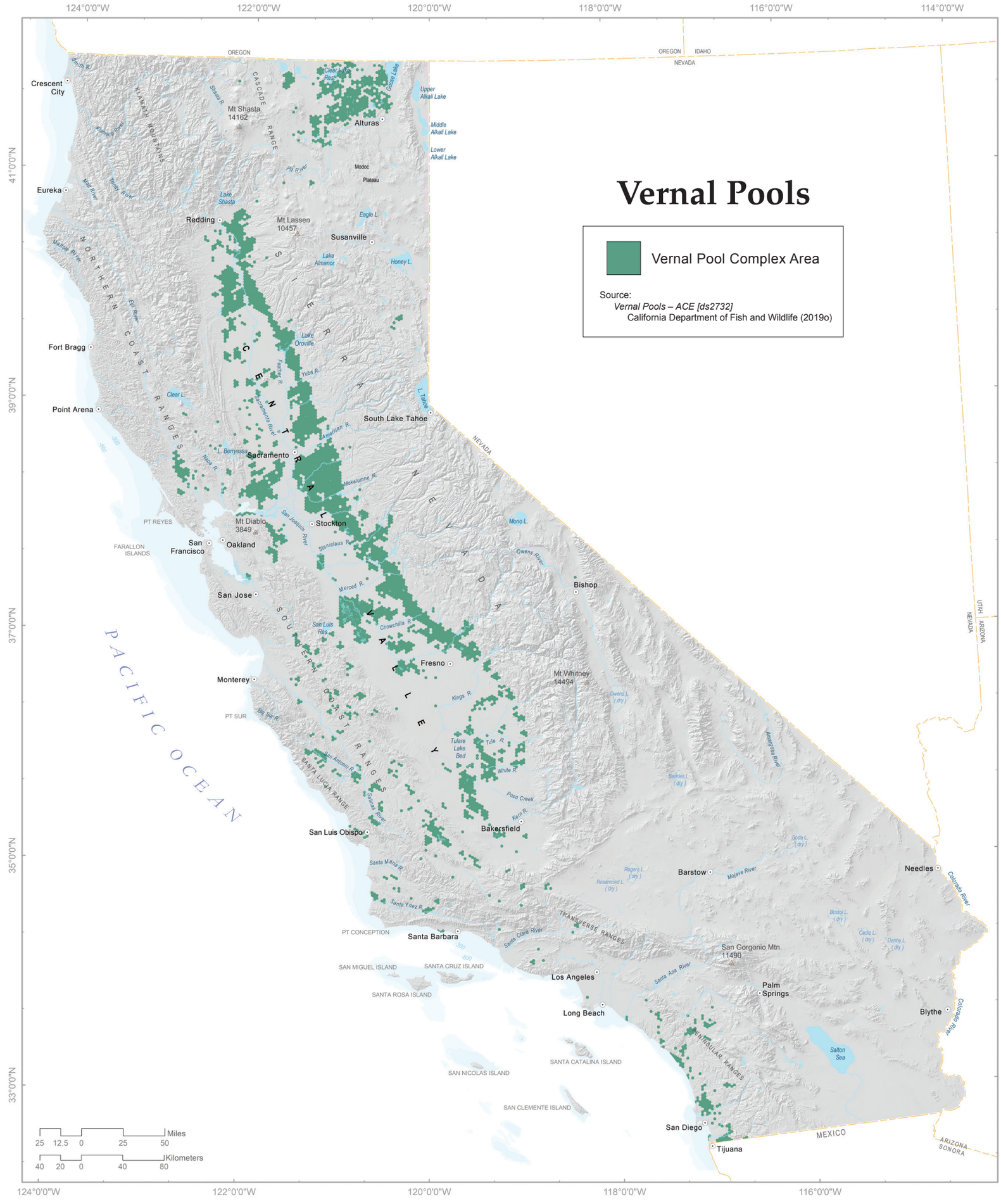


San Diego fairy shrimp (*Branchinecta sandiegonensis*)
Photo: Joanna Gilkeson, USFWS

Many vernal pool plant and animal species are endemic to a local region and are often designated by federal and state government as rare, threatened, or endangered. Typical species include varieties of minty-scented herbs (*Pogogyne* spp.), lemon-scented annual grasses (*Orcuttia* spp.), and delicate fairy shrimp (*Branchinecta* spp.). Another iconic inhabitant is the endangered California tiger salamander (*Ambystoma californiense*).

It is estimated that California's Central Valley alone once had four million acres of vernal pool habitat, which includes the pools themselves and the uplands around them. Today the Central Valley supports just under 770 thousand acres of vernal pool habitat. This loss is largely attributed to urban development and farming, which continue to threaten California's remaining vernal pools.

Otay Mesa mint (*Pogogyne nudiuscula*)
Photo: John Martin, USFWS


Vernal Pools
Vernal Pool Complex Area
Source:
Vernal Pools – ACE [ds2732]
California Department of Fish and Wildlife (2019o)
124°0'0"W
122°0'0"W
120°0'0"W
118°0'0"W
116°0'0"W
114°0'0"W
41°0'0"N
39°0'0"N
37°0'0"N
35°0'0"N
33°0'0"N
OREGON
IDAHO
NEVADA
UTAH
ARIZONA
MEXICO
PACIFIC OCEAN
Crescent City
Eureka
Redding
Fort Bragg
Point Arena
Mt Shasta 14162
Mt Lassen 10457
Mt Diablo 3849
Alturas
Susanville
South Lake Tahoe
Sacramento
Stockton
Oakland
San Francisco
San Jose
Fresno
Monterey
San Luis Obispo
Bakersfield
Santa Barbara
Los Angeles
Long Beach
Palm Springs
Barstow
Needles
Blythe
Bishop
Mt Whitney 14494
San Gorgonio Mtn. 11490
San Diego
Tijuana
Salton Sea
Lake Shasta
Clear Lake Res
Upper Alkali Lake
Middle Alkali Lake
Lower Alkali Lake
Modoc Plateau
Eagle L
Lake Almanor
Honey L
Lake Oroville
L Tahoe
Clear L
L Berryessa
Mono L
Owens River
Mokelumne R
San Luis Res
Chowchilla R
Merced R
Kings R
Tulare Lake Bed
Tule R
White R
Poso Creek
Kern R
Santa Maria R
Santa Ynez R
Santa Clara River
Santa Ana River
Mojave River
Colorado River
Owens L (dry)
Searles L (dry)
Soda L (dry)
Rogers L (dry)
Rosamond L (dry)
Bristol L (dry)
Cadiz L (dry)
Danby L (dry)
PT REYES
FARALLON ISLANDS
PT SUR
PT CONCEPTION
SAN MIGUEL ISLAND
SANTA CRUZ ISLAND
SANTA ROSA ISLAND
SANTA CATALINA ISLAND
SAN NICOLAS ISLAND
SAN CLEMENTE ISLAND
KLAMATH MOUNTAINS
CASCADE RANGE
NORTHERN COAST RANGES
SIERRA NEVADA
CENTRAL VALLEY
SOUTHERN COAST RANGES
SANTA LUCIA RANGE
TRANSVERSE RANGES
PENINSULAR RANGES
Miles
25 12.5 0 25 50
Kilometers
40 20 0 40 80

Trout

California Golden Trout (*Oncorhynchus mykiss aguabonita*) from Big Whitney Meadow shows the characteristic golden yellow body, orange stomach, and red lateral line.
CDFW Photo: Heritage and Wild Trout Program

Coastal Rainbow Trout (*Oncorhynchus mykiss irideus*) from Agua Blanca Creek displays plentiful spots on the body, white edges on the fins, and two eye spots.
CDFW Photo: Heritage and Wild Trout Program

California supports native trout taxa that occupy most cold, clean, freshwater ecosystems across the state. Their ability to adapt to the changes in climate and landscape over California's geologic history has resulted not only in a wide spectrum of trout diversity but one that represents a great range in color and beauty. As California's mountain ranges experienced bouts of uplift, volcanic episodes, and glaciation over time, ancestral trout populations became isolated and cut off from future hybridization (Behnke 1992). This has resulted in distinct groups of trout, representing a minimum of eleven forms that persist today, six of which are endemic to California. These groups include the golden trout of the Kern Plateau, redband trout in remote desert basins of Northern California and the McCloud River, divergent cutthroat trout in the eastern Sierra and in coastal redwood forests, and Coastal Rainbow Trout (*Oncorhynchus mykiss irideus*) that call most of the state's waters their home.

Periodic connection of the Kern River to the Central Valley via Tulare Lake allowed ancient lineages of trout to colonize the Kern River Basin. Subsequent geologic events created physical barriers to upstream fish movement that isolated these populations. Different evolutionary paths ultimately led to three different subspecies: California Golden Trout (*O. m. aguabonita*), Little Kern Golden Trout (*O. m. whitei*), and Kern River Rainbow Trout (*O. m. gilberti*).

Paiute Cutthroat Trout (*Oncorhynchus clarkii seleniris*) from Silver King Creek, showing the nearly spotless body and striking iridescent purplish hue that is characteristic of this trout. This unique species is considered one of the rarest trout in the world.
CDFW Photo: Heritage and Wild Trout Program

California has three subspecies of cutthroat trout, which are found in two drastically different parts of the state: Coastal Cutthroat Trout (*O. clarkii clarkii*), Lahontan Cutthroat Trout (*O. c. henshawi*), and Paiute Cutthroat Trout (*O. c. seleniris*).

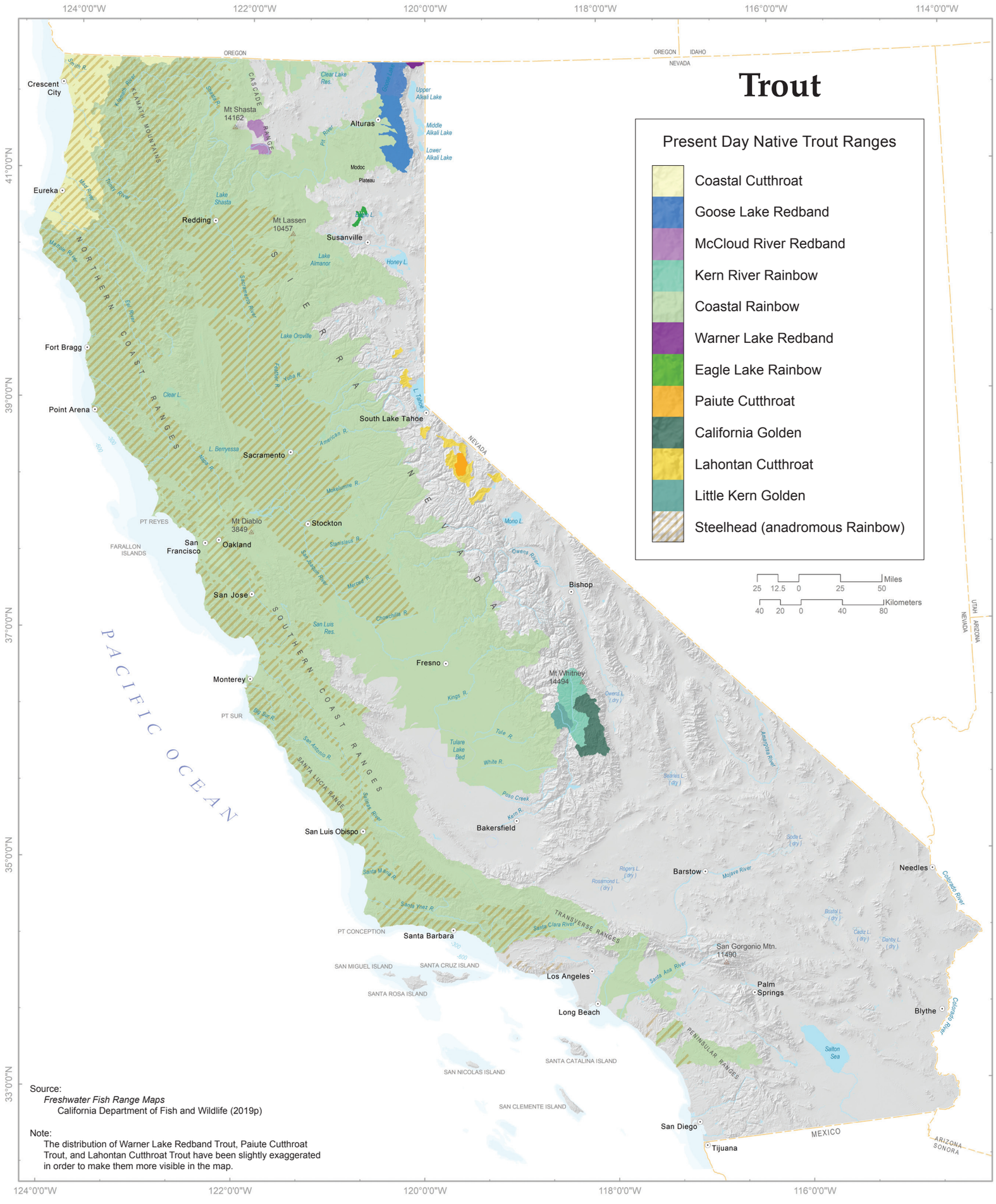
Coastal Cutthroat Trout live with Coastal Rainbow Trout in temperate rainforests, where Chinook and Coho Salmon are an important food source. Lahontan Cutthroat Trout evolved—along with a suite of other native fishes—in the ancient Lahontan basin. Lake Lahontan was a large lake system that covered much of western Nevada and extended into California during the Pleistocene epoch, then contracted following the Ice Age. Lahontan Cutthroat Trout's native waters in California are the Susan, Truckee, Carson, and Walker river drainages. Paiute Cutthroat Trout evolved from the Lahontan Cutthroat Trout in the upper reaches of Silver King Creek in the Carson River watershed.

Lahontan Cutthroat Trout (*Oncorhynchus clarkii henshawi*) from Wolf Creek, has pink and yellow body coloration, large plentiful spots, and distinct parr marks that are characteristic of the fluvial form of this trout.
CDFW Photo: Heritage and Wild Trout Program

Northern California's complex of redband trout showcases a history of isolation due to a reduction of Pleistocene-era waterbodies and geologic events. The McCloud River Redband Trout (*O. m. stonei*) in Northern California are descendants of ancestral redbands that reached the McCloud River through the Sacramento River and were eventually isolated by the development of large waterfalls. Eagle Lake Rainbow Trout (*O. m. aquilarum*) are genetically distinct from Coastal Rainbow Trout and other redband trout of northeastern California. Two additional forms of redband trout occupy desert basins in far northeastern California: Goose Lake Redband Trout (*O. m. ssp.*) and Warner Lakes Redband Trout (*O. m. ssp.*). Understanding of the biodiversity of California's redband trout should improve with more research on these interior trout forms.

For further reading regarding California's native trout, please see California Department of Fish and Wildlife's "An Angler's Guide to the California Heritage Trout Challenge."

Trout



Source:
Freshwater Fish Range Maps
California Department of Fish and Wildlife (2019p)

Note:
The distribution of Warner Lake Redband Trout, Paiute Cutthroat Trout, and Lahontan Cutthroat Trout have been slightly exaggerated in order to make them more visible in the map.

Mojave Desert

Joshua trees (*Yucca brevifolia*) in Joshua Tree National Park

Although considered the smallest North American desert, the Mojave Desert is the largest in California. It stretches over approximately one fifth of the state and extends into southwestern Utah and northwestern Arizona. The Mojave epitomizes much of what we consider to be the true desert of the American southwest. It is home to such desert icons as the Joshua tree (*Yucca brevifolia*), desert tortoise (*Gopherus agassizii*), desert bighorn sheep (*Ovis canadensis nelsoni*), Death Valley, and the lower reaches of the Grand Canyon of the Colorado River. The Mojave Desert is rich and varied, known for its stark beauty, rugged topography, and high biological diversity. For example, there are an estimated 1,400 native plant taxa in the Mojave Desert region of California, 40 of which are endemic to the state (Baldwin et al. 2002).

Mojave fringe-toed lizard (*Uma scoparia*)
Photo: U.S. National Park Service

The Mojave is a transitional desert lying midway between the cool Great Basin Desert to the north and the hot Sonoran Desert to the south. Alluvial fans and basins comprise much of the landscape of the Mojave Desert, with silt and sand forming skirts around the mountains and filling much of the basins. The alluvial fans are typically vegetated with creosote bush (*Larrea tridentata*)–burrobush (*Ambrosia dumosa*) scrub. The basins are vegetated with various salt-tolerant species. In some cases, the basins are so salty that no vegetation grows, and only remarkably flat playas and blinding white salt deposits exist. Lava outcroppings and more than a dozen dune systems occur in the Mojave. Many of the dunes are occupied by unusual plant and animal species such as Eureka dune grass (*Swallenia alexandrae*) and the Mojave fringe-toed lizard (*Uma scoparia*). Higher elevations may receive snow in the winter and support singleleaf pinyon pine (*Pinus monophylla*) and Utah juniper (*Juniperus osteosperma*), with limber pine (*Pinus flexilis*) and bristlecone pine (*Pinus longaeva*) at the highest elevations.

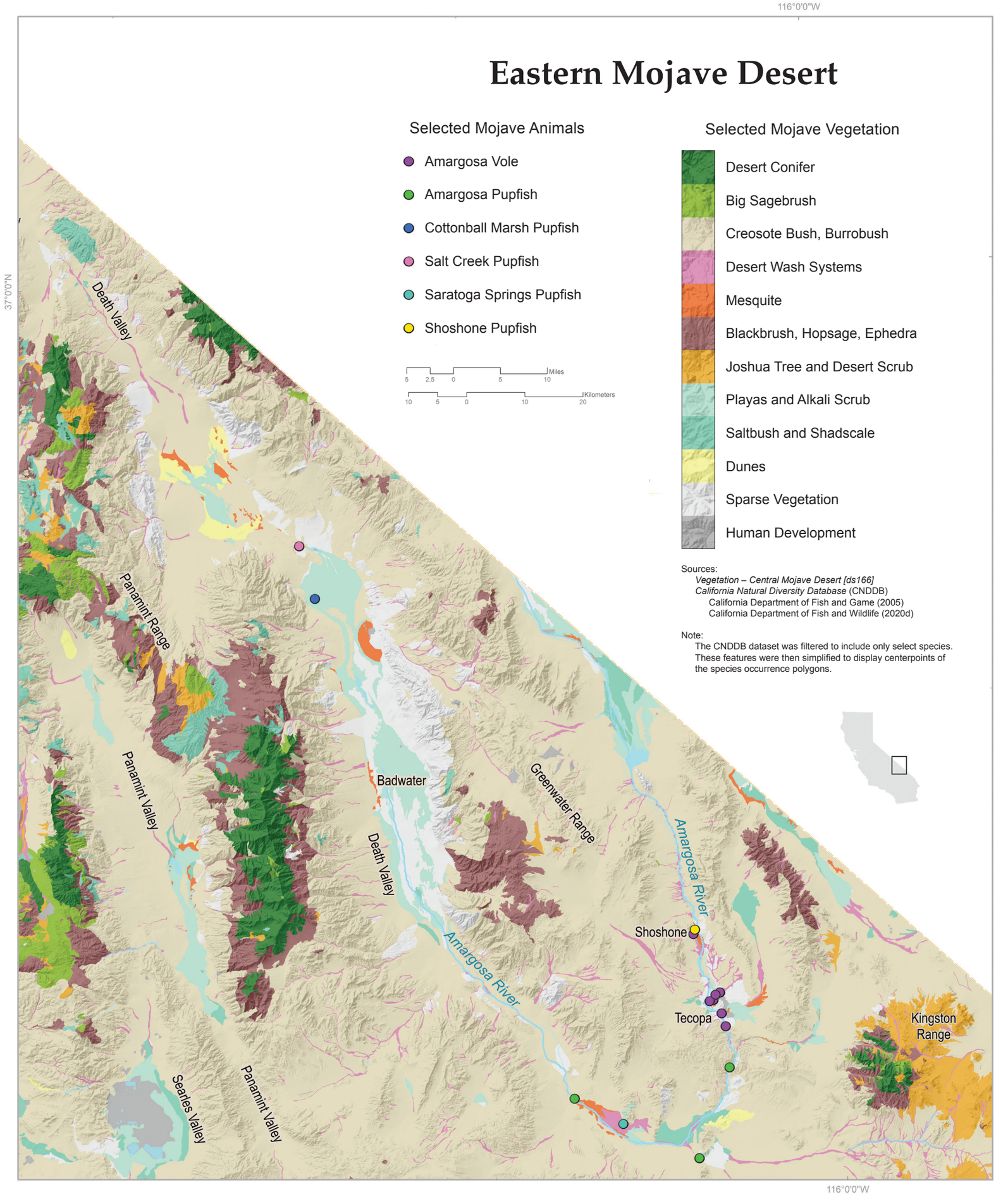
Due to climatic differences, western Mojave habitats differ from those to the east. In the western Mojave, one can find many winter annual herbs such as desert coreopsis (*Coreopsis bigelovii*), goldfields (*Lasthenia californica*), and California poppy (*Eschscholzia californica*). These and many other plants present spectacular wildflower displays in years with ample winter rainfall. The state-threatened and endemic Mohave ground squirrel (*Xerospermophilus mohavensis*) is also found here. To the east, where summer rains frequently occur, certain succulents such as Utah agave (*Agave utahensis*), Spanish bayonet (*Yucca baccata*), Mojave yucca (*Yucca schidigera*), and grasses such as big and little galleta (*Pleuraphis rigida* and *P. jamesii*) are common.

The Amargosa River starts near Beatty, Nevada and flows southerly into California before making a u-turn to terminate in the Badwater Basin of Death Valley (see map). It flows mostly underground, fed by groundwater and springs, but surfaces near the towns of Shoshone and Tecopa. These surface waters and scattered springs represent oases in an otherwise parched landscape. They support a variety of plants and animals, many of which are endemic to the region, including five of California's remaining seven pupfishes (*Cyprinodon* spp.), Amargosa speckled dace (*Rhinichthys osculus nevadensis*), and the endangered Amargosa vole (*Microtus californicus scirpensis*).

Salt Creek pupfish (*Cyprinodon salinus*)
Photo: U.S. National Park Service

Because the Mojave Desert is so close to major metropolitan areas, such as the Los Angeles Basin, and includes several rapidly growing cities, the once wild and unpopulated Mojave is now compromised by the influences of civilization, including recreation and renewable energy development. Careful planning and management will be required to sustain the fascinating and fragile ecosystems of the Mojave Desert.

Eastern Mojave Desert



Sources:
Vegetation – Central Mojave Desert [ds166]
California Natural Diversity Database (CNDDB)
California Department of Fish and Game (2005)
California Department of Fish and Wildlife (2020d)

Note:
The CNDDB dataset was filtered to include only select species. These features were then simplified to display centerpoints of the species occurrence polygons.

Central Valley Grassland Habitat

California's Central Valley grasslands are an important part of the state's rich natural heritage. Spanning about 450 miles north to south and connecting the Sierra Nevada with the inner Coast Ranges east to west, the Central Valley is the heart of California and supports grasslands covering almost 20 percent of California's valley land base.

Swainson's hawk (*Buteo swainsoni*)

For the Central Valley, the general term "grasslands" describes a mosaic of remnant native and extensive non-native or introduced plant communities. Many early accounts of the California Central Valley describe vast, colorful wildflower fields in the spring turning to dry fields of grasses in late summer (Paddison 1999). Today, Central Valley grasslands are dominated by agricultural lands and introduced species, but still retain some of the herbaceous components that historically defined these systems (Sawyer et al. 2009, Schoenherr 2017). The map to the right shows the extent of current grassland vegetation types and illustrates both the distribution and fragmentation of grasslands in the Central Valley.

Kern mallow (*Eremalche kernensis*)
CDFW Photo: Kristi Lazar

Despite these changes, Central Valley grasslands continue to host a surprising biodiversity. Thousands of insect species, hundreds of plant species, and dozens of bird, mammal, and reptile species use the remaining prairie as habitat. The unique geography and plant communities of the Central Valley are also a foundation for key ecosystem services that are essential to the human population. Parts of the Central Valley grassland mosaic provide natural water filtration and support native pollinators essential to both agriculture and California's rich native biodiversity, although at a fraction of their historical levels.

The grasslands are home to several special status species. Some threatened or endangered species, like the Blunt-nosed Leopard Lizard (*Gambelia sila*), are highly adapted to the soils and vegetation of the original valley floor and are almost entirely dependent on remaining habitat remnants. Others, like the Mountain Plover (*Charadrius montanus*) and Swainson's Hawk (*Buteo swainsoni*) have adapted to agricultural land uses that in some ways mimic historic Central Valley grassland conditions. Similarly, several endangered plant species like the California jewelflower (*Caulanthus californicus*), Hoover's wooly-star (*Eriastrum hooveri*), and Kern mallow (*Eremalche kernensis*) are part of the once extensive and highly adapted shrub-grassland complex of the southern San Joaquin Valley. About one quarter of all Species of Special Concern (those often most declining or vulnerable) also use Central Valley grasslands as breeding, foraging, or migratory habitat.

The Central Valley provides an ideal setting for urban, agricultural, and other land uses. As a result, only about 17 percent of the original Central Valley grasslands exist today compared to pre-European settlement times (Schoenherr 2017). This loss, the degradation of remaining native ecosystems, and the intensifying effects of climate change exert pressure on native plant and wildlife populations, driving some to near extinction. However, major habitat restoration and land conservation efforts, either currently underway or completed in the last two decades, provide hope that Central Valley grasslands and the species that depend upon them will be part of California's natural heritage future.

Mountain plover (*Charadrius montanus*)

Central Valley Grassland Habitat