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Acronyms and Abbreviations Used in This Report

5C Program	Five Counties Salmonid Conservation Program
AB	Assembly Bill
ABAG	Bay Area Association of Bay Area Governments
ACWA	Association of California Water Agencies
BLM	Bureau of Land Management
BMO	basin management objective
BO	biological opinion
CAL FIRE	California Department of Forestry and Fire Protection
CASGEM	California Statewide Groundwater Elevation Monitoring
CDPH	California Department of Public Health
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CIMIS	California Irrigation Management Information System
CPUC	California Public Utilities Commission
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CWA	Clean Water Act
CWC	California Water Code
DAC	disadvantaged community
DFW	California Department of Fish and Wildlife
DOF	California Department of Finance
DPR	Department of Pesticide Regulation
DWR	California Department of Water Resources
EI	energy intensity
EIR	environmental impact report
EIS	environmental impact statement
EP	effective precipitation

ESA	Endangered Species Act
ET	evapotranspiration
ETo	reference evapotranspiration
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FRG	Fisheries Review Group
GAMA	Groundwater Ambient Monitoring and Assessment
GHG	greenhouse gas
GWMP	groundwater management plan
gpm	gallons per minute
GPS	global positioning system
HBMWD	Humboldt Bay Municipal Water District
HCP	habitat conservation plan
HIP	high population scenario
HVT	Hoopa Valley Tribe
IRWM	integrated regional water management
KBRA	Klamath Basin Restoration Agreement
KHSA	Klamath Hydroelectric Settlement Agreement
kw/af	kilowatt hours per acre-foot
KWPA	Klamath Water and Power Agency
LLC	limited liability corporation
LLNL	Lawrence Livermore National Laboratory
LOP	low population growth scenario
maf	million acre-feet
mgd	million gallons per day
MHI	median household income
MSL	mean sea level
MTBE	methyl tertiary butyl ether

MWh	megawatt-hour
NCIRWMP	North Coast Integrated Regional Water Management Plan
NCRP	North Coast Resource Partnership
NCRWMG	North Coast Regional Water Management Group
NCRWQCB	North Coast Regional Water Quality Control Board
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NWR	National Wildlife Refuge
PA	planning area
PCB	polychlorinated biphenyl
PCP	pentachlorophenol
PG&E	Pacific Gas & Electric Company
POA	Plan of Action for Phase II
RCD	resource conservation district
RCTWG	Redwood Coast Tsunami Work Group
ROD	Record of Decision
RPA	reasonable and prudent alternative
RPS	Renewables Portfolio Standard
RVCWD	Redwood Valley County Water District
RVIT	Round Valley Indian Tribes
RWMG	regional water management group
RWQCB	regional water quality control board
SB	Senate Bill
SCWA	Sonoma County Water Agency
SWAMP	Surface Water Ambient Monitoring Program
SWN	State Well Number System
SWRCB	State Water Resources Control Board

taf	thousand acre-feet
THP	timber harvest plan
TMDL	total maximum daily load
TPZ	timber production zone
TRD	Trinity River Diversion
TRFEFR	Trinity River Flow Evaluation Final Report
TRFES	Trinity River Flow Evaluation Study
UKL	Upper Klamath Lake
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VBF	variable base flow
WAMP	watershed adaptive management plan
WDR	waste discharge requirements
WRCC	Western Regional Climate Center
YT	Yurok Tribe

Eel River Valley, near Fortuna, CA. The Eel River watershed, the state's third-largest, covers 3,684 square miles and runs south to north for more than 800 miles before emptying into the Pacific Ocean. The Eel River is one of several North Coast rivers that have received State and/or federal Wild and Scenic designation, thus ensuring that it is preserved in a free-flowing condition.

North Coast Hydrologic Region

North Coast Hydrologic Region Summary

The North Coast Hydrologic Region is a unique setting with an extreme diversity of land use and climate. Land use includes aquaculture and larger urban areas near the coast to large cattle operations and low populations in the high mountain deserts. Ranching, farming, rural residential, timber harvest, vineyards, marijuana cultivation, U.S. Forest Service, and park land uses are prevalent. Variation in climate is immense with high precipitation along the coastal mountains to desert conditions in the Modoc Plateau. This chapter begins with an overview of the region, describing the setting and conditions within the region. Topics include information on the watersheds and sub-watersheds in the region with emphasis on developed resources. The chapter continues with a review of activities concerning resource administration and laws affecting resource management. This chapter concludes with a discussion of suggested resource management strategies to help assist local water managers in planning for future water needs.

Current State of the Region

Setting

The North Coast Hydrologic Region encompasses coastal areas, redwood forests, inland mountain valleys, and the semi-desert-like Modoc Plateau (see Figure NC-1). The dominant topographic features in the region are the California Coast Ranges, the Klamath Mountains, and Modoc Plateau. The mountain crests, which form the eastern boundary of the region, are about 6,000 feet in elevation with a few peaks higher than 8,000 feet. Much of the region is mountainous and rugged; only 13 percent of the land is classified as valley or mesa, and more than half of that is in the higher-elevation northeastern part of the region in the upper Klamath River Basin.

The North Coast Hydrologic Region is one of 10 hydrologic regions defined by the California Department of Water Resources (DWR). It shares boundaries with the North Coast Region as defined in Section 13200(a) of Porter-Cologne Water Quality Control Act, which divides the state into nine regional board boundaries:

> North Coast region, which comprises all basins including Lower Klamath Lake and Lost River Basins draining into the Pacific Ocean from the California-Oregon state line southerly to the southerly boundary of the watershed of the Estero de San Antonio and Stemple Creek in Marin and Sonoma Counties.

The North Coast Region is divided into two natural drainage basins, the Klamath River Subbasin and the North Coastal Subbasin. The North Coast Hydrologic Region covers all of Del Norte, Humboldt, Trinity, and Mendocino counties, major portions of Modoc, Siskiyou, and Sonoma counties, and small portions of Glenn, Lake, and Marin counties.

The North Coast Region encompasses a total area of approximately 19,390 square miles, including 340 miles of scenic coastline and remote wilderness areas, as well as urbanized and

Figure NC-1 North Coast Hydrologic Region

agricultural areas. The region is characterized by distinct temperature zones. Along the coast, the climate is moderate and foggy, and the temperature variation is not great. For example, at Eureka, the seasonal variation in temperature has not exceeded 63 °F for the period of record. Inland, however, seasonal temperature may range into 100 °F or higher.

Precipitation over the North Coast region is greater than over any other part of California, and damaging floods are a fairly frequent hazard. Particularly devastating floods occurred in the North Coast area in December of 1955, in December of 1964, in February of 1986, and over New Year's of both 1997 and 2006.

Watersheds

The North Coast region includes many watersheds and basins within its boundaries. Each of the main region's boundaries as defined by DWR, the State Water Resources Control Board (SWRCB), and the North Coast Integrated Regional Water Management Plan (NCIRWMP) coincide with each other. According to the NCIRWMP, several subbasins exist including the Klamath River Subbasin, North Coastal Subbasin, North Coast River Basin, Russian River and Bodega watersheds, each containing many subareas within their boundaries (see Figure NC-2).

Klamath River Subbasin

The Klamath River Subbasin contains Klamath River and all of its tributaries (including Trinity River), the Smith River and its tributaries, Applegate, Illinois, and Winchuck rivers and includes the closed Lost River and Butte Valley hydrologic drainage areas. The western portion of the subbasin is within the Klamath Mountains and Coast Ranges provinces, characterized by steep, rugged peaks ranging to elevations of 6,000 to 8,000 feet with relatively little valley area. The mountain soils are shallow and often unstable. Precipitation ranges from 60 to 125 inches per year in the western portion. The 45-mile coastline is dominated by a narrow coastal plain where heavy fog is common. The eastern portion of the basin receives low to moderate rainfall and includes predominantly high, broad valleys such as the Butte, Shasta, and Scott valleys. The Lost River and Butte Valley hydrologic areas are located in the Modoc-Oregon Lava Plateau. This area is characterized by broad valleys ranging from 4,000 to 6,000 feet in elevation. Typical annual precipitation is 15 to 25 inches. The Shasta Valley hydrologic area lies principally within the Cascade Range. The valley floor elevation is about 2,500 to 3,000 feet, and surrounding mountains range up to 14,162 feet (Mount Shasta). Annual precipitation ranges from below 15 inches in the valley to over 60 inches in the mountains. The Scott River hydrologic area is in the Klamath Mountains to the west of Shasta Valley. The valley floor elevation is also about 2,500 to 3,000 feet, with surrounding mountain ranges up to approximately 8,500 feet. Annual precipitation ranges from below 20 inches in the valley to over 70 inches in the western mountains.

Klamath River Watershed (Oregon and California)

The Klamath is the second largest river in California with an extensive watershed of almost 16,000 square miles including portions of California and Oregon. The Klamath River begins north of Klamath Falls, Oregon, and meets the Pacific Ocean near the town of Klamath, California. For the sake of this discussion, the Klamath Basin is divided into three areas; the upper, middle, and lower Klamath subbasins. Hydrologic subbasins within the Klamath Basin include Butte Valley, Lost River, Salmon River, Scott River, Shasta River, and Trinity River.

Figure NC-2 North Coast Hydrologic Region Watersheds

There are 84 creeks and rivers below Iron Gate Dam and 471 miles of spawning habitat that have been identified by the California Department of Fish and Wildlife (DFW, formerly California Department of Fish and Game).

The Upper Klamath subbasin encompasses the area upstream of the Iron Gate Dam. Only a small part of this area is located in California. The primary subwatershed in California is the Lost River watershed, which covers approximately 1,689 square miles and includes Clear Lake Reservoir in Modoc County. The area around Clear Lake is characterized by high desert streams and is sparsely populated. Land uses in the California portion of the Klamath Basin are primarily cropped agriculture, grazing, and lands administered for the Klamath Basin National Wildlife Refuge. The basin is subject to many complex jurisdictional issues associated with water delivery and utilization of water infrastructure facilities including issues related to irrigation, hydropower, endangered species, tribal rights, and lake level management demands.

The Middle Klamath subbasin is contained wholly within California extending from Iron Gate Dam to the confluence of Scott River about 10 miles upstream from Seiad Valley, excluding the Shasta and Scott rivers. However, the Middle Klamath subbasin is influenced by adjacent Klamath River subbasins (the Upper Klamath, Lower Klamath, and Trinity River drainages) and by the direct effects of tributary rivers (the Shasta and Scott rivers) which flow into the Klamath within the area of the Middle Klamath subbasin. The lower, more western portion has a coastal influenced climate and is dominated by U.S. Forest Service (USFS) lands while the upper, more eastern portion has a drier climate with mixed federal and private ownership.

The Lower Klamath subbasin begins below the confluence of the Klamath and Scott rivers, extending to the Klamath River delta at the Pacific Ocean. Trinity River watershed, although tributary to the Klamath in this subbasin, is considered its own watershed and is not in the Lower Klamath subbasin. The major industry in the watershed is silviculture and some limited mining. Salmon fishing has occurred in the basin since Native American occupation, although since 2006 the commercial fishery has been restricted due to record low populations.

During very wet years, the Mid and Lower Klamath subbasins can flood along the rivers to the extent that many of the communities become stranded. This presents a difficult situation for both those stranded and rescue workers: Power outages occur, bridges can be inundated, roads made impassable, and people with health issues left without power or services necessary for their welfare; e.g., oxygen supplies for those with respiratory problems and other basic necessities such as potable water, heat, and food.

Shasta River Watershed

The Shasta River watershed includes an 800 square-mile area of Siskiyou County. Mount Shasta to the south dominates the landscape, towering higher than 14,000 feet. However, melting snow from Mount Shasta does not contribute significantly to surface flows in the upper Shasta River because runoff sinks into the porous volcanic soils and reappears as springs on the Shasta Valley floor. The headwaters of the Shasta River are near Mount Eddy in the southwest portion of the basin. Except for Mount Shasta, Mount Eddy is the tallest mountain in Siskiyou County and the highest peak in the Klamath Mountains at 9,025 feet. The upper river above Dwinell Reservoir is swift and falls in elevation rapidly. The river below Dwinell Reservoir is much slower and meanders along the Shasta Valley floor. Springs in this reach add to flows and provide much needed cool water for juvenile salmon and steelhead in summer. The Klamath Mountains to the west, strip most of the moisture from ocean air currents as they move eastward. The Shasta Valley itself receives only 11 to 17 inches of rain annually. Because so little rain falls in the Shasta Valley during the growing season, ranchers rely heavily on streamflows and groundwater to irrigate crops and to water livestock. The economy of Shasta Valley, like that of Siskiyou County generally, relies on ranching, farming, tourism, and minimal timber harvesting. Sport-fishing opportunities still draw visitors to Siskiyou County because of numerous mountain lakes and productive streams. However, due to environmental constraints, fish are no longer planted in many of the mountain lakes. Yreka and Weed contain the largest populations in this subwatershed. Potable water in Shasta Valley predominantly comes from groundwater. Growth in the valley has brought about potable water supply issues especially along the mid to lower Shasta River in the rural areas of the valley floor. Development continues at a slow pace due to stressed groundwater supplies in these areas. Although plans exist for further development, and permits have been obtained to build, potable groundwater continues to be a limiting factor to expansion.

Scott River Watershed

The Scott River watershed is a large area with substantial variation in geology and climate. The watershed drains approximately 520,600 acres of land. Major tributaries to the 58-mile-long Scott River in Scott Valley include Shackleford-Mill, Kidder (although dry in the summer), Etna, French, and Moffett creeks, including the South and East Forks of the Scott River. Native vegetation consists of riparian vegetation along the streams, mixed-conifer forest on the western mountain slopes, with scattered meadows and brush. The eastern mountains are covered by extensive areas of brush, oak, western juniper, and both annual and perennial grasses. The confluence of Scott and Klamath rivers is located approximately 10 miles upstream (along Klamath River) from Seiad Valley. The Scott River drainage is bordered to the west and south by 7,000- to 8,000-foot elevation mountain ranges, including the Marble, Salmon, Trinity Alps and Scott mountains. These ranges exert a strong orographic effect on incoming storms, which allows the higher elevation mountains, along the west and south side of the Scott drainage, to receive 60 to 80 inches of precipitation annually. In contrast, the rain-shadow effect of the westside mountains reduces the amount of annual precipitation to 12 to 15 inches on the east side of the watershed. Fort Jones, located at the northern end of Scott Valley, averages 21 inches of precipitation, although rainfall has ranged from 10 inches in 1949 to 35 inches in 1970 showing the variability in the climate. Most of the precipitation in the Scott River watershed falls on the west side, with snow prevailing during the winter above the 5,500-foot level. Snowfall is an important component of the water supply for the region. Due to the geography of the Scott Valley, during very wet years it can rain so much that the valley becomes a lake, affecting traffic and agricultural operations.

Salmon River Watershed

The Salmon River flows from the Trinity Alps, Marble, Russian, and Salmon mountains joining the Klamath River at Somes Bar, California, and is the second largest tributary to the Klamath next to Trinity River. The watershed is almost entirely public land (Klamath National Forest) containing rugged topography that is deeply incised by the river and its tributaries. Nearly the entire watershed is forested. There are no dams, diversions, urban areas, or major industry in the watershed so the water is very high quality. In addition, there are no dams between the Salmon River and the ocean, making it completely accessible to anadromous fish. The cool, clean waters of the Salmon River are critical to the overall health of the Klamath River fishery. The Salmon River provides genetic stock and quality habitat for fish and other aquatic life making this watershed of great importance to the recovery of larger Klamath River watershed. Elevations in the watershed range from 456 feet at its mouth to 8,560 feet at Caribou Mountain in the Trinity Alps. The Salmon River remains culturally significant to the Shasta and Karuk people, some of whom continue to reside on the river. Approximately 67 percent of the watershed is in the Karuk Tribe's Ancestral Territory. Mean annual precipitation in the Salmon River watershed ranges from about 35 inches in the South Fork Salmon River Canyon to about 85 inches in the headwaters of North Fork/Little North Fork and Wooley Creek. The amount of precipitation generally decreases in an easterly direction, and increases with elevation due to orographic effects. Seasonal precipitation patterns include considerable snow, particularly at higher elevations. Approximately 90 percent of the precipitation occurs from October to May. The remainder occurs during summer thunderstorms. Winter precipitation occurs mainly as snow above 4,000 feet, with rain below 4,000 feet elevation. Fluctuation of the snow level occasionally results in rain falling on snow, causing rapid snowmelt. Intense, localized summer showers occur frequently and have been associated with soil erosion and debris torrents.

Trinity River Watershed

The Trinity River Basin drains an area of approximately 2,900 square miles of mountainous terrain. The Trinity River is the largest tributary to the Klamath River. From its headwaters in the Klamath Mountains, the river flows 172 miles south and west through Trinity County, then north through Humboldt County and the Hoopa Valley and Yurok Indian reservations to its confluence with the Klamath River at Weitchpec. Much of the watershed is prone to seismically induced landslides, especially during winter months when soils are saturated. Additionally, inner valley gorges are considered highly unstable. Groundwater resources are relatively plentiful throughout the watershed, but are not well defined. Annual precipitation averages 57 inches a year with a low of 37 inches in Weaverville and Hayfork and a higher rainfall of 75 inches in Trinity Center and 85 inches in the Hoopa Mountains. There are occasional summer thunderstorms that produce extensive runoff and may start wildfires.

The Trinity River watershed is primarily rural with human populations centered near Trinity Center, Weaverville, Lewiston, Hayfork, and Hyampom. Timber harvest has traditionally been a large factor in the economy on both federal and private land. The USFS and the Bureau of Land Management (BLM) manage approximately 80 percent of the land in the Trinity watershed; of the remaining 20 percent, about half are industrial timberlands.

In the early 1950s, two major water-development features were installed above river-mile 112 and the community of Lewiston on the Trinity River. In 1955, the Trinity River Division Act authorized the Trinity River Diversion (TRD). The TRD consists of Lewiston Dam and its reservoir and related facilities and Trinity Dam and its reservoir (known as Trinity Lake). The TRD project diverts a majority of the upper-basin's water yield at Lewiston for power generation and to support the U.S. Bureau of Reclamation's (USBR) Central Valley Project (CVP). The hydrologic changes produced by the TRD project have altered stream-channel conditions and instream habitat for many miles below Lewiston. Trinity River downstream of the TRD provides habitat not only for anadromous salmonids and other native species, but also the non-native brown trout. Operations of the TRD began in 1964 and were integrated with operations of Shasta Dam.

Water quality in the Trinity River Basin ranges from the high quality, pristine waters that emerge from the Trinity Alps wilderness to various degrees of impairment in the main stem and southern tributaries, which are caused in part by human activity. Timber harvest, road construction, and associated activities are recognized as sources of sedimentation and high summer water temperatures. Mining for gold, both currently and historically, is also a source of impairment. Recreational instream suction dredging (mining) causes sedimentation, especially in the main stem and canyon areas, and legacy effects from historic gold mining include acid mine drainage and mercury pollution. Please see section "Regional Resource Management Conditions" for more information on instream mining (suction dredge mining). Marijuana cultivation in this watershed as well as others has also become a source of pollutants that can affect water quality in a number of ways. Increased sediment load caused by land clearing and road building for marijuana farms causes increased turbidity and sediment deposition, both of which can have negative effects on salmonids (and other aquatic organisms) during multiple stages of their life cycle. Fertilizers cause increased nitrogen levels and can lead to algal blooms and decreased dissolved oxygen. Pesticides are toxic to many aquatic organisms. Water diversions for marijuana cultivation can cause cumulative impacts to streamflows and diminish cold water inputs, which are crucial for juvenile salmonids during the summer months.

Smith River Watershed (Oregon and California)

The Smith River is formed by the confluence of its Middle and North forks in Del Norte County, in the extreme northwest corner of California, near the community of Gasquet. The Middle Fork originates in Del Norte County, approximately 60 miles northeast of Crescent City, and flows west. The North Fork Smith River originates in Oregon on the northeast slope of Chetco Peak in the Siskiyou Mountains. The South Fork Smith River enters the Smith River near the community of Hiouchi, California. The South Fork rises on the eastern edge of the Smith River National Recreation Area, approximately 30 miles east-northeast of Crescent City, flowing southwest and then northwest. From the confluence with the South Fork, the Smith River flows generally northwest, entering the Pacific Ocean near the community of Smith River, approximately 10 miles north of Crescent City.

The Smith River estuary is located in Del Norte County near the community of Smith River. The watershed is about 614 square miles. The Smith is the longest wild and scenic river in the United States; as such, there are no impoundments. The Smith River system is the second largest free-flowing river in California next to the South Fork Trinity River. It is considered one of the best fishing regions in the United States with steelhead, Chinook, and other game fishes present. The region receives from 80 to 120 inches of rainfall annually.

In the Smith River Basin, no significant surface water development has occurred. Domestic, agricultural, and industrial water needs are supplied through surface water diversions and groundwater pumping. Further major developments on the Smith River and any of its tributaries are forbidden by the 1972 California Wild and Scenic Rivers Act. However, minor surface water supply projects for high value crops in the Smith River area are possible. Because of both its geology and its limited development, the Smith River is one of the healthiest river systems in California.

Federal land management dominates the Smith River Basin. Six Rivers National Forest manages the Smith River Recreation Area, which includes 305,000 acres, or 476 square miles of the watershed. Siskiyou National Forest manages 91 square miles of the basin within Oregon. Redwood National and California Department of Parks and Recreation (California State Parks) have jurisdiction in 25 square miles of the watershed. The total land managed by government agencies is about 83 percent of the watershed, which leaves 126 square miles in private ownership, predominantly in the lower river basin.

In the Smith River Plain, along the coast from the Oregon border to south of Smith River, is found the majority of farming activities within the watershed — excluding timber — including tulips, lilies, pasture, hay, cattle, and a few field crops. This area is predominantly self-supplied with groundwater for irrigation purposes. Due to runoff from farming, groundwater quality issues exist with concerns about potential groundwater contamination. In addition, climate change will have its affects on the watershed (please refer to “Climate Change” section within this document).

North Coastal Subbasin

The North Coastal Subbasin consists of rugged, forested coastal mountains, including six major river systems: the Eel, Russian, Mad, Navarro, Gualala, and Noyo rivers. In addition, among others, the North Coastal Subbasin includes the Mattole and Garcia rivers and Redwood and Stemple creeks. Soils are generally unstable and erodible, and rainfall is high. The area along the eastern boundary of the basin is mostly National Forest land administered by the USFS. Major population areas are centered on Humboldt Bay in the northern portion of the basin and around Santa Rosa in the southern portion. The Santa Rosa area is on the northern fringe of the greater San Francisco Bay urban area and has experienced rapid population growth in the period following the Second World War. The economy of the remainder of the basin has developed more slowly than other areas in California.

Humboldt Bay Regional Watershed

The Humboldt Bay watershed is considered to encompass water bodies that drain to the Pacific Ocean from Humboldt Bay north to Redwood Creek. The major river systems in the watershed are the Mad River and Redwood Creek. Other water bodies within this watershed include Humboldt Bay and Mad River Slough, coastal lagoons (Big, Stone, and Freshwater lagoons) and streams (Elk and Little rivers and Freshwater, Jacoby, and Maple creeks). In the east, the terrain is elevated hill slope with coastal plain occurring in the west. Precipitation ranges from 32 to 98 inches annually. The streams support production of anadromous salmonids, including steelhead and cutthroat trout, coho and Chinook salmon.

Humboldt Bay is a unique coastal feature on the North Coast and will confront many interesting and difficult water quality, commerce, and human health and safety issues as the effects of climate change become more pronounced. Potential impacts from climate change to the Humboldt Bay area include modifications to Highway 101, wastewater treatment facilities, aquaculture facilities, industrial facilities, Humboldt Bay nuclear power plant, agriculture, wetlands and wetland functions, and native species and habitat to name a few.

Humboldt Bay is an important commercial and recreational shellfish growing and harvesting area and provides the largest port between San Francisco and Coos Bay, Oregon. Urbanized areas include Trinidad, McKinleyville, Arcata, and Eureka; and rural residential areas are scattered throughout the watershed. The majority of the population lives in the Humboldt Bay area cities of Arcata and Eureka.

The Eureka waterfront was the site of several industrial operations that left the soil and groundwater contaminated with heavy metals, petroleum products, and pentachlorophenol's (PCPs). The waterfront is now undergoing redevelopment, and decontamination efforts continue.

Redwood Creek

Redwood Creek flows into the Pacific Ocean near the town of Orick located about 35 miles north of Eureka. Redwood Creek drains a 285 square-mile area and is about 67 miles long. The watershed is located entirely within Humboldt County.

Redwood Creek is a basin of mixed ownership and contains a rich blend of industrial and non-industrial timberlands, coastal and upland agricultural lands, State and federal national parks, other federal properties, and the unincorporated town of Orick. Redwood Creek supports three federally listed as threatened salmonids species as well as the non-listed coastal cutthroat trout and resident fish species. The watershed also provides domestic water supplies to rural communities and recreational opportunities.

Redwood Creek is a model watershed where government agencies, private landowners, nonprofit organizations and the local communities are cooperating to restore and protect water quality and the associated aquatic and riparian resources, providing economic opportunity to the Orick community. The watershed has a rich history of scientific studies that spans decades and well-established cooperation between groups with seemingly conflicting interests. The watershed is home to pioneering work in watershed restoration and erosion control.

The Redwood Creek watershed is a mixed ownership of private (56 percent) and public (44 percent) lands. More than 90 percent of the private lands are managed for timber production and ranching by eight private landowners. The upper two-thirds of the watershed contain vast expanses of timber and ranch lands managed primarily by seven landowners. Timberlands have been maintained in large unbroken tracts of lands, which have slowed rural residential development in upland areas. Located along the coast, the small town of Orick is the only municipality in the watershed and has a population of about 357 people (2010 U.S. Census). Orick is relatively isolated from other north coast communities and qualifies as a "disadvantaged community." (See "Demographics" section, subsection "Disadvantaged Communities.")

Redwood National Park and Prairie Creek Redwoods State Park are located in the lower part of the Redwood Creek basin. This subbasin has been extensively researched and is considered a "reference watershed" that displays nearly pristine conditions and is home to significant old growth stands of coast redwood. The protection of streamside redwoods along Redwood Creek was a central issue for the establishment and expansion of Redwood National Park and is linked to upstream watershed conditions.

In the upper reaches of Redwood Creek, the sub-division of one of the large tracts of private land has incidentally led to many small-scale marijuana gardens, potentially leading to increases in sedimentation, fertilizer and pesticide runoff, and lower flows within the watershed.

Mad River

The Mad River watershed has a long history of timber harvest on both USFS and private land with gravel mining still occurring in the lower portions of the watershed. Private landowners conduct grazing and limited agriculture in the flat areas along the river. The Mad River is Clean Water Act (CWA) section 303(d) listed for sediment and temperature impacts. The primary issues for water quality are forestry related, with urbanization and associated industrial and public non-point-sources. The drinking water for most of the Humboldt Bay area is supplied by Ranney Collectors in Mad River with other coastal streams providing drinking water for other communities. Ruth Reservoir on the Mad River has a season of impoundment of the natural flow (impaired flows) and a season when releases increase flows above natural levels (augmented flows), thereby continuously supplying water to the Mad River. (Ruth Reservoir has a 48,030 acre-foot storage capacity.) Although these supplies are dependent on adequate precipitation and flows throughout the season, the watershed continues to supply sufficient water for the demand.

Eel River

The Eel River watershed is a magnificent resource in North Coastal California. Running south to north, this watershed is the state's third-largest, covering 3,684 square miles. Stretched out, the river and its tributaries would be 3,448 miles long. The main stem stretches more than 200 air miles and more than 800 river miles from the headwaters above Lake Pillsbury in Lake County to the ocean.

The main tributaries to the Eel River are the Van Duzen River, the Bear River, and Yager, Larabee, Bull, and Salmon creeks. Lake Pillsbury is located near the headwaters of the main stem Eel. The upper watershed is mountainous, and soils are steep and highly erodible. In the west, the river meanders on a coastal plain and is joined by the Salt River before entering the Pacific Ocean. Several dairies are located on the coastal plain, as well as several small towns. Other communities in the watershed include Scotia, Garberville/ Redway, Laytonville, and Willits. In many of the alluvial valleys, surface water and groundwater are closely connected, thus surface water withdrawals have a substantial effect on local groundwater supplies. A Northwestern railroad line following along the Eel River has fallen into disrepair due to numerous landslides and accidents. Currently, there are no plans to revive the railroad due to the high cost of highway realignment and construction. The Eel River watershed is a well-known recreation destination with numerous State and private campgrounds along its length; beneficial uses include both water contact and noncontact uses such as swimming and boating. The river also supports a large recreational fishing industry being the third largest producer of salmon and steelhead in the state. Due to the erodible soils, steep terrain, and land use history, there is significant concern for the viability of this anadromous fishery resource.

The Eel River has received both State (1972) and federal (1981) Wild and Scenic River designation, a title which is to protect the river from dams and ensure that environmental concerns rank equally with development and industry. Many tributaries are affected by small surface-water diversions for agriculture (often marijuana cultivation) and other uses. These diversions may cause cumulative impacts to flows. In addition, these diversions may cause mortality for juvenile salmonids and other aquatic organisms if diversions are not screened or are improperly screened.

A long-standing transfer of water occurs downstream from Lake Pillsbury at Cape Horn Dam (Van Arsdale Reservoir) moving water from the Eel River to the Russian River watershed (PG&E's Potter Valley Project). This out-of-basin transfer from the Eel River to the Russian River began in 1908 with the Eel River Power and Irrigation Company. The purpose of this project was to supply the nearby town of Ukiah with electricity and improve streamflows in the

Russian River for municipal, industrial, and agricultural uses. The areas served by this water have become dependent on this source, creating pressure to continue the diversion in opposition to full restoration of the Eel River to its pre-diverted state. For additional information on the Potter Valley Project, see “Project Operations” section in this report.

North Coast Rivers Basin

The North Coast River Basin also contains other major watersheds not listed above. These include the Bear River, Mattole River, Ten Mile River, Noyo River, Big River, Albion River, Navarro River, Greenwood, Elk and Alder creeks, Garcia River, Gualala River, and the Russian and Bodega watersheds.

Bear River

Bear River is a coastal stream located to the north of the Mattole River watershed draining approximately 53,287 acres to the Pacific Ocean. The connection between the Bear River and the Pacific Ocean is periodically blocked by a temporary sand bar during summer low flow. The lagoon-type estuary is approximately one-quarter mile in length. The two major land uses in the basin consist of agricultural grazing and timber harvest. Humboldt Redwood Company (formerly Pacific Lumber) owns 16,537 acres of land in the upper portion of the watershed, all of which is covered by its 1999 Habitat Conservation Plan (HCP). The majority of remaining acreage in the watershed is in private ownership (36,839 acres), and 161 acres are managed by California State Parks.

Mattole River

The headwaters of the Mattole River begin in Mendocino County, and it flows north 62 river miles, through steep, forested lands in Humboldt County and into the ocean 10 miles south of Cape Mendocino. Tributaries to the Mattole River include Mill, Squaw, Bear, Thompson, Honeydew, and Bridge creeks. The watershed encompasses approximately 304 square miles and is subject to varying rainfall. Near the coast, the river receives about 50 inches per year while near the headwaters, about 115 inches of rainfall occurs per year. The largest communities are Petrolia, Honeydew, and Whitethorn, but the 2,000-person population is scattered throughout the watershed. Small landowners (those with less than 450 acres) own about 43 percent of the watershed. The BLM owns about 12 percent, and commercial timber companies own most of the remaining land. Silviculture and ranching are the predominant businesses. As mentioned above, the Mattole watershed has ranches and many small private land holdings. The upper Mattole River has a water storage program for rural residents to forbear water diversion during low flow for the benefit of coho salmon and other aquatic species.

Water quality problems are those associated with timber harvest, road building, forest conversion, and overgrazing. In addition, an increase in marijuana cultivation in this watershed has led to increased road building and forest conversion in the rural areas, affecting water quality. Fish species known to inhabit the Mattole River include coho, Chinook, steelhead, rainbow trout, and brook lamprey; other species include the southern torrent salamander and tailed frog.

Ten Mile River

The Ten Mile River watershed covers approximately 120 square miles. It is about 8 miles north of the City of Fort Bragg and shares ridges with Pudding Creek and the North Fork of the Noyo River to the south and Wages Creek and the South Fork of the Eel River to the north. Elevations range between sea level and 3,205 feet. Near the coast, the terrain comprises an estuary and a broad river floodplain with more rugged mountainous topography in the eastern portion of the watershed. Most of the basin, except the northeast grasslands, coastal plain, and estuary, is characterized by narrow drainages bordered by steep to moderately steep slopes. The watershed has abundant rainfall and cool temperatures during the winter with dry, warm summers interspersed with breezes and coastal fog. Precipitation in the western part of the watershed is about 70 inches per year while about 40 inches per year occurs in the eastern part of the watershed.

The watershed is entirely privately owned. Hawthorne Timber Company, LLC, which is managed by Campbell Timberland Management, LLC, owns about 85 percent of the watershed. Three small non¬industrial timber owners and a few residences make up the remainder of the ownership. The watershed has a long history of timber harvest.

The coldwater fishery that supports coho, Chinook, and steelhead is the primary and most sensitive beneficial use in the watershed. Protection of these species is considered to protect any of the other beneficial uses identified in the watershed that could be impaired due to water quality.

Noyo River

The Noyo River watershed encompasses the 113 square-mile coastal drainage system immediately west of the City of Willits, flowing into the Pacific Ocean at the City of Fort Bragg. The climate consists of moderate temperatures — an annual average of 53 °F — and an average annual rainfall of 40 to 65 inches.

Silviculture is the primary land use within the watershed. Approximately 50 percent of the watershed is owned by two commercial silviculture operations: the Mendocino Redwood Company and Hawthorne Timber Company (managed by Campbell Timberland Management). The Jackson Demonstration State Forest (administered by the California Department of Forestry and Fire Protection — CAL FIRE) encompasses about 19 percent of the watershed. Critical Coastal Areas in the vicinity of the watershed include Pudding Creek, Noyo River, and the Pygmy Forest Ecological Staircase. Minor land uses in the basin include ranching and recreation. The mouth of the Noyo River contains a marina and fish processing facilities in support of the local commercial fishing industry. The Noyo is the primary drinking water source for the City of Fort Bragg and also provides habitat for steelhead, coho, and Chinook. It is listed as impaired by sediment, due in part to timber harvest, grazing, and related human activities.

Big River

The Big River watershed drains about 181 square miles. The watershed drains from east to west, and shares ridges with the Noyo River watershed to the north, the Eel River watershed to the east, and the Little, Albion, and Navarro River watersheds to the south. The Big River estuary is located immediately south of the town of Mendocino. The climate is characterized by a pattern of low-intensity rainfall in the winter and cool, dry summers with coastal fog. Mean annual precipitation is approximately 40 inches near the western part of the watershed on the coast and about 51 inches at Willits to the east. The eastern part of this watershed receives more rainfall due to the orographic effect.

The predominant current and historical land use is silviculture with less area used for ranching. The largest community is the town of Mendocino. Together, the five largest property owners — four private timber companies and Jackson State Demonstration Forest — own 83 percent of the watershed. Thirty-one property owners own another 14 percent of the land (parcels from 160 acres to 3,760 acres), and private residences make up the rest of the land use.

Albion River

The Albion River watershed drains approximately 43 square miles. It drains primarily from east to west, and shares ridges with the Big River watershed to the north and northeast and the Navarro River watershed to the south and southeast. The Albion River estuary is located near the town of Albion, about 16 miles south of the City of Fort Bragg. Elevations range from sea level to 1,566 feet, and the watershed is dominated by relatively flat marine terraces that extend several miles inland and are incised by gorges carved by the major river channels and streams. The climate in the watershed is characterized by a pattern of low intensity rainfall in the winter and cool, dry summers with coastal fog. Mean annual precipitation is about 40 inches near the western margin of the watershed and about 51 inches to the east at Willits. The main tributaries of the Albion River include Railroad Gulch, Pleasant Valley Creek, Duck Pond Gulch, South Fork Albion River, Tom Bell Creek, North Fork Albion River, and Marsh Creek.

More than half of the watershed (54 percent) is owned by Mendocino Redwood Company. Smaller industrial timberland ownerships, some ranches, and numerous smaller parcels that are mostly residences comprise the other half. The predominant historical and current land use is silviculture, with some agricultural and recreational uses. The Albion River estuary, which remains open to the sea year round, is used as a commercial and sport-fishing harbor for small boats. The river and estuary have historically served as habitat for coho, Chinook, and steelhead. Beneficial uses associated with the coldwater fishery are the most sensitive of the beneficial uses in the watershed; protection of these beneficial uses is thought to protect other beneficial uses harmed by excessive sediment.

Navarro River

The Navarro River watershed encompasses approximately 315 square miles. The Navarro River flows through the Coast Ranges, Anderson Valley, and into the Pacific Ocean. It is the largest coastal basin in Mendocino County. Rainfall averages about 40 inches per year at Philo and mostly occurs between December and March.

Land uses in the watershed include silviculture (70 percent), rangeland (25 percent), and agriculture (5 percent) with a small percentage devoted to rural residential development. Timber production, ranching, and other agricultural activities are historical activities that continue to the present day, but the fishery has decreased. Anderson Valley today supports orchards and a growing viticulture industry.

Navarro River and most of its tributaries are designated by the SWRCB as fully appropriated. As such, no additional surface water diversions can occur without SWRCB review and approval (University of California Cooperative Extension 2013).

Greenwood Creek

The Greenwood Creek watershed encompasses approximately 25 square miles and is located on the southern Mendocino Coast with Greenwood Ridge as its northern border, Clift Ridge as its southern border, and Signal Ridge as its eastern border. Greenwood Creek is a Class I coastal stream and provides habitat for steelhead and coho salmon.

Land use in the watershed is primarily for timber production, viticulture, fruit orchards, residential, and some cattle ranching. Most of the watershed is privately owned. Mendocino Redwood Company holds about 60 percent as Timber Production Zone (TPZ) land, and approximately 50 smaller landowners own the rest of the watershed. The only public land in or adjacent to Greenwood Creek is Greenwood State Beach, which contains the Greenwood Creek estuary and a small parcel owned by the Elk County Water District.

Garcia River

The Garcia River watershed encompasses approximately 114 square miles in southwestern Mendocino County. The river forms an estuary that extends from the ocean to the confluence of Hathaway Creek. The floodplains of the lower portion of the watershed are primarily cropland.

The primary historical land uses include silviculture, dairy ranching, and gravel mining; these have not changed during the past two decades. Timber-harvesting remains the dominant land use activity, but land conversion to hillside vineyards is becoming a concern for production of sediment. The watershed is completely privately owned by multiple owners. The river and estuary provide habitat for salmonids, and identified beneficial uses include commercial and sport-fishing. The Garcia River has been listed as impaired due to sediment.

Gualala River

The Gualala River watershed encompasses about 300 square miles; the Gualala River flows from Mendocino County to Sonoma County in a north-south direction, reaching the ocean at the town of Gualala. The watershed contains mostly mountainous terrain where tributaries flow through steep valleys with narrow floors that contain erodible soil. Most of the annual precipitation occurs between October and April, with the greatest amounts in January. Rainfall averages about 38 inches per year at the coast and up to 100 inches per year on the inland peaks.

The primary historical land uses are silviculture, orchards, and ranching with timber harvest still an important industry. Timber companies own about one-third of the watershed; Gualala Redwoods Inc. is the largest commercial owner, holding about 30,000 acres. Orchards and ranching are on the decline while the watershed has seen an increase in hillside vineyard development, which can threaten to impair water quality with respect to sediment delivery. However, the SWRCB, through regulation, has put into place requirements for runoff protections from hillside vineyards so sediment loading in the rivers from vineyard development should not occur. The Gualala River provides the primary source of drinking water for Sea Ranch and Gualala. The watershed supports an anadromous fishery that includes coho salmon.

Russian River Watershed and the Russian River Project

The Russian River watershed encompasses 1,485 square miles in Mendocino and Sonoma counties. It is bounded by the Coast Ranges on both the east and west. The main stem is about

110 miles long and flows from north of Ukiah southward through Redwood Valley (Mendocino County) to its confluence with Mark West Creek (Mirabel Park), where it turns west, passes through the Coast Ranges, and empties into the Pacific Ocean approximately 20 miles west of Santa Rosa. The summer climate is moist and cool near the coast with temperatures increasing in the valley areas, which are isolated from the cooling coastal influence. During winter, average rainfall ranges from 30 to 80 inches, depending on locale.

The reservoirs that provide flood protection and water supply storage include Lake Sonoma (Warm Springs Dam) located at the confluence of Warm Springs Creek and Dry Creek west of Healdsburg and Lake Mendocino (Coyote Valley Dam) on the East Fork Russian River near Ukiah. A diversion from the Eel River via PG&E's Potter Valley Project (Van Arsdale Reservoir, Cape Horn Dam) for the purpose of power production provides benefit to the overall water storage in Lake Mendocino. The Russian River watershed supplies drinking water for over 600,000 people.

Lake Sonoma and Lake Mendocino and their associated facilities (collectively referred to as the Russian River Project) are operated in accordance with criteria established by SWRCB's Decision 1610. Decision 1610 established the most recent minimum instream flow requirements for Dry Creek and the Russian River. Flood releases from both reservoirs are controlled by the U.S. Army Corps of Engineers (USACE).

Sonoma County Water Agency (SCWA) makes no diversions from the Russian River between Lake Mendocino and the Russian River's confluence with Dry Creek, but it does authorize diversions through other SCWA water right permits. In addition, numerous domestic, agricultural, and municipal diversions occur on that portion of the Russian River; and SCWA maintains minimum instream flows regardless of the extent of diversions by others.

The Russian River watershed is primarily an agricultural area with the greatest emphasis on vineyard and orchard crops. Water is diverted from the Russian River and its tributaries in both Mendocino and Sonoma counties for extensive agricultural and domestic purposes. Major orchard crops include prunes, pears, and apples; other crops such as cherries and walnuts are also produced. Besides agriculture, there is a growing trend toward light industry and commercial development and a significant telecommunications industry within the region. The production and processing of timber, agricultural and animal products, gravel removal and processing, energy production and miscellaneous light manufacturing operations are additional industrial activities in the watershed. The Russian River watershed also has developed an international reputation for the production of premium wines, contributing to a strong tourism industry within the region.

Bodega Watershed

The Bodega watershed contains streams with headwaters in the Coast Ranges entering the Pacific Ocean south of the Russian River. Salmon, Americano, and Stemple creeks and their associated estuaries are the main water bodies within this watershed. The terrain is relatively steep and erodible and is sensitive to disturbance. Cooler temperatures and relatively high winter rainfall due to coastal influences typify the climate of the Bodega watershed. Because of the Mediterranean climate, summertime flows are often nonexistent in Americano and Stemple creeks; Salmon Creek flow is low but sustained. Each of these subwatersheds have estuary areas; however, the Estero Americano (Americano Creek) and the Estero de San Antonio

(Stemple Creek) are prized for their resemblance to fjords and the enhanced resource values associated with isolated estuarine environments.

Groundwater Aquifers and Wells

Groundwater resources in the North Coast Hydrologic Region are supplied by both alluvial and fractured rock aquifers. Alluvial aquifers are composed of sand and gravel or finer grained sediments, with groundwater stored within the voids, or pore space, between the alluvial sediments. Fractured-rock aquifers consist of impermeable granitic, metamorphic, volcanic, and hard sedimentary rocks, with groundwater being stored within cracks, fractures, or other void spaces. The distribution and extent of alluvial and fractured-rock aquifers and water wells vary significantly within the region. A brief description of the aquifers for the region is provided below.

Alluvial Aquifers

The North Coast Hydrologic Region contains 63 alluvial groundwater basins and subbasins recognized under Bulletin 118-2003 (California Department of Water Resources 2003). They underlie approximately 1,600 square miles, or 8 percent of the hydrologic region. The majority of the groundwater in the region is stored in alluvial aquifers. Figure NC-3 shows the location of the alluvial groundwater basins and subbasins, and Table NC-1 lists the associated names and numbers. The most heavily used groundwater basin in the region is the Klamath River Valley Groundwater Basin, which is located in the northeastern portion of the region along the Oregon border in Modoc and Siskiyou counties. Other significant groundwater basins in the region are Santa Rosa Valley, Wilson Grove Formation Highlands, Eel River Valley, Butte Valley, Shasta Valley, and Scott River Valley groundwater basins.

Fractured-Rock Aquifers

Fractured-rock aquifers in the foothill and mountain areas adjacent to the many alluvial groundwater basins also provide groundwater supply in the region. Groundwater from fractured rock aquifers tends to supply individual domestic and stock wells, or small community water systems. Fractured rock aquifers, and the wells that they supply, tend to have less capacity and reliability than the wells in alluvial aquifers. However, localized fractured rocks within the Klamath, Butte, and Shasta Valley groundwater basins tend to form some of the most highly productive fractured-rock aquifers in California.

In Klamath River Valley Groundwater Basin, the two major fractured rock aquifers are the Pleistocene Intermediate Basalt and the Miocene to Pliocene Lower Basalt. Fracturing of the Pleistocene Intermediate Basalt appears to be extensive resulting in high permeability and high well-yield in most locations producing yield between 2,000 gallons per minute (gpm) and 4,000 gpm. Wells constructed as part of the 2001 Emergency Well Drilling Program in the Tule Lake Subbasin produce groundwater primarily from the lower basalt at rates from 6,000 gpm to 12,000 gpm. However, groundwater elevation data collected from these wells indicate that recharge within the basin are slow.

In Butte Valley Groundwater Basin, the primary fractured rock aquifers are the Butte Valley Basalt, the Holocene and Pleistocene Pyroclastic Rocks, and the High Cascade Volcanics. The Butte Valley Basalt is highly permeable, fractured, and vesicular basalt located primarily in the

Figure NC-3 Alluvial Groundwater Basins and Subbasins within the North Coast Hydrologic Region

southern and southeastern portions of the groundwater basin. The Butte Valley Basalt yields large amounts of groundwater to wells; however, a study completed in the early 1980s determined that this aquifer was already developed to its maximum productivity.

In Shasta Valley Groundwater Basin, the predominant fractured aquifer the Holocene age Pluto's Cave Basalt is a highly productive and locally valuable fractured-rock aquifer. Groundwater discharge to the Shasta River from the Pluto's Cave Basalt aquifer is the primary source of cold water inflow to the river during summer months and relatively warmer water in winter months; both are critically important to the fishery. The average well yield in the Pluto's Cave Basalt aquifer is 1,300 gpm, with yields up to 4,000 gpm. A more recent review of 142 well drillers' logs indicate an average well yield of about 350 gpm and a maximum yield of about 1,400 gpm (California Department of Water Resources 2011).

More detailed information regarding the aquifers in the North Coast Hydrologic Region is available online from *California Water Plan Update 2013,* Volume 4, *Reference Guide,* in the article "California's Groundwater Update 2013," and in Bulletin 118-2003.

Well Infrastructure and Distribution

Well logs submitted to DWR for water supply wells completed during 1977 through 2010 were used to evaluate the distribution of water wells and the uses of groundwater in the North Coast Hydrologic Region. Many wells could have been drilled prior to 1977 or without submitting well logs. As a result, the total number of wells in the region is probably higher than what is reported here. DWR does not have well logs for all the wells drilled in the region; and for some well logs, information regarding well location or use is inaccurate, incomplete, ambiguous, or missing. Hence, some well logs could not be used in the current assessment. However, for a regional scale evaluation of well installation and distribution, the quality of the data is considered adequate and informative. The number and distribution of wells in the region are grouped according to their location by county and according to six most common well-use types: domestic, irrigation, public supply, industrial, monitoring, and other. Public supply wells include all wells identified in the well completion report as municipal or public. Wells identified as "other" include a combination of the less common well types, such as stock wells, test wells, or unidentified wells (no information listed on the well log).

Well log data for counties that fall within multiple hydrologic regions were assigned to the hydrologic region containing the majority of alluvial groundwater basins within the county. Well log information listed in Table NC-2 and illustrated in Figure NC-4 show that the distribution and number of wells vary widely by county and by use. The total number of wells installed in the region between 1977 and 2010 is approximately 35,000, and ranges from a low of fewer than 1,300 in Del Norte County to a high of about 15,800 in Sonoma County. In most counties, domestic use wells make up the majority of well logs — about 10,800 in Sonoma County, followed by about 5,800 in Mendocino County, and 5,100 in Siskiyou County. The one exception is Humboldt County where over 60 percent of the wells are monitoring wells. Communities with a high percentage of monitoring wells compared to other well types may indicate the presence of groundwater quality monitoring to help characterize groundwater quality issues.

Figure NC-5 shows that domestic wells make up the majority of well logs (71 percent) in the region, while irrigation wells account for only about 5 percent of well logs. A higher percentage

Table NC-1 Alluvial Groundwater Basins and Subbasins within the North Coast Hydrologic Region

Basin/Subbasin		Basin Name	Basin/Subbasin		Basin Name
1-1		Smith River Plain	1-33		Larabee Valley
1-2		Klamath River Valley	1-34		Dinsmores Town Area
	1-2.01	Tule Lake	1-35		Hyampom Valley
	1-2.02	Lower Klamath	1-36		Hettenshaw Valley
1-3		Butte Valley	1-37		Cottoneva Creek Valley
1-4		Shasta Valley	1-38		Lower Laytonville Valley
1-5		Scott River Valley	1-39		Branscomb Town Area
1-6		Hayfork Valley	1-40		Ten Mile River Valley
1-7		Hoopa Valley	1-41		Little Valley
1-8		Mad River Valley	1-42		Sherwood Valley
	1-8.01	Mad River Lowland	1-43		Williams Valley
	1-8.02	Dows Prairie School Area	1-44		Eden Valley
1-9		Eureka Plain	1-45		Big River Valley
1-10		Eel River Valley	1-46		Navarro River Valley
1-11		Covelo Round Valley	1-48		Gravelly Valley
1-12		Laytonville Valley	1-49		Annapolis Ohlson Ranch Formation Highlands
1-13		Little Lake Valley	1-50		Knights Valley
1-14		Lower Klamath River Valley	1-51		Potter Valley
1-15		Happy Camp Town Area	1-52		Ukiah Valley
1-16		Seiad Valley	1-53		Sanel Valley
1-17		Bray Town Area	1-54		Alexander Valley
1-18		Red Rock Valley		1-54.01	Alexander Area
1-19		Anderson Valley		1-54.02	Cloverdale Area
1-20		Garcia River Valley	1-55		Santa Rosa Valley
1-21		Fort Bragg Terrace Area		1-55.01	Santa Rosa Plain
1-22		Fairchild Swamp Valley		1-55.02	Healdsburg Area
1-25		Prairie Creek Area		1-55.03	Rincon Valley

Basin/Subbasin	Basin Name	Basin/Subbasin	Basin Name
1-26	Redwood Creek Area	1-56	McDowell Valley
1-27	Big Lagoon Area	1-57	Bodega Bay Area
1-28	Mattole River Valley	1-59	Wilson Grove Formation Highlands
1-29	Honeydew Town Area	1-60	Lower Russian River Valley
1-30	Pepperwood Town Area	1-61	Fort Ross Terrace Deposits
1-31	Weott Town Area	1-62	Wilson Point Area
1-32	Garberville Town Area		

of domestic wells and lower percentage of irrigation wells point to the more rural-domestic setting and low use of groundwater for irrigation in the region.

Figure NC-6 shows a cyclic pattern of well installation for the region, with new well construction ranging from about 500 to 1,600 wells per year, with an average of about 1,000 wells per year. The large fluctuation in domestic well drilling is likely associated with population booms and residential housing construction. The increase in domestic well drilling in the region during the late 1980s and early 1990s is likely due to increases in housing construction during this time. Similarly, the 2007 to 2010 decline in domestic well drilling is likely due to declining economic conditions and related drop in housing construction.

The onset of monitoring well installation in the mid- to late-1980s is likely associated with federal underground storage tank programs signed into law in the mid-1980s. The installation of monitoring wells in the region peaked in 1991 at about 470 wells, with an average of about 320 monitoring wells installed per year from 1988 through 1995. From 1998 through 2004, about 300 monitoring wells were installed per year. Since 2004, monitoring well installation in the region has averaged approximately 160 wells per year.

Comparing Figure NC-6 with other data shows that irrigation well installation is more closely related to hydrologic conditions, cropping trends, and surface water supply cutbacks. Installation of irrigation wells averaged about 50 wells per year until the late 1990s when the Klamath River Valley Basin and the Tule Lake subbasin experienced an extended period of drought. From 1998 through 2003, about 90 wells per year were installed. In the years following this drought, installation of wells dropped back to a rate of about 50 wells per year on average.

More detailed information regarding assumptions and methods of reporting well log information is available online from *California Water Plan Update 2013,* Volume 4, *Reference Guide,* in the article “California’s Groundwater Update 2013.”

Table NC-2 Number of Well Logs by County and Use for the North Coast Hydrologic Region (1977-2010)

County	Total Number of Well Logs by Well Use						Total Well Records[a]
	Domestic	Irrigation	Public Supply	Industrial	Monitoring	Other	
Del Norte	980	30	20	5	178	57	1,270
Humboldt	647	29	51	7	1,421	189	2,344
Mendocino	5,771	157	119	20	852	163	7,082
Siskiyou	5,120	445	86	20	663	358	6,692
Sonoma	10,750	1,215	366	95	2,878	529	15,833
Trinity	1,442	23	47	3	163	56	1,734
Total well records	24,710	1,899	689	150	6,155	1,352	34,955

Note:

[a] Represents number of wells installed 1977-2010.

North Coast Hydrologic Region Groundwater Monitoring

Groundwater monitoring and evaluation is a key aspect to understanding groundwater conditions, identifying effective resource management strategies, and implementing sustainable resource management practices. California Water Code (CWC) Section 10753.7 requires local agencies seeking State funds administered by DWR to prepare and implement groundwater management plans (GWMPs) that include monitoring of groundwater levels, groundwater quality, inelastic land subsidence, and changes in surface water flow and quality that directly affect groundwater levels or quality. This section summarizes some of the groundwater level, groundwater quality, and land subsidence monitoring efforts within the North Coast Hydrologic Region.

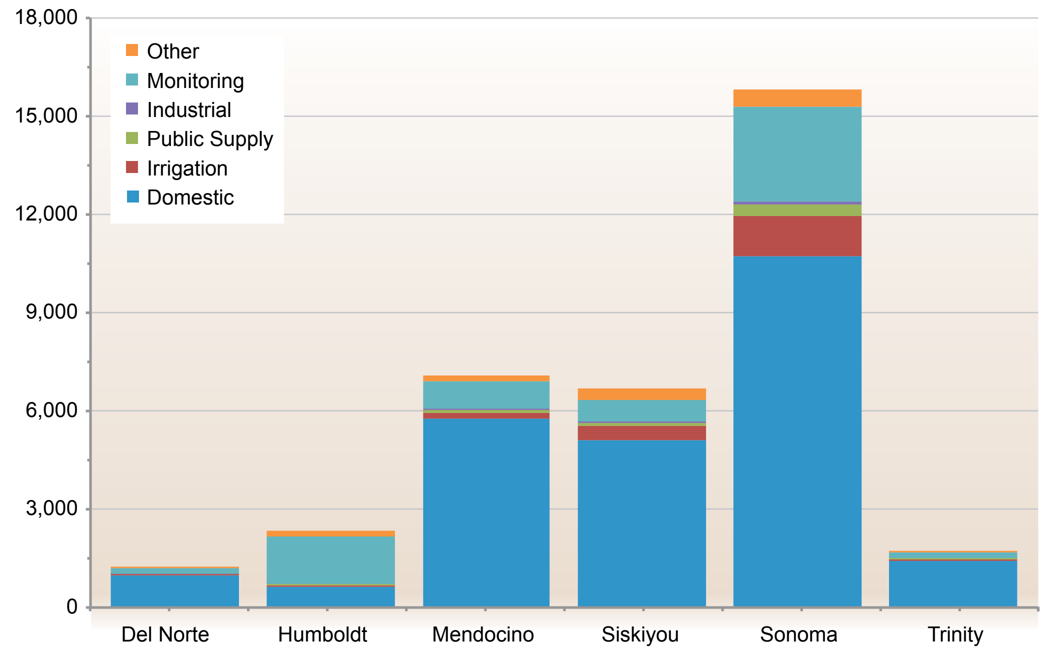
Additional information regarding the methods, assumptions, and data availability associated with the groundwater monitoring is available online from *California Water Plan Update 2013,* Volume 4, *Reference Guide*, in the article "California's Groundwater Update 2013."

Groundwater Level Monitoring

To strengthen existing groundwater level monitoring in the state by DWR, USBR, U.S. Geological Survey (USGS), local agencies and communities, the California Legislature passed Senate Bill 7X 6 in 2009. The law requires that groundwater elevation data be collected in a systematic manner on a statewide basis and be made readily and widely available to the public. DWR was charged with administering the program, which is now known as California Statewide Groundwater Elevation Monitoring (CASGEM). Additional and current information on the program is available online at http://www.water.ca.gov/groundwater/casgem/.

The locations of monitoring wells by monitoring entity and monitoring well type in the North Coast region are shown in Figure NC-7. Irrigation wells, other wells, and domestic wells account

Figure NC-4 Number of Well Logs by County and Use for the North Coast Hydrologic Region (1977-2010)



for 36, 33, and 19 percent of the monitoring wells in the region, respectively. Observation wells and public supply wells compromise only 9 and 3 percent of the monitoring wells, respectively.

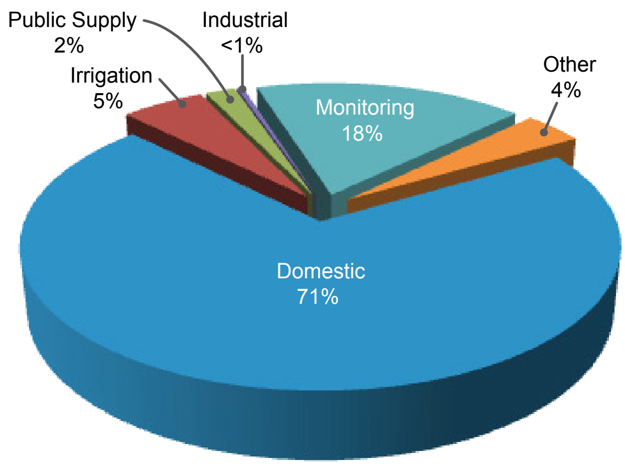
A list of the number of monitoring wells in the region by monitoring agencies, cooperators, and CASGEM monitoring entities is provided in Table NC-3. Groundwater levels have been actively monitored in 194 wells in the region since 2010. DWR monitors 123 wells — 90 wells in 15 basins and 33 wells outside Bulletin 118-2003 alluvial basins (California Department of Water Resources 2003); the USGS monitors 37 wells in 10 basins; and three CASGEM monitoring entities monitor 34 wells in 6 basins.

CASGEM Basin Prioritization

Figure NC-8 shows the groundwater basin prioritization for the North Coast region. Of the 63 basins within the region, 8 basins were identified as medium priority, 2 basins as low priority, and the remaining 53 basins as very low priority. No basin was identified as either high or very high priority. Table NC-4 lists the medium CASGEM priority groundwater basins for the region. The eight basins designated as medium priority include more than 60 percent of the population and account for about 80 percent of groundwater supply in the region. Basin prioritization could be a valuable tool to help evaluate, focus, and align limited resources for effective groundwater management, and reliable and sustainable groundwater resources.

More detailed information on groundwater basin prioritization is available at http://www.water.ca.gov/groundwater/casgem/basin_prioritization.cfm

Figure NC-5 Percentage of Well Logs by Use for the North Coast Hydrologic Region (1977-2010)



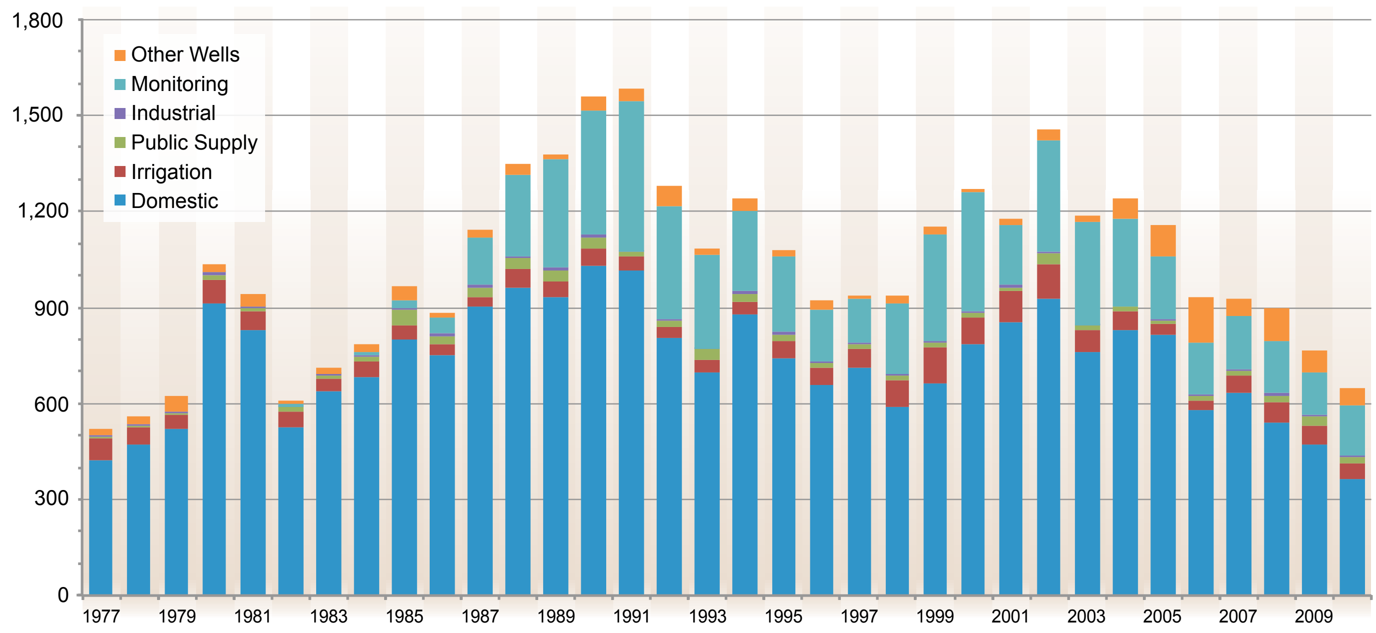
Groundwater Quality Monitoring

Groundwater quality monitoring is an important aspect to effective groundwater basin management and is one of the components that are required to be included in groundwater management planning in order for local agencies to be eligible for State funds. Numerous State, federal, and local agencies participate in groundwater quality monitoring efforts throughout California. Regional and statewide groundwater quality monitoring information and data are available on the SWRCB Groundwater Ambient Monitoring and Assessment (GAMA) Web site and the GeoTracker GAMA groundwater information system developed as part of the Groundwater Quality Monitoring Act of 2001. The GAMA Web site describes the GAMA program and provides links to all published GAMA and related reports. The GeoTracker GAMA groundwater information system geographically displays information and includes analytical tools and reporting features to assess groundwater quality. This system currently includes groundwater data from the SWRCB, Regional Water Quality Control Boards (RWQCBs), California Department of Public Health (CDPH), Department of Pesticide Regulation (DPR), DWR, USGS, and Lawrence Livermore National Laboratory (LLNL). In addition to groundwater quality data, GeoTracker GAMA has more than 2.5 million depth-to-groundwater measurements from the RWQCBs and DWR, and also has information about hydraulically fractured oil and gas wells from the California Division of Oil, Gas, and Geothermal Resources. Table NC-5 provides agency-specific groundwater quality information.

Land Subsidence Monitoring

Land subsidence has been shown to occur in areas experiencing significant declines in groundwater levels. When groundwater is extracted from aquifers in sufficient quantity, the groundwater level is lowered and the water pressure, which supports the sediment grains structure, decreases. In unconsolidated deposits, as aquifer pressures decrease, the increased weight from overlying sediments may compact the fine-grained sediments and permanently decrease the porosity of the aquifer and the ability of the aquifer to store water. Elastic land subsidence is the reversible and temporary fluctuation of earth's surface in response to seasonal groundwater extraction and recharge. Inelastic land subsidence is the irreversible and permanent decline in the earth's surface due to the collapse or compaction of the pore structure within the fine-grained portions of an aquifer system (U.S. Geological Survey 1999). Land subsidence thus results in irreversible compaction of the aquifer and permanent loss of aquifer storage capacity, and has serious effects on groundwater supply and development. Land subsidence due to aquifer compaction causes costly damage to the gradient and flood capacity of conveyance channels, to water system infrastructure (including wells), and to farming operations.

Figure NC-6 Number of Well Logs Filed per Year by Use for the North Coast Hydrologic Region (1977-2010)



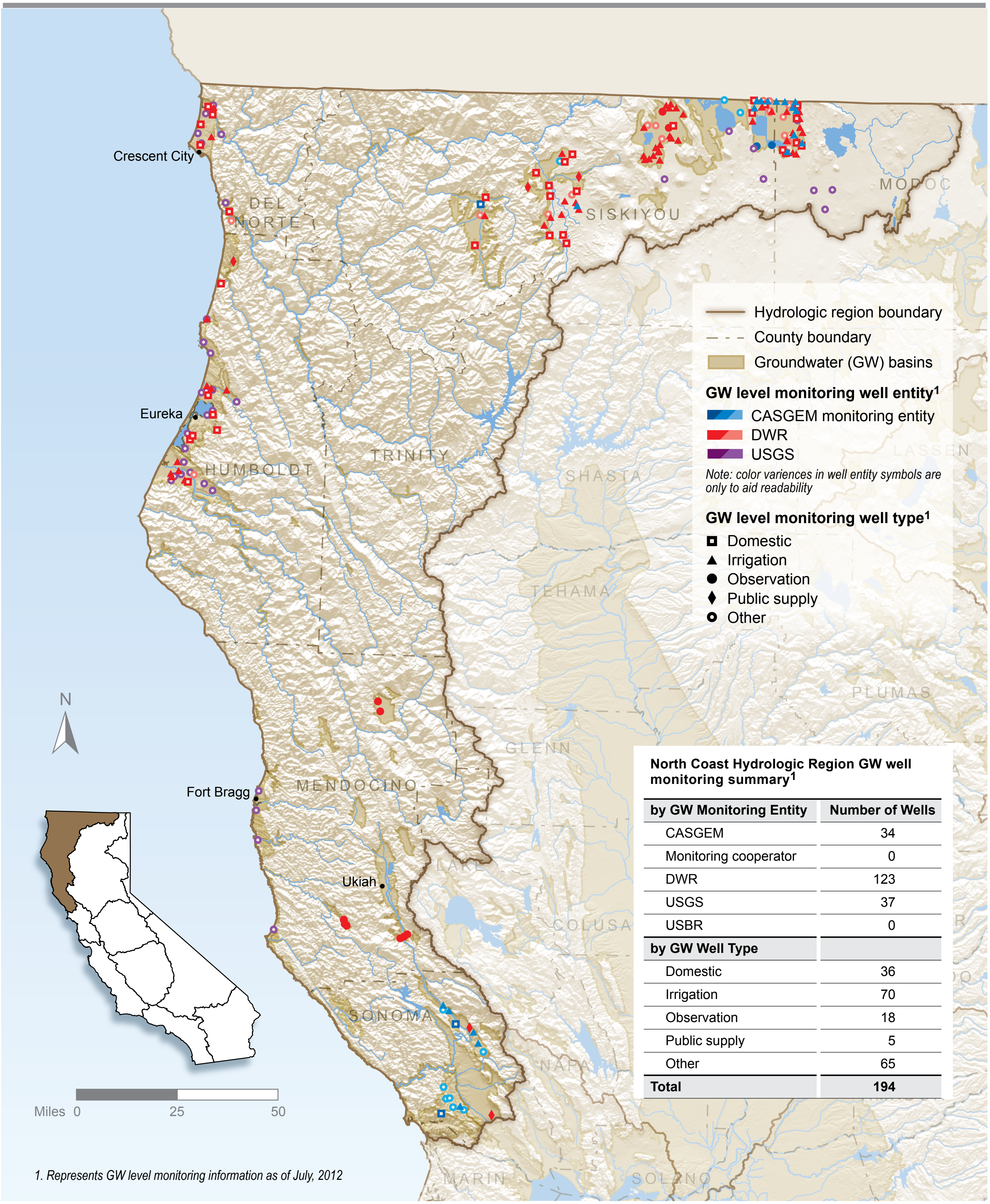
Most groundwater basins along the coastal portion of the North Coast region have limited risk for land subsidence due to groundwater withdrawal. Consequently, no land subsidence monitoring efforts are known to exist along the coastal portion of the region. However, recent increases in groundwater withdrawals for some inland groundwater basins have resulted in the installation of land subsidence monitoring instruments, for example, in the Tule Lake subbasin. The Tule Lake GPS (global positioning system) land subsidence monitoring network was put in place in 2001 and 2002 as part of the 2001 Klamath Basin Drought Emergency and in response to concerns about the potential for land subsidence in the thick lakebed deposits of the basin after constructing several deep, high-production agricultural supply wells. The existing GPS land subsidence network consists of 23 stations, with 16 stations within the Tule Lake subbasin and 7 stations within hard rock along the outside edge of the basin.

Ecosystems

Natural ecosystems are the result of the interactions of the abiotic and biotic (nonliving and living) components that interact as a unit. The climate, location, soil, biota, and topography of the North Coast region have contributed to the development of large ecosystems that have come to characterize the region. Major ecosystems of the region include forests, estuaries and coastal tidelands, riverine, and sagebrush steppe.

Conditions in the region are conducive to forest ecosystems. From an ecosystem perspective, a forest ecosystem comprises all its plants, animals, and other organisms as well as the natural woodland units. Forests store large amounts of water because of their large size and physiological characteristics. They are important regulators of hydrologic processes, especially those involving groundwater, evaporation, and precipitation patterns. Forests accumulate large amounts of biomass and have been referred to as the most effective land cover for maintaining water

Figure NC-7 Monitoring Well Location by Agency, Monitoring Cooperator, and CASGEM Monitoring Entity in the North Coast Hydrologic Region



North Coast Hydrologic Region GW well monitoring summary[1]

by GW Monitoring Entity	Number of Wells
CASGEM	34
Monitoring cooperator	0
DWR	123
USGS	37
USBR	0
by GW Well Type	
Domestic	36
Irrigation	70
Observation	18
Public supply	5
Other	65
Total	**194**

1. Represents GW level monitoring information as of July, 2012

Table NC-3 Groundwater Level Monitoring Wells by Monitoring Entity in the North Coast Hydrologic Region

State and Federal Agencies	Number of Wells
Depaertement of Water Resources	123
U.S. Geological Survey	37
Total State and federal wells:	160
Monitoring Cooperators	Number of Wells
N/A	
Total cooperator wells:	0
CASGEM Monitoring Entities	Number of Wells
Siskiyou County Public Health and Community Development	5
Sonoma County Permit and Resource Management Department	14
Tulelake Irrigation District	15
Total CASGEM monitoring wells	34
Grand total	194

Notes:

CASGEM = California Statewide Groundwater Elevation Monitoring

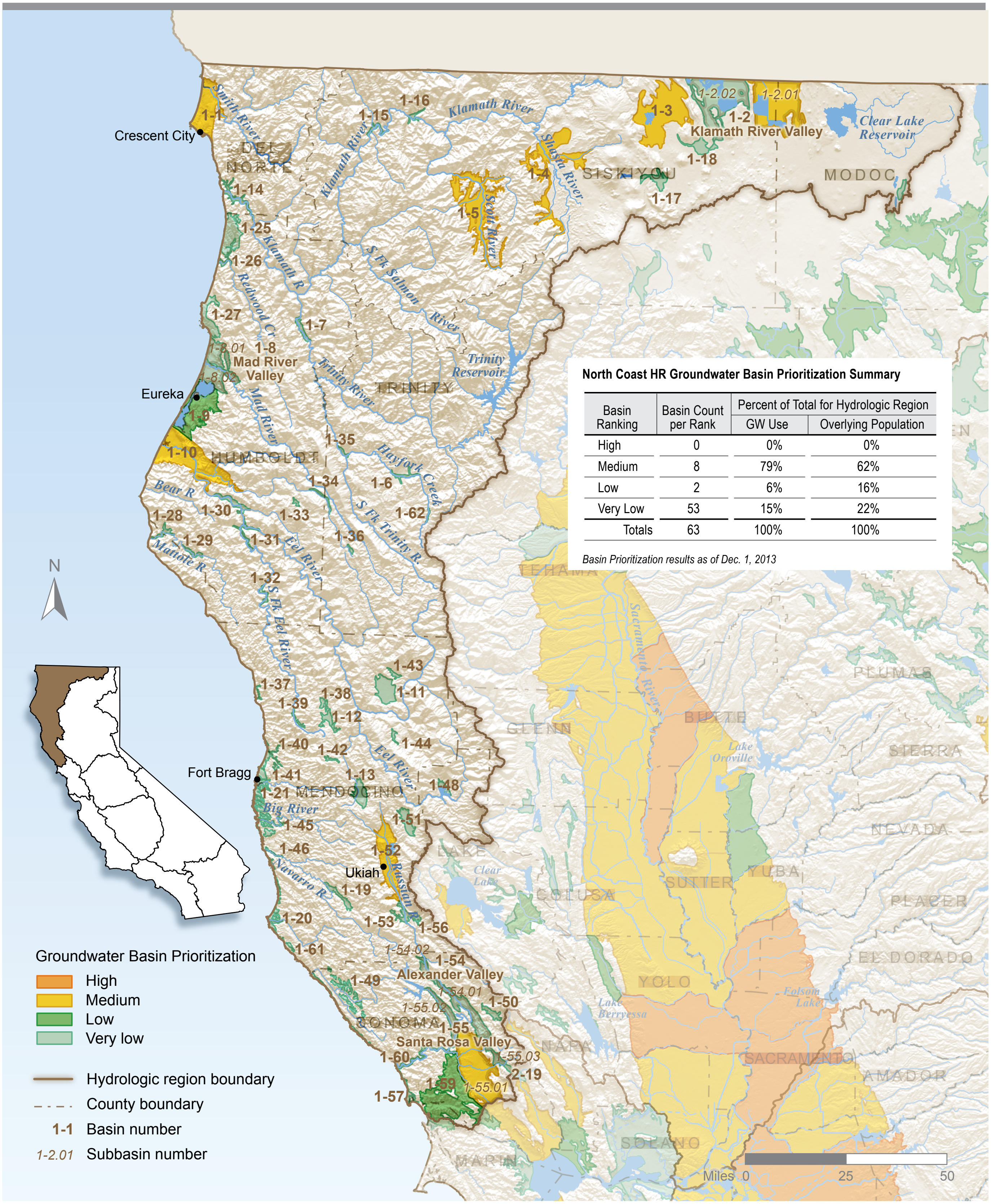
Table represents monitoring information as of July, 2012.

quality. Forest cover has been directly linked to drinking water treatment costs: The more forest in a source watershed, the lower the treatment costs. It should be noted however, that where forests are overgrown, the trees often do not allow the snow to reach the ground, which allows it to evaporate before water collects. It has been said that each mature tree uses approximately 100 gallons of water a day. Where forests are managed properly, larger quantities of water are available for the streams.

An estuary is a coastal area where fresh water from rivers and streams meets and mixes with salt water from the ocean. Estuaries and littoral (near shore) ecosystems are very significant to the North Coast because they provide feeding and nesting habitat for many species of waterfowl and shore birds and are an important feature for migratory birds along the Pacific Flyway. Estuaries and coastal ecosystems are valuable to foraging sea birds and marine mammals. Estuaries function as feeding and sheltering habitats for salmonids. The North Coast Hydrologic Region includes 340 miles of coastline.

Tidelands and marshes, too, are extremely important to many species of waterfowl and shore birds, both for feeding and nesting. Cultivated land and pasture lands also provide supplemental food for many birds, including the Tricolored Blackbird. Tideland areas along the North Coast provide important habitat for marine invertebrates and nursery areas for forage fish, game fish, and crustaceans. Offshore coastal rocks are used by many species of seabirds as nesting areas.

Figure NC-8 CASGEM Groundwater Basin Prioritization for the North Coast Hydrologic Region



North Coast HR Groundwater Basin Prioritization Summary

Basin Ranking	Basin Count per Rank	Percent of Total for Hydrologic Region	
		GW Use	Overlying Population
High	0	0%	0%
Medium	8	79%	62%
Low	2	6%	16%
Very Low	53	15%	22%
Totals	63	100%	100%

Basin Prioritization results as of Dec. 1, 2013

Table NC-4 CASGEM Groundwater Basin Prioritization for the North Coast Hydrologic Region

Basin Prioritization	Count	Basin/ Subbasin Number	Basin Name	Subbasin Name	2010 Census Population
Medium	1	1-4	Shasta Lake		5,333
Medium	2	1-55.01	Santa Rosa Valley	Santa Rose Plain	250,375
Medium	3	1-1	Smith River Plain		24,588
Medium	4	1-2.01	Klamath River Valley	Tule Lake	2,261
Medium	5	1-52	Ukiah Valley		32,761
Medium	6	1-10	Eel River Valley		21,558
Medium	7	1-5	Scott River Valley		3,520
Medium	8	1-3	Butte Valley		1,464
Low	2	See *California Water Plan Update 2013*, Volume 4 *Reference Guide,* article "California's Groundwater Update 2013."			
Very Low	53	See *California Water Plan Update 2013*, Volume 4 *Reference Guide,* article "California's Groundwater Update 2013."			
Totals	**63**	**Population of groundwater basin area**			**550,630**

Notes:

Senate Bill 7x 6 (SBx7 6; Part 2.11 to Division 6 of the California Water Code Sections 10920 et seq.) requires, as part of the CASGEM program, DWR to prioritize groundwater basins to help identify, evaluate, and determine the need for additional groundwater level monitoring by considering available data that include the population overlying the basin, the rate of current and projected growth of the population overlying the basin, the number of public supply wells that draw from the basin, the total number of wells that draw from the basin, the irrigated acreage overlying the basin, the degree to which persons overlying the basin rely on groundwater as their primary source of water, any documented impacts on the groundwater within the basin, including overdraft, subsidence, saline intrusion, and other water quality degradation, and any other information determined to be relevant by the DWR.

Using groundwater reliance as the leading indicator of basin priority, DWR evaluated California's 515 alluvial groundwater basins and categorized them into five groups - very high, high, medium, low, and very low.

Riverine ecosystems are those environments that relate to, are formed by, or are situated on streams or rivers. These systems are complex and result from the physical, chemical, and biological processes acting upon that system. Many of the rivers of the North Coast retain functional habitats and geomorphic processes but are affected by land use practices and invasion of non-native plants. The life cycle of salmonids is closely interwoven with water quality and quantity and, therefore, is an excellent indicator of the "health" of streams and rivers.

The common perceptions of the North Coast ecosystems are related to the forests, rivers, and proximity to the ocean. However, in the northeastern portion of this region, Modoc and Siskiyou counties, sagebrush steppe ecosystems are predominant. A sagebrush steppe ecosystem is largely treeless and dry with dominant plant communities consisting of sagebrush shrubs and short bunchgrasses.

Table NC-5 Sources of Groundwater Quality Information for the North Coast Hydrologic Region

Agency	Links to Information
State Water Resources Control Board http://www.waterboards.ca.gov/	Groundwater http://www.waterboards.ca.gov/water_issues/programs/#groundwater • Communities that Rely on a Contaminated Groundwater Source for Drinking Water http://www.waterboards.ca.gov/water_issues/programs/gama/ab2222/index.shtml • Hydrogeologically Vulnerable Areas http://www.waterboards.ca.gov/gama/docs/hva_map_table.pdf • Aquifer Storage and Recovery http://www.waterboards.ca.gov/water_issues/programs/asr/index.shtml GAMA http://www.waterboards.ca.gov/gama/index.shtml • GeoTracker GAMA (Monitoring Data) http://www.waterboards.ca.gov/gama/geotracker_gama.shtml • Domestic Well Project http://www.waterboards.ca.gov/gama/domestic_well.shtml • Priority Basin Project http://www.waterboards.ca.gov/water_issues/programs/gama/sw_basin_assesmt.shtml • Special Studies Project http://www.waterboards.ca.gov/water_issues/programs/gama/special_studies.shtml • California Aquifer Susceptibility Project http://www.waterboards.ca.gov/water_issues/programs/gama/cas.shtml Contaminant Sites Land Disposal Program http://www.waterboards.ca.gov/water_issues/programs/land_disposal/ Department of Defense Program http://www.waterboards.ca.gov/water_issues/programs/dept_of_defense/ Underground Storage Tank Program http://www.waterboards.ca.gov/ust/index.shtml Brownfields http://www.waterboards.ca.gov/water_issues/programs/brownfields/
California Department of Public Health http://www.cdph.ca.gov/Pages/DEFAULT.aspx	Division of Drinking Water and Environmental Management http://www.cdph.ca.gov/programs/Pages/DDWEM.aspx • Drinking Water Source Assessment and Protection (DWSAP) Program http://www.cdph.ca.gov/certlic/drinkingwater/Pages/DWSAP.aspx • Chemicals and Contaminants in Drinking Water http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Chemicalcontaminants.aspx • Chromium-6 http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Chromium6.aspx • Groundwater Replenishment with Recycled Water http://www.cdph.ca.gov/HealthInfo/environhealth/water/Pages/Waterrecycling.aspx

Agency	Links to Information
California Department of Water Resources http://www.water.ca.gov/	Groundwater Information Center http://www.water.ca.gov/groundwater/index.cfm Bulletin 118 Groundwater Basins http://www.water.ca.gov/groundwater/bulletin118/gwbasin_maps_descriptions.cfm California Statewide Groundwater Elevation Monitoring (CASGEM) http://www.water.ca.gov/groundwater/casgem/ Groundwater Level Monitoring http://www.water.ca.gov/groundwater/data_and_monitoring/gw_level_monitoring.cfm Groundwater Quality Monitoring http://www.water.ca.gov/groundwater/data_and_monitoring/gw_quality_monitoring.cfm Well Construction Standards http://www.water.ca.gov/groundwater/well_info_and_other/well_standards.cfm Well Completion Reports http://www.water.ca.gov/groundwater/well_info_and_other/well_completion_reports.cfm
California Department of Toxic Substances Control http://www.dtsc.ca.gov/	EnviroStor http://www.envirostor.dtsc.ca.gov/public/
California Department of Pesticide Regulation http://www.cdpr.ca.gov/	Groundwater Protection Program http://www.cdpr.ca.gov/docs/emon/grndwtr/index.htm Well Sampling Database http://www.cdpr.ca.gov/docs/emon/grndwtr/gwp_sampling.htm Groundwater Protection Area Maps http://www.cdpr.ca.gov/docs/emon/grndwtr/gwpa_maps.htm
U.S. Environmental Protection Agency http://www.epa.gov/safewater/	US EPA STORET Environmental Data System http://www.epa.gov/storet/
U.S. Geological Survey http://ca.water.usgs.gov/	USGS Water Data for the Nation http://waterdata.usgs.gov/nwis)

Flood

In the North Coast Hydrologic Region, forest management practices are the most significant issue affecting flood management (see “Flood Management” subsection under “Regional Resources Management Conditions” in this report). Maintaining the natural attenuation and function of floodplains in this hydrologic region will help to protect more than 320 sensitive species that live in the floodplains. Another issue is coastal flooding, including tsunamis, which can impact more than $4 billion in assets (crops, buildings, and public infrastructure). See Box NC-1 “Near Coastal Issues.” In addition, illegal cultivation of marijuana in the forests (on both public and private land) — with over fertilization and pesticide use, land clearing and illegal water diversions — sets the stage for increased runoff during rain events carrying toxics and sediment into the streams and rivers, degrading the environment.

Communities in the North Coast Hydrologic Region have suffered frequent flood damage since the winter of 1861 when devastating floods were recorded. Torrential rains caused flooding throughout the hydrologic region in 1937. Winter floods between 1935 and 1945 in Sonoma County spurred the USACE to develop a flood management plan and construct Coyote Valley

Box NC-1 Near-Coastal Issues

Coastal regions in California share common concerns and issues. The 2013 update of the California Water Plan is introducing a focus on near-coastal issues. The issues common to all coastal areas include increased coastal flooding especially as it relates to climate change, sea level rise, and the potential degradation of aquifer water quality. Desalination may provide a future water supply source for drinking water, but impacts on adjacent water conditions and ecosystems are of concern. Stormwater and wastewater management are significant near-coastal issues, including the impacts of runoff and discharge on coastal water quality. Near-coastal planners and resource managers have increased attention to ecological linkages between freshwater flows, wetlands, and anadromous fish species. Conjunctive water management strategies as applied in near-coastal areas consider groundwater management for recharge and water supply for multiple land uses and objectives.

Climate change is anticipated to have profound effects on the North Coast regions, as the effects of climate change will alter rain patterns and intensity as well as temperatures. Because of the interrelationship of water supply, quality, floods and flooding, land use and fisheries, coastal managers are relying on current science and recommended strategies for adaptation and resource management.

Find information on near-coastal issues in the North Coast region under the “Flood Management” and “Climate Change” subsections.

Dam, which impounded Lake Mendocino upon completion in 1957 (U.S. Army Corps of Engineers, Coyote Valley Dam 2010).

For a complete record of floods, refer to the *California Flood Future Report*, Attachment C: “Flood History of California Technical Memorandum” (California Department of Water Resources and U.S. Army Corps of Engineers 2013).

Recent Tsunamis on the California Coast

This region was struck by a tsunami in March 1964 as a result of an earthquake in Prince William Sound, off the south coast of Alaska. The earthquake generated a tsunami that towered more than 20 feet when it made landfall on the North Coast. The huge wave smashed into Crescent City in the early morning of March 28 and devastated the community. Parts of Citizens Dock, a major distribution hub for the city’s bustling natural resources industry, were completely wrecked; and several fishing vessels were capsized. The massive wave damaged 289 homes and businesses; 11 people were killed; and 3 were never found. Damages were estimated at $16 million in 1964 dollars.

In March 2011, a tsunami generated off the coast of Japan, recorded throughout the California coast, struck Crescent City Harbor with an 8.1-foot wave, destroying much of the harbor and resulting in one death near Klamath. There was also major damage to docks and boats at Noyo Harbor. Estimated damage in the region was $24 million.

Climate

Weather conditions vary dramatically within the North Coast Hydrologic Region from the cooler coastal areas to the arid inland valleys in Siskiyou and Modoc counties. In the western coastal portion of this region, average temperatures are moderated by the influence of the Pacific Ocean and range from highs in the mid-80s in the summer to lows in the mid-30s during the winter. In the inland regions of Siskiyou and Modoc counties, temperatures are more variable, where summer high temperatures usually reach the 100-degree mark and winter low temperatures are often in the low-30-degree range. The heavy rainfall over the mountainous portions of the region makes it the most water-abundant area of California. Mean annual runoff is about 29 million acre-feet (maf), which constitutes about 41 percent of the state's total natural runoff, which is the largest volume compared to all other hydrologic regions of California. The major rivers in decreasing order of average annual runoff are: the Klamath with 11 maf; the Eel, 6 maf; the Smith, 3 maf; the Russian, 1.6 maf; the Mad, 1 maf, and the Mattole, 1 maf. The principal reaches (and tributaries) of the Klamath, Eel, and Smith rivers have been designated wild and scenic under federal and State law. Annual average precipitation in the North Coast region is 53 inches, ranging from over 100 inches per year in eastern Del Norte County to less than 15 inches annually in the Lost River drainage area of Modoc County. A relatively small fraction of the precipitation is in the form of snow; only at elevations above 4,000 feet does snow remain on the ground for appreciable periods.

Precipitation, or rainfall, varies greatly within the North Coast region depending upon location and time of year. The combination of mountainous terrain with high peaks and steep narrow valleys compared to higher elevation plateaus present conditions favorable to variable rainfall patterns. In general, precipitation is higher in the northwest mountains and decreases toward the east and southeast.

In the coastal communities to the north near Crescent City in Del Norte County, average precipitation for the period from 1971 through 2000 is about 64 inches with the highest rainfall normally during December. At Eureka in Humboldt County, average precipitation for the same period is about 48 inches. At Fort Bragg in Mendocino County along the coast, it is about 43 inches; at Bodega Bay in Sonoma County, about 37 inches.

In the mountains within the coastal counties, precipitation increases (compared to the coastal communities) due to the orographic effect causing moisture in the air to condense and fall as rain or snow. At Ship Mountain in Del Norte County with an elevation of approximately 5,320 feet, about 145 inches of rainfall occurs annually with the highest rainfall during the month of December. Moving south to Spike Buck Mountain in Humboldt County at approximately 5,480 feet, about 61 inches of rainfall occurs on average. In Mendocino County along Chamberlain Ridge at 2,020 feet elevation, about 48 inches of rainfall occurs with the highest precipitation during the month of January. At Sonoma Mountain in Sonoma County, at 2,460 feet elevation, precipitation averages about 29 inches with the heaviest amounts falling during January.

Moving inland toward northeast California, at Boulder Peak in Siskiyou County at 8,300 feet, about 47 inches of rainfall normally occurs with the heaviest rainfall happening in January. Moving farther east to Mount Shasta in Siskiyou County at about 14,160 feet, average rainfall and snow amounts to near 56 inches with the highest rainfall occurring during January. In contrast, at Weed in Siskiyou County at approximately 3,550 feet elevation and only 10 miles away from Mount Shasta (air miles), the average rainfall is about 31 inches. Moving to eastern Siskiyou County at Mount Hoffman near 7,910 feet elevation, about 47 inches of rainfall occurs.

In western Modoc County (the eastern portion of the North Coast region), representative precipitation in the Tule Lake agricultural area at the town of Newell, 4,042 feet elevation, amount to near 12 inches annually with November, December, and January having the highest amounts. At Blue Mountain near the eastern edge of the North Coast region at 5,750 feet elevation (about 27 air miles from the town of Newell and an increase of about 1,700 feet in elevation), precipitation amounts to an average of about 21 inches per year.

Demographics

The North Coast region includes all residents of Del Norte, Humboldt, Trinity, and Mendocino counties, the majority of Modoc, Siskiyou, and Sonoma counties, and a small percentage of the populations of Glenn, Lake and Marin counties.

Population

According to the California Department of Finance (DOF), the population of the entire North Coast region was 671,344 in year 2010, which is less than 2 percent of California's total population. More than half of this region's population lives in its southern part, primarily in Santa Rosa and the surrounding communities of Cotati, Healdsburg, Rohnert Park, Sebastopol, and Windsor along the Russian River watershed. Urban growth in these cities is heavily influenced by the overall urban expansion of the adjacent San Francisco Bay region.

The majority of the North Coast region's population (2010 U.S. Census, California Department of Finance) is concentrated in the southern portion of the region, in Sonoma and Marin counties, with 370,753 and 316 residents respectively, or approximately 55 percent of all inhabitants in the region. Only a portion of these two counties are in this hydrologic region. The remainder is part of the San Francisco Bay Hydrologic Region. Marin County and part of Sonoma County are part of the nine-county Bay Area Association of Bay Area Governments (ABAG). For additional information on ABAG, see: http://www.abag.ca.gov/. Mendocino and Humboldt counties comprise 87,841 and 134,623 residents, respectively.

The remainder of the region's population is distributed in its north/northeast and southeast sections. In the north/northeast areas, Del Norte County had 28,610 residents; Siskiyou County, 34,264; and Modoc County, 1,083. Three counties represent the southeast section's population: Glenn with 0, Lake with 68, and Trinity with 13,786 residents (California Department of Finance 2010). Trinity County is wholly contained within the region while Glenn and Lake counties are only partially represented.

The North Coast region has experienced steady population growth over the past two decades and is projected to continue positive growth through the year 2050 (California Department of Finance 2010). Due to the rural nature of much of the region and the fact that there is a lower associated cost of living, many communities within the region are seeing an influx of retirees from larger, more urbanized settings. This has placed pressure on existing community services. Additionally, as population densities encroach in the more urban settings, some of the more rural communities are becoming bedroom communities. There is also a rise in migrant workers within the region. Modoc County has a county-operated migrant camp. For both Modoc and Siskiyou counties, many of their migrant workers are becoming permanent residents. Meanwhile, younger residents continue to leave the area seeking higher-paying jobs.

When compared with the year 2000 regional population of 637,127, the 671,344 in 2010 represents a growth rate of about 5.4 percent over the 10 years, which is a little more than half the statewide growth rate of about 9.7 percent over the same period. Recent projections indicate that the regional population is expected to grow to about 814,889 by year 2050, which represents approximately 21 percent increase from year 2010 totals. Table NC-6 lists the North Coast region's total population from year 1990 through year 2010, with current projections to year 2050. More than half of this projected growth is anticipated to occur in the Santa Rosa region, as urban populations from the San Francisco Bay area continue to expand northward. Population increases in the rural communities in the northern portion of this region are projected to grow more slowly due to the geographic location, few transportation corridors, and a lack of adequate harbors.

Tribal Communities

In the North Coast Hydrologic Region, 4 percent of the residents identify themselves as Native Americans (indigenous or tribal peoples), significantly higher than in the 1.7 percent in the statewide population. Several tribes live in the North Coast region, but the Yurok Tribe is the largest in both the North Coast and California. Many of the tribes here are federally recognized, but some are not (Tables NC-7 and NC-8). In addition, many tribes exist within the region, with both large and small numbers of registered individuals. However, many tribes existing within the region have not obtained Federal Reservation status as of the writing of this report. The following subsections include information on the Yurok Tribe and Reservation, the Hoopa Valley Reservation, and the Round Valley Reservation.

Yurok Tribe and Reservation

The Yurok Tribe is the largest tribe in California with more than 5,000 enrolled members. The tribe provides numerous services to the local community and membership with its more than 200 employees. The tribe's major initiatives include the Hoopa-Yurok Settlement Act, dam removal, natural resources protection, sustainable economic development enterprises, and land acquisition. The Yurok Tribe's territory consists of all Ancestral Lands, specifically including but not limited to the Yurok Reservation lands, which extend from one mile on each side from the mouth of the Klamath River and upriver for a distance of 44 miles. The Yurok Tribe's people are also known historically as the Pohlik-la, Ner-er-er, Petch-ik-lah, and Klamath River Indians. The Yurok Reservation (Yurok lands) includes 63,035 acres. Only a small portion of the Yurok Reservation has been developed for residential housing, and much of that lacks basic services such as electricity and telephone (Yurok Tribe 2006).

The Yurok Tribe is in the process of establishing a hotel-casino in Klamath, California, with proceeds to go toward improving conditions for tribal members. Improvements will include electricity, potable water, and telephone services within the reservation. In addition, a per capita distribution plan will include a one-time dispersion of funds to all tribal members regardless of age concerning past timber harvesting on Yurok lands (Yurok Tribe 2013).

Hoopa Valley Reservation

The People of Hoopa Valley are one of California's first cultures. In 1864, a Peace and Friendship Treaty was negotiated with the United States. In 1896, the Department of the Interior began preparing a land allotment list, and in 1909 a proclamation was handed down by President Theodore Roosevelt. This list was not completed and approved until 1923. The "Hupa People" successfully avoided the physical destruction of their valley homeland, and in modern times

Table NC-6 Population Growth Trends, North Coast Hydrologic Region

	Estimates		Projections							
COUNTY	2000	2010	2015	2020	2025	2030	2035	2040	2045	2050
Del Norte	27,447	28,572	29,297	29,967	30,715	31,252	31,691	32,163	32,617	33,191
Glenn	0	0	0	0	0	0	0	0	0	0
Humboldt	126,665	134,553	137,276	140,019	142,141	143,811	145,149	145,509	145,803	146,120
Lake		61	64	67	70	74	77	81	85	89
Marin		316	318	320	322	324	328	332	335	339
Mendocino	86,506	87,925	89,614	91,718	93,885	95,355	96,696	97,913	99,504	101,684
Modoc		1,085	1,102	1,117	1,138	1,154	1,168	1,183	1,206	1,232
Siskiyou		34,283	35,050	36,205	37,307	38,116	38,798	39,417	40,000	40,797
Sonoma		370,025	380,631	391,025	403,214	415,476	428,406	440,041	453,159	469,128
Trinity	12,958	13,881	13,925	14,365	14,914	15,309	15,703	16,048	16,414	16,846
Totals		**670,701**	**687,276**	**704,804**	**723,707**	**740,872**	**758,016**	**772,687**	**789,123**	**809,426**

Note:

Values represent population in the North Coast Hydrologic Region. Data modified only for counties that exist in two hydrologic regions.

created one of the first successful self-governance tribal structures in the nation. According to the 2010 U.S. Census, the Hoopa Valley Reservation includes 3,041 people with 82.4 percent of Native American heritage.

The Hupa people traditionally occupied lands in the far northwestern corner of California. The boundaries of the reservation were established by Executive Order on June 23, 1876, pursuant to the Congressional Act of April 3, 1864. The boundaries were expanded by executive order in 1891 to connect the old Klamath River (Yurok) Reservation to the Hoopa Valley Reservation. Further confirmation of the ownership by the Hupa Tribe of the Hoopa Valley Reservation came on October 31, 1988, with President Ronald Reagan's signature on Public Law 100-580, the Hoopa/Yurok Settlement Act.

The Hupa People have occupied their lands since time immemorial, and the past century has really been the shortest in their history. However, up until the late 1800s, there is little or no written record on the rich history and culture that is now the Hoopa Valley Tribe. Much of the tradition and lore that exists today has been passed along between generations via an extensive oral tradition. The ceremonies and traditions continue in the similar manners as they have since the beginning, and will continue into the future (Hoopa Valley Tribe 2003).

Table NC-7 Federally Recognized Tribes in North Coast Hydrologic Region

Name of Tribe	Cultural Affiliation
Bear River Band of the Rohnerville Rancheria	Wiyot, Mattole
Big Lagoon Rancheria	Yurok, Tolowa
Blue Lake Rancheria	Wiyot, Yurok, Hupa
Cahto Indian Tribe of the Laytonville Rancheria	Cahto, Pomo
Cher-Ae Heights Indian Community of the Trinidad Rancheria	Yurok, Wiyot, Tolowa
Cloverdale Rancheria of Pomo Indians of California	Pomo
Coyote Valley Band of Pomo Indians of California	Pomo
Dry Creek Rancheria Band of Pomo Indians of California	Pomo
Elk Valley Rancheria	Tolowa
Federated Indians of Graton Rancheria	Coast Miwok, Southern Pomo
Guidiville Rancheria of California	Pomo
Hoopa Valley Tribe	Hupa
Hopland Band of Pomo Indians of the Hopland Rancheria	Pomo
Karuk Tribe	Karuk
Kashia Band of Pomo Indians of the Stewarts Point Rancheria	Pomo
Lytton Rancheria of California	Pomo
Manchester Band of Pomo Indians of the Manchester-Point Arena Rancheria	Pomo
Pinoleville Pomo Nation	Pomo
Pit River Tribe (Eleven Bands, includes XL Ranch, Big Bend, Likely, Lookout, Montgomery Creek and Roaring Creek Rancherias)	Achomawi (Achumawi, Ajumawi), Aporidge, Astariwawi (Astarawi), Atsuge (Atsugewi), Atwamsini, Hanhawi (Hammawi), Hewisedawi, Ilmawi, Itsatawi, Kosalextawi (Kosalektawi), Madesi
Potter Valley Tribe	Pomo
Quartz Valley Indian Community of the Quartz Valley Indian Reservation	Klamath, Karuk, Shasta
Redwood Valley Rancheria of Pomo Indians	Pomo
Resighini Rancheria	Yurok
Round Valley Indian Tribes of the Round Valley Reservation	Wailacki, Yuki, Pomo, Concow, Nomlacki, Pit River
Sherwood Valley Rancheria of Pomo Indians	Pomo
Smith River Rancheria	Tolowa
Wiyot Tribe	Wiyot
Yurok Tribe of the Yurok Reservation	Yurok

Sources: Department of the Interior, Bureau of Indian Affairs.

Table NC-8 California Native American Tribes (Non-Recognized) in North Coast Hydrologic Region

California Native American Tribe	Cultural Affiliation
Melochundum Band of Tolowa Indians	Tolowa
Eel River Nation of Sovereign Wailaki	Eel River Athapaskans
SheBelNa Band of Mendocino Coast Pomo Indians	Pomo
Noyo River Indian Community	Sinkyone
Yokayo Tribe of Indians	Pomo
Shasta Tribe (Shasta Nation)	Konomihu, New River Indians, Okwanuchu
Mishewal-Wappo Tribe of Alexander Valley	Wappo Indians
Tsnungwe Council	Hupa, South Fork Hupa
Nor-Rel-Muk Nation (formerly Hayfork Band; formerly Nor-El-Muk Band of Wintu Indians	Wintu

Source: California Native American Heritage Commission, California Department of Water Resources

Round Valley Reservation (A Sovereign Nation of Confederated Tribes)

The Round Valley Indian Reservation is federally recognized, lying primarily in northern Mendocino County with a small part of it extending northward into southern Trinity County. The total land area, including off-reservation trust land, is 36.27 square miles. More than two-thirds of this area is off-reservation trust land, including about 405 acres in the community of Covelo. Population estimates for 2010 show just over 3,000 people are tribal members with about half living on the reservation (Center for Applied Research 2010).

The Round Valley Indians consist of the Covelo Indian Community. This community is an accumulation of small tribes; the Yuki (who were the original inhabitants of Round Valley), Concow Maidu, Little Lake and other Pomo, Nomlaki, Cahto, Wailaki, and Pit River peoples. These tribes were forced onto the land formerly occupied by the Yuki tribe. From years of intermarriage, a common lifestyle and a shared land base, a unified community emerged. The descendants of these peoples formed a new tribe on the reservation, the Covelo Indian Community, later to be called the Round Valley Indian Tribes. Their heritage is a rich combination of different cultures with a common reservation experience and history. (Round Valley Indian Tribes 2011; Center for Applied Research 2010).

Disadvantaged Communities

Disadvantaged community (DAC) status is determined based on the DAC definition provided in Proposition 84 and 1E Integrated Regional Water Management (IRWM) Grant Guidelines (see http://www.water.ca.gov/irwm/grants/implementation.cfm), dated August 2010. A Median Household Income (MHI) of less than $48,706 is the DAC threshold in California (80 percent of the statewide MHI of $60,882). In 2010, households in California included an average of 2.89 people. According to the 2010 U.S. Census, 47.64 percent of all census blocks in this region are within a DAC. This amounts to 46.25 percent of the North Coast region's population considered as disadvantaged, see Figure NC-9.

The NCIRWMP places a strong emphasis on ensuring the inclusion of DACs in the planning and implementation process. DACs have been involved in all aspects of the NCIRWM planning effort from its inception, including plan review and input, attendance, and participation at meetings; DACs comprise a substantial portion of the priority project proponents who are currently implementing projects. See http://www.northcoastirwmp.net/Content/10344/North_Coast_IRWMP_Implementation_Projects.html for more information (North Coast Regional Integrated Water Management Plan, Phase III 2012).

The NCIRWMP identifies six primary objectives (see "Water in the Environment" under "Regional Resource Management Conditions"). One of the objectives is to address environmental justice issues as they relate to DACs — drinking water quality, and public health. Public discussions indicate that some believe that DACs in small rural areas and small family businesses carry a disproportionate burden when communities address environmental issues to protect endangered species, water quality, and natural resources. These requirements may impact the ability of local businesses (including agriculture, silviculture and mining), communities, economies and counties to provide services (affects tax base). One case in point is the removal of dams on the Klamath River. The decision is based on environmental improvement for fisheries, but it could have adverse effects on Siskiyou and Modoc counties (DAC areas) e.g., impacts to homeowners by dewatering of lakes with homes built along the shores, loss of recreational income for the counties, decrease in electrical power generation, and decrease in flood control capability.

Land Use Patterns

Forest and rangeland represent about 98 percent of this region's land area. Much of the region is identified as national forests, State and national parks, under the jurisdiction of the federal BLM, and Native Indian lands such as the Hoopa Valley and Round Mountain reservations. The major land uses in the North Coast region consist of timber production, agriculture, fish and wildlife management, parks, recreational areas, and open space. In recent years, the timber industry has declined as a result of economic issues and the expansion of environmental regulations (Siskiyou County 1978-2009; National Forest Growth 2009).

Failure to manage national forests by thinning and harvesting has caused an unnatural massive buildup of biomass which has reduced water available to streams by canopy interception of snow with the resultant increase in evapotranspiration (ET).

Over the past 10 years, there has been a sharp increase in cultivation and conversion of forest lands to marijuana agriculture. Marijuana is a water-intensive crop, averaging 6 gallons per plant per day (for a mature plant, grown outside) according to the Humboldt Grower's Association 2010 document: "Humboldt County 314-55.1 Medical Marijuana Land Uses Draft Proposal" (proposed "Medical Marijuana Health and Safety Code"). This industry uses a variety of irrigation methods, often utilizing surface water diversions. For more information, please see: http://library.humboldt.edu/humco/holdings/HGA2.pdf.

Vacationers, boaters, anglers, and sightseers are attracted to the region's 340 miles of scenic ocean shoreline, including nearby forests with more than half of California's redwoods. The

Figure NC-9 Disadvantaged Communities in the North Coast Hydrologic Region

inland regions are mountainous and include 10 wilderness areas run by the USFS. More than 40 State parks, numerous USFS campgrounds, the Smith River National Recreation Area, and the Redwood National Park are within this hydrologic region.

Climate, soils, water supply, and remoteness from markets are factors that limit the types of agricultural crops that can be grown in the North Coast region. In the inland valley areas, there is more irrigable land than can be irrigated with existing developed water. The trend in land use has been one of land consolidation to form larger holdings and the conversion of prime agricultural land to urban growth. This trend is a result of low crop values, the lack of additional inexpensive surface water, and the ability to use only the most economically developable groundwater. The cost of environmental regulation and uncertainty of continued water supply for irrigation also contribute to decisions to convert land from agricultural use.

California has designated agricultural water use as a primary beneficial use of water. Irrigated agriculture in the North Coast region uses most of the region's developed water supplies. Irrigation today accounts for about 81 percent of the region's non-environmental water use, while municipal and industrial use is about 19 percent. About 422,300 acres, or about 3.4 percent of the region, is irrigated. Of that, 276,840 acres lie in the Middle and Upper Klamath River basins, above the confluence of the Salmon and Klamath rivers, where the main irrigated crops are pasture and alfalfa, grain, potatoes, garlic, strawberries, horse radish, and a few other assorted truck crops. Agricultural areas in these basins include Scott, Shasta, and Butte valleys and Tule Lake region and account for approximately 65 percent of irrigated agriculture within the North Coast region. Even though the predominant crops in the remainder of the region are pasture and alfalfa, there are significant acreages of other crops including orchards, vineyards, and various row and truck crops. The highest value crops in the region are the substantial acres of grapes and orchards in the Russian River Basin and ornamental flowers and bulbs in Del Norte County.

In the southern portion of the region, the total acreage of fruit and nut orchards decreased over a 15-year period. For example, in Sonoma County, orchards declined from 48,800 acres in 1992 to approximately 3,600 acres in 2007. However, the amount of irrigation water used on orchards did not decrease in the same proportion because many of the apple, prune, and walnut orchards taken out of production were not irrigated. In addition, as the acreage of orchards declined, the acreage planted in vineyards increased. In Sonoma County, grape acreage increased from 34,399 acres in 1992 to 57,568 acres in 2007, an increase of 23,169 acres.

Most of the newer grape vineyards use drip irrigation systems for irrigation allowing plantings in areas previously unavailable, i.e., sloping hillsides. However, in addition to irrigation for production, overhead sprinklers are used in vineyards for frost protection in the spring and for post-harvest irrigation in the fall, increasing the water demand for this crop over the direct water use by the crop. Land previously non-irrigated and subsequently placed in production increases the water demand of the region beyond historical levels. With the development of low pressure drip irrigation systems, farmers are able to move in to areas unavailable prior to the low pressure technologies. This places a greater demand on the available water resources requiring surface water infrastructure improvements or reliance on groundwater (National Agricultural Statistics Service 1994, 2008, 2011; Sonoma County Agricultural Commissioner 2008).

According to the 2007 Census of Agriculture, the North Coast Hydrologic Region contained 249 dairy farms with 54,234 milk cows. This amounted to about 11.5 percent of the dairy farms in California and about 2.9 percent of the milk cows. The majority of the dairy farms in the North

Coast Region in 2007 were in Humboldt County with 82 farms and in Sonoma County with 93 farms. A comparison of 2007 to 2002 data, shows a trend of fewer and larger dairy farms in the region over the 5-year period (National Agricultural Statistics Service 2002, 2007).

Dairies can have water quality impacts resulting from discharges of waste and/or whey to streams, and from the presence of animals in waterways. The North Coast Regional Water Quality Control Board (NCRWQCB) Dairy Regulation Program offers three permitting options: a National Pollutant Discharge Elimination System (NPDES) permit, a Waste Discharge Requirements Order, and a Waiver of Waste Discharge Requirements, depending on the level of risk to water resources. Unlike most other regions, the dairies in the North Coast are mostly small and family-run, concentrated in southern Sonoma County and the Eel River delta in Humboldt County. Groundwater impacts (such as nitrates) from dairies have not been documented, but groundwater monitoring will be performed, pursuant to the Dairy Program requirements.

Urban acreage in the North Coast region is located primarily in the Eureka area and Russian River basin. (See content under “Population” in “Demographics” section.)

Land use issues in the region include activities causing soil erosion such as road construction, logging, and hillside agriculture (vineyards), which affects native fish spawning. However, there is very little new road construction in the forests, and the USFS has implemented its Travel Management Plan, closing many roads. Logging is very limited. Where there is logging, roads are being improved and designed to reduce sediment. Logging practices have been modified to limit damage to the forest.

Since the principal reaches of the Klamath, Eel, and Smith rivers have been designated wild and scenic under federal and State law, they are protected from additional large-scale water development. Many of the region’s watersheds support threatened and endangered species of plants and animals, and many North Coast streams and rivers support runs of salmon and steelhead trout.

Diversity of Agriculture in North Coast Region

Agriculture in the North Coast region is as diverse as its climate and people. Aquaculture along the coast to potatoes and wild rice grown in the high desert areas of Modoc County depict the diversity of crop production in the region. Although grain, hay, pasture, livestock and lumber account for the majority of crops produced, many other crops provide for the rural lifestyle and setting in Northern California. Each county in the North Coast region is unique in its mix of crops, especially when compared to the region as a whole. Agricultural Commissioners’ Crop Reports (available online http://www.nass.usda.gov/Statistics_by_State/California/Publications/AgComm/Summary/index.asp) provide details on each of the counties major crop mix as well as approximate value of each commodity.

Although not found in the Agricultural Commissioners’ Crop Reports, one crop that is common to most areas in the region is marijuana — for both legal and illegal distribution. Many areas in the coastal and inland counties provide ideal soil and weather conditions for marijuana growth with water being the limiting factor. According to local county supervisors, small, legal (medical) marijuana crops grown for personal uses are not significantly impacting the environment. Unfortunately, although the USFS and logging companies are doing all they can to assist in improving the watersheds, clandestine marijuana growers — with their large surface water diversions, illegal road building, and land clearing — are continuing to cause sediment and chemical runoff that negatively affect the watersheds.

Regional Resource Management Conditions

Water in the Environment

The NCIRWMP identifies six primary objectives for the region. These objectives are consistent with State water management elements, State priorities and objectives, and IRWM Program Preferences. For more information on IRWM, see the following links: http://www.water.ca.gov/irwm/grants/index.cfm and http://www.water.ca.gov/irwm/stratplan/. The primary objectives are (1) conserve and enhance native salmonid populations by protecting and restoring required habitats, water quality, and watershed processes; (2) protect and enhance drinking water quality to ensure public health; (3) ensure adequate water supply while minimizing environmental impacts; (4) support implementation of total maximum daily loads (TMDLs), the NCRWQCB Watershed Management Initiative, and the Nonpoint Source Program Plan; (5) address environmental justice issues as they relate to disadvantaged communities, drinking water quality and public health; (6) provide an ongoing, inclusive framework for efficient intra-regional cooperation, planning, and project implementation.

Instream Fisheries Requirements

SWRCB adopted the North Coast Instream Flow Policy on May 4, 2010. It applies to applications to appropriate water, small domestic use and livestock stock pond registrations, and water right petitions. This policy applies to water diversions from all streams and tributaries discharging to the Pacific Ocean from the mouth of the Mattole River south to San Francisco and all streams and tributaries discharging to northern San Pablo Bay. The policy area includes approximately 5,900 stream miles and encompasses 3.1 million watershed acres (4,900 square miles) in Marin, Sonoma, portions of Napa, Mendocino, and Humboldt counties (State Water Resources Control Board 2012). In 2012, SWRCB vacated the 2010 Policy for Maintaining Instream Flows in Northern California Coastal Streams. A hearing for adoption of a revised policy was held by the SWRCB on October 22, 2013. For more information, see http://www.waterboards.ca.gov/waterrights/water_issues/programs/instream_flows/.

Water Supplies

Many of the smaller communities and rural areas in the North Coast region are supplied by small local surface water and groundwater systems. Larger water supply projects in this region include USBR's Klamath Project, the USACE Russian River Project (Lake Mendocino and Lake Sonoma), and the Humboldt Bay Municipal Water District's Ruth Reservoir, which serves coastal communities from Eureka to McKinleyville. Because the Upper Klamath River watershed is in both California and Oregon, the federal Klamath Project includes water supply facilities in both states. Facilities within the California portion include Clear Lake Reservoir for water supply, Tule Lake and Lower Klamath Lake as waterfowl refuges, and Iron Gate Reservoir as a hydroelectric facility of Pacific Power and Light Company. The primary water supply facilities on the Oregon side are Gerber Reservoir and Upper Klamath Lake. The Klamath Project is the largest agricultural irrigation project in the region and supplies water to about 240,000 acres, of which 62 percent is in Oregon and 38 percent is in California. To maintain adequate instream fishery flows for the lower Klamath River, water releases must be coordinated among the various reservoirs operated by different agencies within both states.

Two of the largest water supply reservoirs in the North Coast region are USBR's 2.437-maf Trinity Lake on the Trinity River and the USACE 380,000 acre-foot Lake Sonoma in the Russian River watershed. These facilities provide water for instream flows, recreation, hydropower, and water supply purposes. Water from Trinity Lake is exported from the North Coast region to the Sacramento River region through USBR's Clear Creek Tunnel. Lake Sonoma is operated to provide flood control and instream flows in the Lower Russian River in Sonoma County. An intra-basin water transfer system owned and operated by PG&E, known as the Potter Valley Project, has been in existence since 1908 and diverts water from the upper reaches of the Eel River at Cape Horn Dam through a tunnel to the East Fork Russian River upstream from Lake Mendocino (see "Pacific Gas &Electric's Potter Valley Project" under "Project Operations" section). The water stored behind Coyote Dam (Lake Mendocino, built in 1958) provides water to meet instream flows, agriculture, recreation, hydropower, and water supply in Mendocino County and in Sonoma County, particularly upstream of the Russian River confluence with Dry Creek.

Early gold mining activities in the Scott and Shasta River valleys established water rights as early as the 1850s and 1860s. These rivers have been declared "fully appropriated" and are adjudicated under decree of the Superior Court of Siskiyou County.

Surface Water

Surface water storage in the North Coast region in 2006, a wet year, was 2,060 thousand acre-feet (taf) at the end of November. In 2007, during the beginning period of the most recent drought, surface water storage at the end of November was 1,621 taf. In November 2008, reservoir storage was 1,257 taf; in 2009, it was 1,169 taf; in 2010, 1,892 taf; and in 2011, it was 2,308 taf, showing how variable the water supply can be. For comparison, reservoir storage at the end of November 1977 (the driest period in recent years) was 304 taf whereas the wettest period in recent times was in 1983 when the North Coast had 2,264 taf of storage (although less than in 2011). This water is used for urban, municipal, rural residential needs, agriculture, State and federal water supply projects, managed wetlands, required Delta outflow, instream flow, and wild and scenic rivers flow. When water supplies fall short, as they did in 2008 and 2009, the wild and scenic rivers and environmental uses receive the largest reductions.

The amount of surface water in the North Coast region is extremely dependent upon precipitation as described above. In very wet years, there may be a surplus; but in drought years, quantity is limited and can become a source of contention between water users. For example, the Klamath Basin has had water shortage problems in the recent past that have led to confrontations between farmers and regulators and farmers and environmentalists. As the population of the region grows, drinking water will continue to experience increases in demand, making the identification of alternative sources for agricultural and landscape irrigation a high priority. The North Coast Regional Water Management Group, now known as the North Coast Resource Partnership (NCRP) provides the framework for regional cooperation and collaboration to determine the optimal strategies to ensure that surface water supply is able to meet environmental and human-related beneficial uses during both surplus and drought water years. Please refer to Figure NC-10 for the regions inflows and outflows in water year 2010.

Groundwater

In the North Coast Hydrologic Region, there is limited large-scale groundwater development due to the small number of significant coastal aquifers. Most of the groundwater development has occurred from shallow wells installed adjacent to rivers. However, as indicated previously, there are significant groundwater basins underlying the Klamath River valley along the Oregon border and the southern tip of the region underlying Santa Rosa in Sonoma County. Many domestic and irrigation wells draw water from permeable zones within these deposits. Despite the limits on large-scale infrastructure, groundwater is utilized widely throughout the region for individual domestic, agricultural, and industrial water uses. Many rural areas rely exclusively on private wells for residential water. There are also an unknown number of small dams, and water-related infrastructure, which may have a large cumulative impact on groundwater. Groundwater is a significant water source for some small rural communities that rely on residential wells for water, but as discussed below groundwater contributes to about one-third of the total water supply in the region.

Groundwater basins in the Redwood Creek watershed are the Redwood Creek Area and Prairie Creek Area groundwater basins. The Orick Community Services District provides domestic water through a centralized distribution system that includes two wells located adjacent to Redwood Creek in the northern part of town. In the Redwood Creek watershed, there are no water development projects such as dams and surface water diversions.

Siskiyou County has developed several codes regarding groundwater. A Groundwater Advisory Committee has been appointed and is active for Scott Valley (Siskiyou County Code of Ordinances 2012). Adjudication for the Scott Valley includes a defined interrelated groundwater area.

The amount of groundwater supply in the North Coast region varies yearly with precipitation, infiltration, and the amount of withdrawals from groundwater basins. Withdrawals, in turn, are in part dependent on the amount of surface water available for municipalities that use both surface and groundwater for supply needs.

In Sonoma County, in addition to surface water, groundwater is an important water source because it provides the domestic water supply for most of the unincorporated portions of the county and is a primary source of water for agricultural uses. Groundwater also provides a portion of SCWA's water supply, extracted from three SCWA wells located along the Russian River-Cotati Intertie Pipeline in the Santa Rosa Plain,. Most of SCWA's customers also have their own local groundwater supplies. For more information on groundwater resources and management in Sonoma County, see the Volume 2 regional report, *San Francisco Bay Hydrologic Region*.

Groundwater supply estimates are based on water supply and balance information derived from DWR land use surveys, and from groundwater supply information that water purveyors or other State agencies voluntarily provide to DWR. Groundwater supply is reported by water year (October 1 through September 30) and categorized according to agriculture, urban, and managed wetlands uses. The groundwater information is presented by planning area (PA), county, and by the type of use. Although groundwater accounts for about one-third of the region's water supply, the majority of groundwater supplies (83 percent) are used to meet agricultural use while 16 percent goes to urban use. Only about 1 percent of the groundwater supply is used to meet wetlands use.

Figure NC-10 **North Coast Regional Inflows and Outflows in 2010**

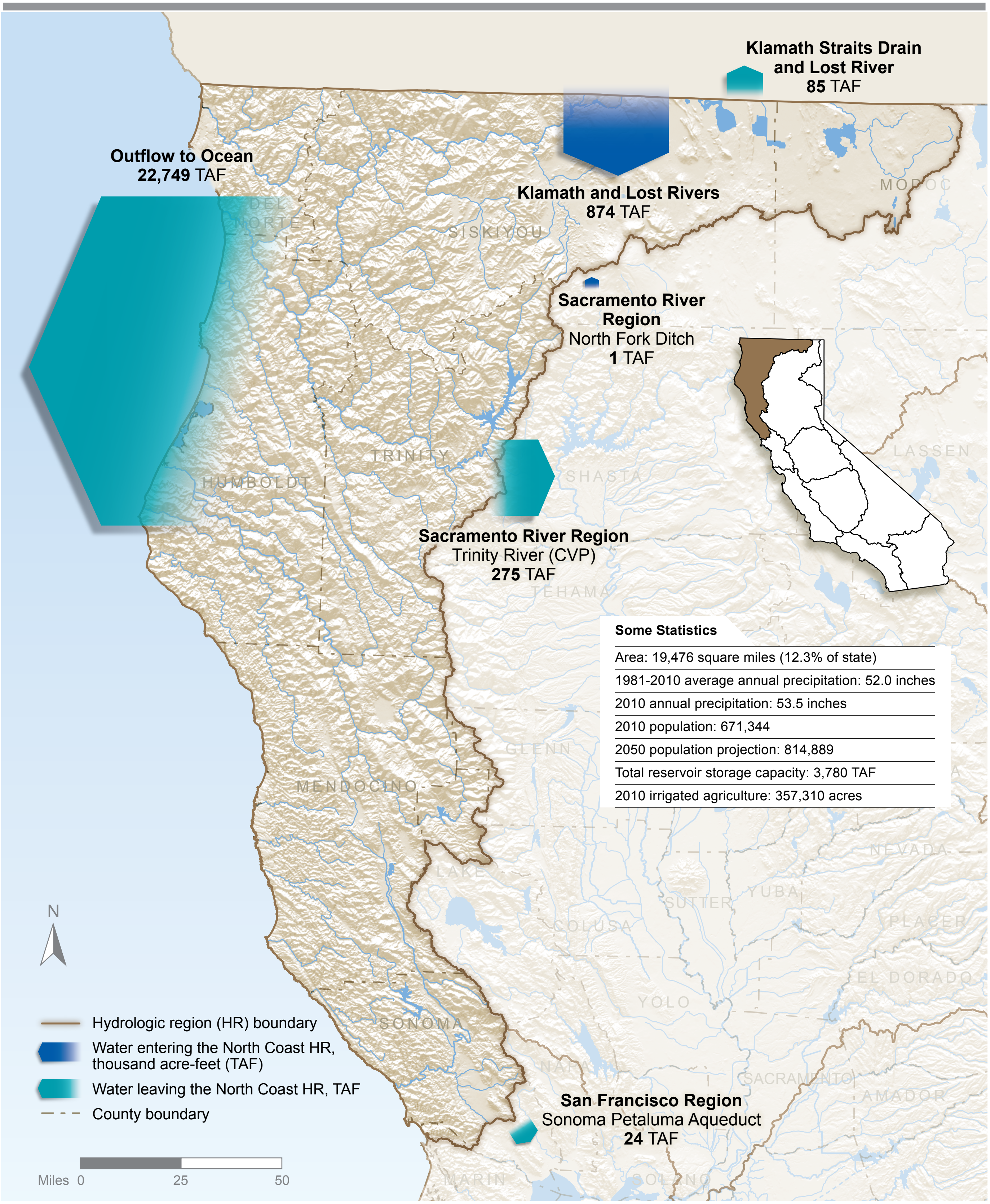


Figure NC-11 depicts the planning area locations and the associated 2005-2010 groundwater supply in the region. The estimated average annual 2005-2010 total water supply for the region is about one maf, of which 364 taf is from groundwater supply (32 percent). (Reference to total water supply represents the sum of surface water and groundwater supplies in the region and local reuse.) The figure also shows that the Upper Klamath planning area is the largest user of groundwater in the region: an average annual supply of 192 taf (53 percent of the total groundwater supply for the region).

Table NC-9 provides the 2005-2010 average annual groundwater supply by planning area and by type of use. Groundwater supplies meet 41 percent (301 taf) of the overall agricultural water use and 41 percent of the overall urban water use (60 taf) in the region. Groundwater resources are used for meeting only 1 percent of the managed wetlands use. Although the Upper Klamath planning area relies on groundwater supplies for only 24 percent of its overall water use, it relies on groundwater to meet 63 percent of its urban water use. The Coastal planning area provides an average annual groundwater supply of 82 taf (62 percent of the overall water supply), which meets 77 percent of the agricultural water use and 37 percent of the urban water use in the planning area. Similarly the Russian River area provides an average annual groundwater supply of 76 taf (50 percent of the overall water supply), which meets 62 percent of the agricultural water use and 38 percent of the urban water use in the planning area.

Although groundwater extraction in the region accounts for only about 2 percent of California's 2005-2010 average annual groundwater supply, it accounts for 100 percent of domestic supply for many rural communities in the region and is also heavily relied upon to meet agricultural uses. Regional totals for groundwater based on county area will vary from the planning area estimates shown in Table NC-9 because county boundaries do not necessarily align with planning area or hydrologic region boundaries.

For the North Coast Hydrologic Region, county groundwater supply is reported for Del Norte, Siskiyou, Trinity, Humboldt, Mendocino, and Sonoma counties; groundwater supply for Modoc and Lake Counties are reported in the Sacramento River Hydrologic Region report. Table NC-10 shows that groundwater contributes to 39 percent of the total water supply for the six-county area; ranging from 30 percent for Siskiyou County to 72 percent for Humboldt County. Groundwater supplies in the six-county area are used to meet 48 percent of the agricultural water use and 40 percent of the urban water use.

Changes in annual groundwater supply and type of use may be related to a number of factors, such as changes in surface water availability, urban and agricultural growth, market fluctuations, and water use efficiency practices. Figures NC-12 and NC-13 summarize the 2002 through 2010 groundwater supply trends for the North Coast Hydrologic Region.

The right side of Figure NC-12 illustrates the annual amount of groundwater versus other water supplies, while the left side identifies the percent of the overall water supply provided by groundwater relative to other water supplies. The center column in the figure identifies the water year along with the corresponding amount of precipitation, as a percentage of the 30-year running average for the region. The figure indicates that the annual groundwater supply for the region has fluctuated between 300 taf (in 2005) and 400 taf (in 2007), each year providing 32 percent of the total water supply.

Figure NC-11 **Contribution of Groundwater to the North Coast Hydrologic Region Water Supply by Planning Area (2005-2010)**

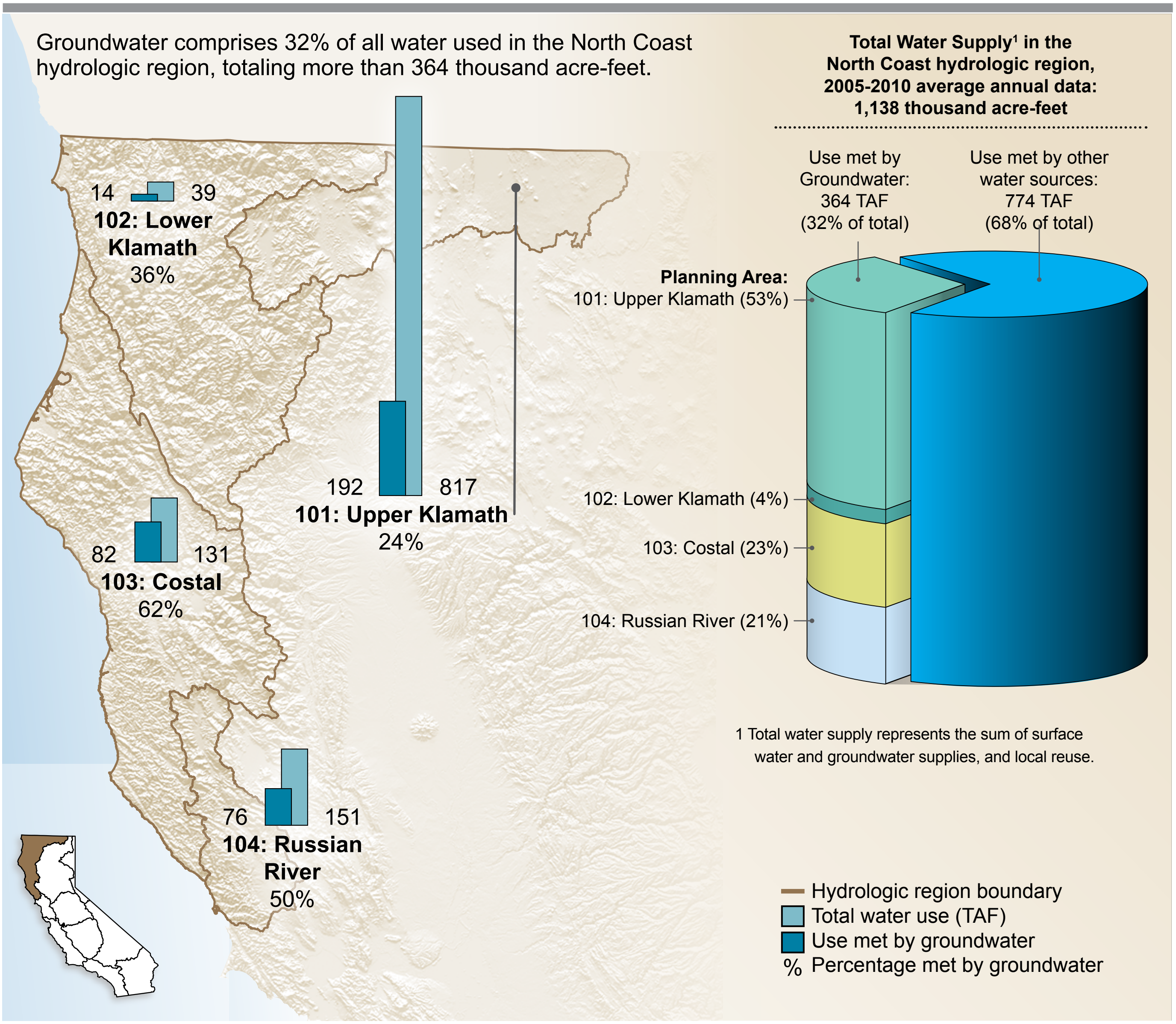


Figure NC-13 shows the annual amount and percentage of groundwater supply to meet urban, agricultural, and managed wetland uses. The figure indicates that about 80 to 85 percent of the annual groundwater supply met agricultural use and about 15 to 20 percent of the annual groundwater supply met urban use. Groundwater remained a minor supply at about 1 percent for meeting managed wetland use.

More detailed information regarding groundwater water supply and use analysis is available online from *California Water Plan Update 2013,* Volume 4, *Reference Guide,* in the article "California's Groundwater Update 2013."

Table NC-9 North Coast Hydrologic Region Average Annual Groundwater Supply by Planning Area (PA) and by Type of Use (2005-2010)

North Coast Hydrologic Region		Agriculture Use Met by Groundwater		Urban Use Met by Groundwater		Managed Wetlands Use Met by Groundwater		Total Water Use Met by Groundwater	
PA NUMBER	PA NAME	TAF	PERCENT	TAF	PERCENT	TAF	PERCENT	TAF	PERCENT
101	Upper Klamath	182.6	33	7.2	65	2.5	1	192.3	24
102	Lower Klamath	8.2	30	5.9	51	0.0	0	14.1	36
103	Coastal	63.9	77	18.1	37	0.0	0	81.9	62
104	Russian River	46.7	62	29.1	38	0.0	0	75.8	50
2005-2010 annual average region total		**301.3**	**41**	**60.3**	**41**	**2.5**	**1**	**364.0**	**32**

Notes:

TAF = thousand acre-feet

Percent use is the percent of the total water supply that is met by groundwater, by type of use.

2005-1010 precipitation equals 99 percent of the 30-year average for the North Coast Region.

Recycled Water

Municipal recycled water is provided by 15 public and private water suppliers in the North Coast region. In 2009, the year of the last detailed recycled water use survey, almost 26,000 acre-feet (af) of municipal recycled water was beneficially reused in the region. This represents just less than 4 percent of the state's 669,000 af for that year. Almost half of the North Coast recycled water was used at a single location — the Geysers geothermal facility (see "Geysers Recharge Project" below). Another 8,700 af were provided for agricultural irrigation by nine recycled water suppliers, including the City of Windsor and Rohnert Park, SCWA, and the California Department of Corrections and Rehabilitation at Pelican Bay. The City of Arcata beneficially reused 1,855 af to support the 100-acre Arcata Marsh.

Additional information on statewide municipal recycled water is included *California Water Plan Update 2013,* Volume 3, Chapter 12, "Municipal Recycled Water." Additional information on specific recycled water uses in the North Coast Hydrologic Region can be found in Volume 4.

Geysers Recharge Project

The Santa Rosa Sub-regional Reclamation System reclaims water, treats it to a tertiary level, and distributes it to agricultural users, golf courses, public and private landscaping, and the Geysers steamfield. Santa Rosa's reclamation system is one of the largest reclaimed water agricultural irrigation systems in the country. For the Geysers Recharge Project, reclaimed water is piped

Figure NC-12 North Coast Hydrologic Region Annual Groundwater Water Supply Trend (2002-2010)

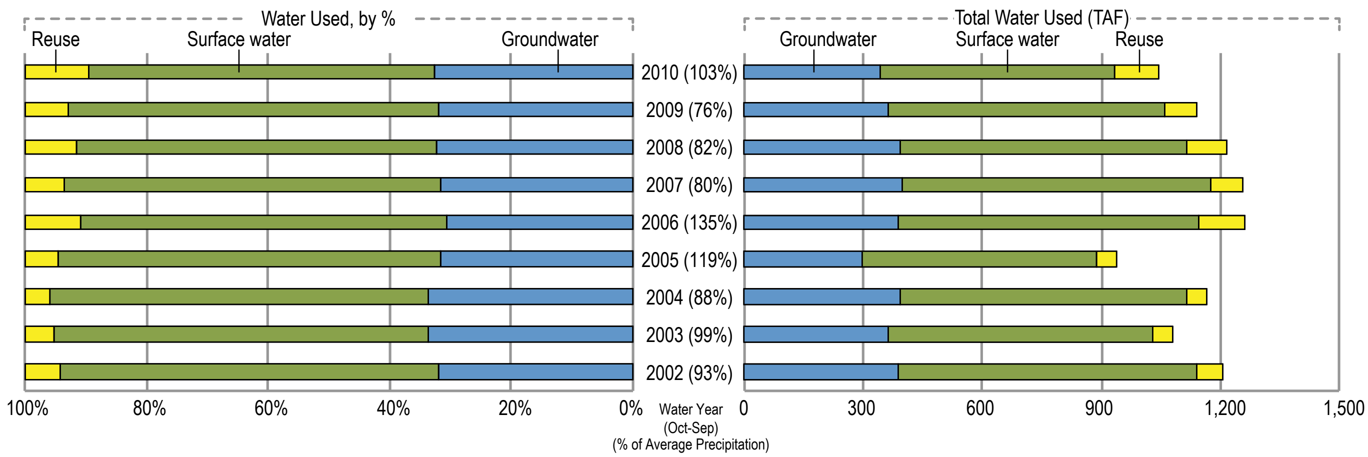
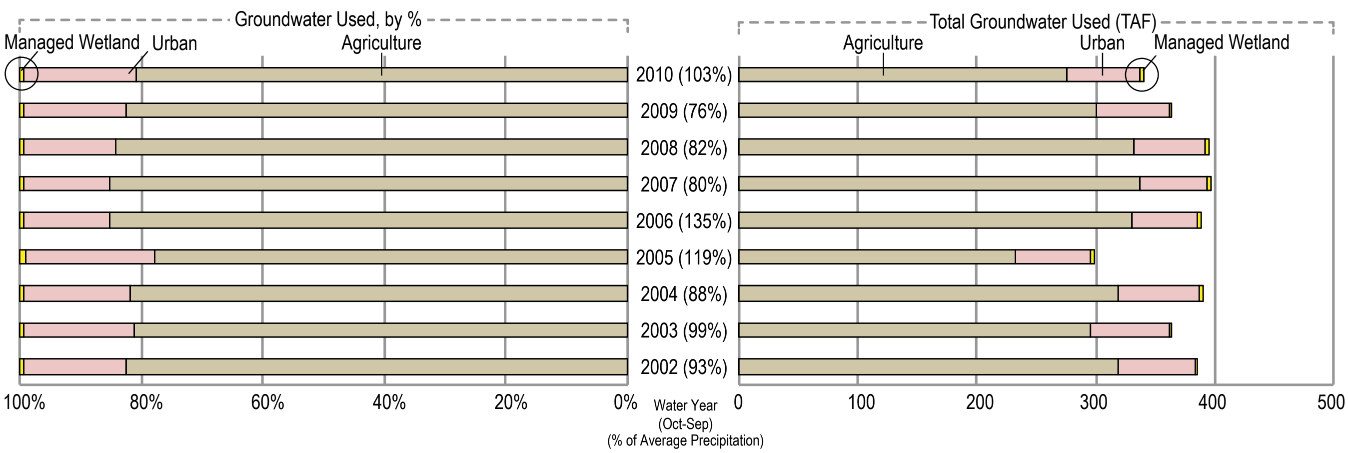


Figure NC-13 North Coast Hydrologic Region Annual Groundwater Supply Trend by Type of Use (2002-2010)



through a 42-mile pipeline and injected into underground wells in the Geysers steamfield in Sonoma and Lake counties. Once within the wells, the water is gradually heated by geothermal activity to produce a steam that is then utilized to produce electricity at nearby power plants. The Geysers Recharge Project was chosen as a means to dispose of treated wastewater during the winter months, when there is no demand for agricultural irrigation. The Sub-regional Reclamation System had previously been discharging the unused water to the Russian River, but stricter water quality regulations removed this option. The Sub-regional Reclamation System is currently exploring other means of reusing or disposing of current and future amounts of reclaimed water in order to best manage water resources.

In November 2003, the Geysers Recharge Project began pumping 11 million gallons per day of highly treated wastewater from the Laguna Treatment Plant to the Geysers steamfields, high

Table NC-10 North Coast Hydrologic Region Average Annual Groundwater Supply by County and by Type of Use (2005-2010)

North Coast Hydrologic Region	Agriculture Use Met by Groundwater		Urban Use Met by Groundwater		Managed Wetlands Use Met by Groundwater		Total Water Use Met by Groundwater	
COUNTY	TAF	PERCENT	TAF	PERCENT	TAF	PERCENT	TAF	PERCENT
Del Norte	4.6	49	1.7	40	0.0	0	6.3	46
Siskiyou	175.0	39	11.4	56	2.5	1	188.9	30
Trinity	3.2	35	1.8	42	0.0	0	5.0	37
Humboldt	58.5	92	17.9	42	0.0	0	76.4	72
Mendocino	24.3	47	7.4	43	0.0	0	31.7	46
Sonoma	43.7	74	29.6	35	0.0	0	73.3	51
2005-2010 annual average total:	**309.3**	**48**	**69.5**	**40**	**2.5**	**1**	**381.6**	**39**

Notes:

TAF = thousand acre-feet

Percent use is the percent of the total water supply that is met by groundwater, by type of use.

2005-2010 precipitation equals 99 percent of the 30-year average for the North Coast Region.

in the Mayacamas Mountains. In January 2008, the delivery was up to 12.62 mgd helping to generate enough electricity for 100,000 households in Sonoma and other North Bay counties.

The Geysers Expansion Project builds on the Geysers Recharge Project and will increase recycled water deliveries to the Geysers steamfield up to 19.8 mgd or as much as an additional 3,209 million gallons per year. Santa Rosa has completed negotiations with Calpine, the steamfield operator, and has signed a contract to send more water to the Geysers.

Imported/Exported Water

The North Coast region does not import water, but water transfers do occur within the region. For example, Eel River water is diverted at the Van Arsdale Dam into the East Fork of the Russian River (via PG&E's Potter Valley Project). The North Coast generally exports more water to other regions than the volume of water consumed within the region for agricultural and urban uses. Two out-of-region transfers include the CVP's TRD and wholesale water sales into the northern part of the San Francisco Bay Hydrologic Region via SCWA's and North Marin Water District transmission systems. See "Project Operations" section of this document for additional information.

Water Uses

The principal developed uses of environmental water occur in the Lower Klamath Lake, Tule Lake and Clear Lake National Wildlife refuges, and the Butte Valley and Shasta Valley wildlife areas. In Butte Valley, most of the water for wildlife comes from about 3,000 af of groundwater. As a result of the passage of both federal and State Wild and Scenic Rivers Acts in 1968 and 1972, many of the major rivers in the North Coast region have been preserved to maintain their free-flowing character and provide for environmental uses. Most of the Eel, Klamath, Trinity, and Smith rivers are designated as wild and scenic, which preserves these river resources and protects them from new water development. On the Trinity River, efforts to restore the fishery led to a federal Record of Decision (ROD) in year 2000 to increase the fishery flow releases from Trinity Lake. After several years of legal challenges, this decision was upheld by a July 2004 federal court decision. The water allocated to downstream fishery flows is now being increased from the previous 340,000 acre-feet per year (af/yr.), to a new schedule that ranges between 368,600 af in a critically dry year to more than 700,000 af/yr. in a wet water year. Biologists and CVP operators are still working on the development of daily, weekly, and monthly water-release schedules that will make the best use of these new water allocations.

Drinking Water

The region has an estimated 262 community drinking water systems. The majority (over 85 percent) of these community drinking water systems are considered small (serving fewer than 3,300 people) with most small water systems serving fewer than 500 people (Table NC-11). Small water systems face unique financial and operational challenges in providing safe drinking water. Given their small customer base, many small water systems cannot develop or access the technical, managerial, and financial resources needed to comply with new and existing regulations. These water systems may be geographically isolated, and their staff often lacks the time or expertise to make needed infrastructure repairs; install or operate treatment; or develop comprehensive source water protection plans, financial plans or asset management plans (U.S. Environmental Protection Agency 2012).

In contrast, medium and large water systems account for less than 15 percent of region’s drinking water systems; however, these systems deliver drinking water to more than 80 percent of the region’s population (see Table NC-11). These water systems generally have financial resources to hire staff to oversee daily operations and maintenance needs and to hire staff for planning future infrastructure replacement and capital improvements. This helps to ensure that existing and future drinking water standards can be met.

Agricultural Water Use

Annual Reference ET rates (Spatial ETo) for Selected Locations

Following are the annual reference evapotranspiration (ETo) rates from California Irrigation Management Information System (CIMIS):

- Smith River (Del Norte County) 42.36 inches
- Fortuna (Humboldt County) 44.58 inches
- Ukiah (Mendocino County) 43.64 inches
- Santa Rosa (Sonoma County) 40.24 inches

Table NC-11 Summary of Community Water System Inventory within the North Coast Hydrologic Region

Water System Size by Population	Community Water Systems (CWS)		Population Served	
	SYSTEMS	PERCENT	POPULATION	PERCENT
Large > 10,000	11	4	359,575	66
Medium 3,301-10,000	16	6	95,992	18
Small 500–3,300	40	15	57,482	11
Very small < 500	193	74	28,116	5
CWS that primarily provide wholesale water	2	1	---	---
Total	**262**	**---**	**541,165**	**---**

Source: California Department of Public Health (CDPH) Permits, Inspection, Compliance, Monitoring, and Enforcement Database, June 2012.

Note: Population estimates are as reported by each water system to CDPH and may include seasonal visitors.

- Etna (Siskiyou County, Scott Valley) 44.62 inches
- Montague (Siskiyou County, Shasta Valley) 44.19 inches
- Macdoel (Siskiyou County, Butte Valley) 43.50 inches
- Tule Lake (Modoc and Siskiyou counties) 42.99 inches

Values estimated by CIMIS and Spatial CIMIS do not account for rainfall, light rain (trace), fog, or dew formation. These values are site-specific and require direct observation by those applying the information. Rainfall entering the crop-soil profile (effective precipitation) can be subtracted from the water use demand on a daily basis. Effective precipitation (EP) is the amount of rainfall actually entering the soil and available to the plant, not running off as surface water or percolating through the soil beyond the root zone. For additional information on EP or rainfall, see web page at http://www.fao.org/docrep/S2022E/s2022e03.htm. Light rain, fog, and dew contribute to lowering the crop water demand by lowering the temperature and increasing the humidity in the micro-environment of the plant. When present, trace precipitation, fog, and dew only form for short time periods requiring frequent observation and good record-keeping. This is most important along the coast as fog and dew in these areas can contribute a great deal to meeting the water use demands of the crop. For more information on light rain, fog, and dew accounting for crop water use demand, see Correcting soil water balance calculations for dew, fog, and light rainfall by R. Moratiel, D. Spano, P. Nicolosi and R.L. Snyder, Irrigation Science paper: DOI 10.1007/s00271-011-0320-2 (California Department of Water Resources 2009).

Scott and Shasta Valley Study on Alfalfa Water Use

Blaine Hanson, Extension Specialist (Emeritus), Land, Air and Water Resources (University of California, Davis), in cooperation with Steve Orloff, Siskiyou County Farm Advisor (University of California Cooperative Extension), et al.., have been working on a study of alfalfa water use in California (including Scott and Shasta Valleys) from 2007 through 2010. The intention of the study is to develop new crop water-use values for alfalfa to be used by agriculture and planning and to compare these findings to historical text book assumptions. As of the writing of this document, study results are not yet published. However, preliminary results indicate that historical, seasonal ET rates for alfalfa in California have been overestimated, with the amount dependent on where the crop is grown and the type of soil. Observed seasonal alfalfa water use from this study for the Scott and Shasta valleys ranged from 32.8 to 39.6 inches whereas historical estimates ranged from 36.5 to 44.0 inches. The average seasonal difference between these two methods yielded a 3.25-inch over-application when using the historical values compared to the observed amounts. The median difference between the two methods is 2.25 inches for the season. As an example, if one were to apply an additional 3.25 inches of water over a typical 160-acre field for the season, the additional water necessary to apply would amount to 520 acre-inches or 43.3 af of additional water. This would be additional water required to meet expected seasonal crop demand if using the historical values. Furthermore, this additional water would need to be diverted or pumped during the irrigation season in order to meet the expected demand, which would require additional expense. (This does not count the water necessary to overcome the irrigation system efficiency and assumes a good uniformity of application.)

New Vineyard Irrigation Practices

The new vineyard installations use the latest technologies ensuring the optimum use of resources. However, non-point-source pollution from vineyards, including pesticides, is still a concern. Current cultural practices recommended by University of California Cooperative Extension include minimum tillage to prevent soil transport and minimum applications of fertilizer and pesticide at an agronomically proper rate. The goal of these recommendations is to minimize the impact agricultural (vineyard) management has on the environment. Although most vineyards with microspray and drip irrigation systems do not have much runoff, agricultural tail water return systems and settling basins for runoff help to conserve and protect water supplies.

Water Conservation Act of 2009 (SB X7-7) Implementation Status

Thirteen North Coast urban water suppliers have submitted 2010 urban water management plans to DWR. The Water Conservation Act of 2009 (SB X7-7) required urban water suppliers to calculate baseline water use and set 2015 and 2020 water use targets. The urban water management plans indicate the North Coast Hydrologic Region had a population-weighted baseline average water use of 147 gallons per capita per day with an average population-weighted 2020 target of 127 gallons per capita per day. The Baseline and Target Data for the North Coast urban water suppliers is available on the DWR Urban Water Use Efficiency Web site http://www.water.ca.gov/wateruseefficiency/.

The Water Conservation Act of 2009 (SB X7-7) required agricultural water suppliers who supply more than 25,000 irrigated acres to prepare and adopt agricultural water management plans by December 31, 2012, and update those plans by December 31, 2015, and every 5 years thereafter. All of the North Coast agricultural water suppliers supply fewer than 25,000 irrigated acres; as of August 2013, no agricultural water management plan had been submitted from the North Coast region.

Water Balance Summaries

Water balance figure and the narrative discussion below provide a detailed summary of the actual region-wide water supplies and water uses from years 2001 through 2010 for the entire North Coast region. Figure NC-14 summarizes the dedicated and developed urban, agricultural, and environmental water uses in the region for 2001 through 2010. The figure also provides a graphical presentation of all of the water supply sources that are used to meet the developed water uses within this hydrologic region for these years. As shown on the first graph, the volume of water dedicated to wild and scenic rivers, called "statutory required outflows," is the largest component of dedicated water uses in the region. The information presented in the Table NC-12 also indicates that the volume of water exported to other regions is generally greater than all the water consumptively used for urban, agriculture and wildlife refuges within the North Coast region. For more information on the water balances and portfolios, go to Volume 5, *Technical Guide*.

The water balance information for North Coast Hydrologic Region is summarized by planning area. In this region, the four PAs are Upper Klamath (PA 101), Lower Klamath (PA 102), Coastal (PA 103), and Russian River (PA 104).

Upper Klamath PA is primarily agricultural in nature, with water use ranging from about 615 to 680 taf per year, in comparison to about 10 to 12 taf urban use. This PA also supports considerable managed wetlands, which consumed about 225 taf water in 2010. This value is less than was applied in previous years, in which as much as 400 taf was used. There are no instream or wild and scenic designated rivers in this PA. Surface water supplies are split more or less equally between local supplies and the local federal project, at about 250 taf each. This supply is augmented with groundwater and reuse. Groundwater extraction averages about 180 to 200 taf, with about 70 to 75 taf being recharged back into the aquifer. Between 2006 and 2010, 125 to 156 taf of applied water was reused. Previously stored water (22 to 25 taf) was added to make up the difference between applied water and supplies.

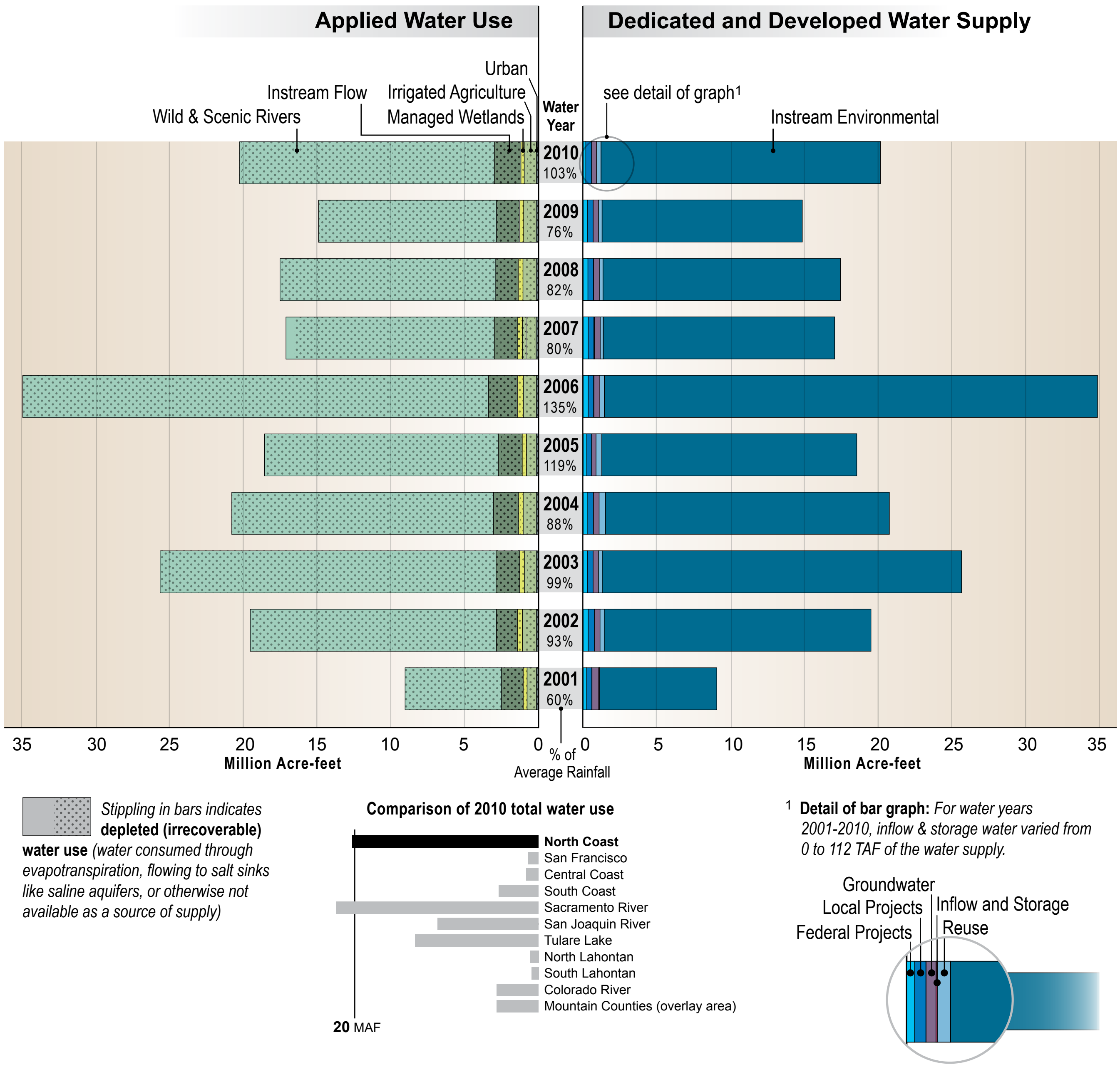
In the Lower Klamath PA, the primary application of water is for instream environmental uses. Instream and Wild and Scenic Requirements in these rivers of account for about 10 maf to 22 maf of applied water. The urban use is about the same as in the Upper Klamath PA. Agricultural applied water equals 20 taf to 40 taf, and there are no managed wetlands in this PA. As can be expected, most of the water comes from local sources, with about 4 taf to 7 taf from groundwater and another 2 taf from reuse.

In the Coastal PA, there are still a few wild and scenic rivers, which account for most of the applied water, ranging between 3 maf to 11 maf. Instream use is next in volume with about 100 taf. Urban use is greater than either of the more northern PAs, at about 50 taf; and agricultural applied water ranges from about 55 taf to 100 taf. There are a few managed wetlands in the PA, using about a thousand ace-feet total. Most of the water supply is from local sources, with an additional 100 taf of groundwater being pumped. 30,000 af are recharged back into the aquifer. There has been an increase to about 30 taf per year in reuse during 2008 to 2010.

The Russian River PA is the most urbanized area of the North Coast Hydrologic Region. Urban applied water ranges from 80 to 94 taf. There is about 100 to 125 taf for agricultural uses and 90 to 100 taf from instream. There are no wild and scenic rivers or managed wetlands in this PA. Local supplies account for about 100 to 133 taf. Local imports have been decreasing from

Figure NC-14 North Coast Water Balance by Water Year, 2001–2010

California's water resources vary significantly from year to year. Ten recent years show this variability for water use and water supply. Applied Water Use shows how water is applied to urban and agricultural sectors and dedicated to the environment and the Dedicated and Developed Water Supply shows where the water came from each year to meet those uses. Dedicated and Developed Water Supply does not include the approximately 125 million acre-feet (MAF) of statewide precipitation and inflow in an average year that either evaporates, are used by native vegetation, provides rainfall for agriculture and managed wetlands, or flow out of the state or to salt sinks like saline aquifers (see Table NC-12). Groundwater extraction includes annually about 2 MAF more groundwater used statewide than what naturally recharges – called groundwater overdraft. Overdraft is characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years.



For further details, refer to Vol. 5, *Technical Guide*, and the Volume 4 article, "California's Groundwater Update 2013."

Key Water Supply and Water Use Definitions

Applied water. The total amount of water that is diverted from any source to meet the demands of water users without adjusting for water that is depleted, returned to the developed supply or considered irrecoverable (see water balance figure).

Consumptive use is the amount of applied water used and no longer available as a source of supply. Applied water is greater than consumptive use because it includes consumptive use, reuse, and outflows.

Instream environmental. Instream flows used only for environmental purposes.

Instream flow. The use of water within its natural watercourse as specified in an agreement, water rights permit, court order, FERC license, etc.

Groundwater Extraction. An annual estimate of water withdrawn from banked, adjudicated, and unadjudicated groundwater basins.

Recycled water. Municipal water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur and is therefore considered a valuable resource.

Reused water. The application of previously used water to meet a beneficial use, whether treated or not prior to the subsequent use.

Urban water use. The use of water for urban purposes, including residential, commercial, industrial, recreation, energy production, military, and institutional classes. The term is applied in the sense that it is a kind of use rather than a place of use.

Water balance. An analysis of the total developed/dedicated supplies, uses, and operational characteristics for a region. It shows what water was applied to actual uses so that use equals supply.

North Coast Water Balance by Water Year Data Table (TAF)

	2001 (60%)	**2002** (93%)	**2003** (99%)	**2004** (88%)	**2005** (119%)	**2006** (135%)	**2007** (80%)	**2008** (82%)	**2009** (76%)	**2010** (103%)
APPLIED WATER USE										
Urban	149	152	155	157	155	153	159	158	161	155
Irrigated Agriculture	633	942	811	891	663	884	931	903	851	824
Managed Wetlands	254	345	304	301	291	399	311	311	281	225
Req Delta Outflow	0	0	0	0	0	0	0	0	0	0
Instream Flow	1,474	1,422	1,617	1,711	1,613	1,968	1,596	1,533	1,558	1,801
Wild & Scenic R.	6,548	16,697	22,783	17,752	15,866	31,583	14,132	14,632	12,075	17,274
Total Uses	**9,057**	**19,557**	**25,669**	**20,811**	**18,587**	**34,987**	**17,129**	**17,537**	**14,926**	**20,278**
DEPLETED WATER USE (STIPPLING)										
Urban	127	97	96	99	101	74	91	81	93	77
Irrigated Agriculture	516	708	612	656	485	667	694	665	621	611
Managed Wetlands	223	249	215	209	184	299	239	217	199	163
Req Delta Outflow	0	0	0	0	0	0	0	0	0	0
Instream Flow	1,474	1,398	1,593	1,509	1,428	1,879	1,557	1,484	1,508	1,689
Wild & Scenic R.	6,548	16,697	22,783	17,752	15,866	31,583	14,132	14,632	12,075	17,274
Total Uses	**8,888**	**19,148**	**25,298**	**20,225**	**18,064**	**34,502**	**16,712**	**17,078**	**14,496**	**19,814**
DEDICATED AND DEVELOPED WATER SUPPLY										
Instream	7,934	18,095	24,375	19,261	17,294	33,443	15,689	16,110	13,583	18,951
Local Projects	341	370	345	382	327	367	369	376	370	393
Local Imported Deliveries	18	47	46	2	2	38	41	3	2	1
Colorado Project	0	0	0	0	0	0	0	0	0	0
Federal Projects	238	336	274	304	241	338	336	316	297	173
State Project	0	0	0	0	0	0	0	0	0	0
Groundwater Extraction	453	386	364	391	298	388	398	394	363	343
Inflow & Storage	0	41	11	45	35	107	85	86	66	112
Reuse & Seepage	62	283	255	426	390	307	212	252	243	304
Recycled Water	12	0	0	0	0	0	0	0	1	1
Total Supplies	**9,057**	**19,557**	**25,669**	**20,811**	**18,587**	**34,987**	**17,129**	**17,537**	**14,926**	**20,278**

Table NC-12 **North Coast Hydrologic Region Water Balance for 2001-2010 (in taf)**

North Coast (taf)	Water Year (Percent of Normal Precipitation)									
	2001 (60%)	2002 (93%)	2003 (99%)	2004 (88%)	2005 (119%)	2006 (135%)	2007 (80%)	2008 (82%)	2009 (76%)	2010 (103%)
WATER ENTERING THE REGION										
Precipitation	31,254	50,520	53,304	47,461	64,296	72,720	43,139	44,265	40,870	55,352
Inflow from Oregon/Mexico	988	995	1,000	973	909	2,241	1,145	1,182	966	874
Inflow from Colorado River	0	0	0	0	0	0	0	0	0	0
Imports from Other Regions	2	2	2	2	2	2	2	2	2	1
Total	**32,244**	**51,517**	**54,306**	**48,436**	**65,207**	**74,963**	**44,286**	**45,449**	**41,838**	**56,227**
WATER LEAVING THE REGION										
Consumptive use of applied water[a] (Ag, M&I, Wetlands)	678	931	814	855	663	857	891	835	802	780
Outflow to Oregon/Nevada/ Mexico	66	100	72	85	67	123	98	97	53	85
Exports to other regions	703	671	895	1,023	498	1,386	648	587	567	299
Statutory required outflow to salt sink	8,021	18,095	24,375	19,261	17,294	33,462	15,689	16,116	13,583	18,963
Additional outflow to salt sink	5,396	3,873	5,611	4,499	4,192	10,870	2,691	3,239	2,111	3,770
Evaporation, evapotranspiration of native vegetation, groundwater subsurface outflows, natural and incidental runoff, ag effective precipitation & other outflows	18,018	28,085	22,366	23,129	42,509	28,509	24,966	25,214	25,203	31,888
Total	**32,882**	**51,755**	**54,133**	**48,852**	**65,222**	**75,207**	**44,983**	**46,087**	**42,319**	**55,785**
CHANGE IN SUPPLY										
[+] Water added to storage [-] Water removed from storage										
Surface reservoirs	-491	14	414	-166	170	12	-434	-378	-246	667
Groundwater[b]	-147	-252	-241	-250	-185	-256	-263	-260	-235	-225
Total	**-638**	**-238**	**173**	**-416**	**-15**	**-244**	**-697**	**-638**	**-481**	**442**
Applied water[a] (ag, urban, wetlands) (compare with consumptive use)	1,036	1,439	1,270	1,348	1,108	1,437	1,401	1,372	1,293	1,203

Notes:

taf = thousand acre-feet

M&I = municipal and industrial

[a] Definition: Consumptive use is the amount of applied water used and no longer available as a source of supply. Applied water is greater than consumptive use because it includes consumptive use, reuse, and outflows.

[b] Definition: Change in Supply: Groundwater – The difference between water extracted from and water recharged into groundwater basins in a region. All regions and years were calculated using the following equation: change in supply: groundwater = intentional recharge + deep percolation of applied water + conveyance deep percolation and seepage - withdrawals.

This equation does not include unknown factors such as natural recharge and subsurface inflow and outflow. For further details, refer to Volume 4, *Reference Guide*, the article “California’s Groundwater Update 2013” and Volume 5, *Technical Guide*.

about 40 taf in 2006 to none in 2010. About 75 taf of groundwater supplements this, with about 15 to 25 taf recharged back into the aquifer. The instream flows are reused as part of the local supply. There is also some recycled water in this planning area, which varies from 12 taf to zero, depending on the year and other conditions.

The water portfolios are estimates of present water balances of water uses and supplies for each region in California. The water portfolios are aggregated to spatial scales unique to the California Water Plan including the detailed analysis unit, planning area, and hydrologic region. Technical enhancements will allow this information to be evaluated at boundaries used by water purveyors and regional water management groups. A significant part of this work is to transition from the existing spreadsheet-based data storage of the water portfolio information to an enterprise data management system that will facilitate sharing of information through the Internet. Additional enhancements are under way to describe the hydrologic cycle components more fully within the water portfolios — groundwater in particular.

Project Operations

Pacific Gas & Electric's Potter Valley Project

The northern edge of Potter Valley in Lake County separates the Russian River watershed from the Eel River watershed, and in the year 1900 it was an ideal place to build a hydroelectric power plant. The Potter Valley Project was first licensed as a hydroelectric power plant in 1922 by the Federal Power Commission. The current license expires on April 14, 2022. See "Potter Valley Project FERC License" under "Water Governance" in this report. Annual flows in the Eel River are quite variable. In the relatively dry year of 2009, the peak flow in the beginning of March — as measured passing Cape Horn Dam at gage E-11 (downstream of the diversion) — for one day was over 5,000 cubic feet per second, quickly dropping to approximately 1,000 cfs and then back to the winter steady state of around 150 cfs before the next major rain. Peak winter flows can occasionally exceed 100,000 cfs. These winter storm events are captured and stored behind Scott Dam (Lake Pillsbury) for later use. Per a 2006 bathymetric survey, the maximum storage in Lake Pillsbury is 74,993 acre feet. From spring until fall, on an average rainfall year, approximately 125 cfs is diverted through the Potter Valley Project into the Russian River watershed. (Potter Valley Irrigation District 2010). This water is used by the Potter Valley Irrigation District, and a portion of it flows into Lake Mendocino.

Coyote Valley Dam and Lake Mendocino

Lake Mendocino is located on the East Fork of the Russian River (downstream of the Potter Valley Project hydroelectric facility), about 5 miles northeast of Ukiah in Mendocino County. The Coyote Dam (also known as Coyote Valley Dam) project was authorized by the Flood Control Act of 1944 and completed in 1958 for purposes of flood control, water supply, recreation, and streamflow regulation. Lake Mendocino has a flood storage capacity of 122,400 af and a total surface area of 1,822 acres. The lake has an ungated spillway, designed for a maximum release of 35,800 cfs. Major facilities include an anadromous endangered/protected fish species egg collection and imprinting facility, visitor cultural center complex, park headquarters, City of Ukiah-run electrical power plant (hydropower), developed campgrounds (300 sites), 18 primitive boat-in/hike-in campsites, a trail system, two boat launch ramps, swim beach, and picnic areas. Of the park's 5,110 acres, 689 are devoted to wildlife management (U.S. Army Corps of Engineers 2010a).

Warm Springs Dam and Lake Sonoma

Warm Springs Dam and Lake Sonoma is located on Dry Creek in Sonoma County, approximately 14 miles above the confluence with the Russian River. The project is located on 15,966 acres of land, situated approximately 14 miles northwest of Healdsburg.

Warm Springs Dam forms Lake Sonoma, which has a design capacity of 381,000 af and drains an area of approximately 130 square miles, or about 9 percent of the total Russian River basin. Construction started in 1967 and was completed in 1982. The dam is operated and maintained by USACE. The storage space for water conservation is owned by the SCWA, while the remaining part of the project is owned by USACE, which directs flood control releases from Warm Springs Dam.

The Don Clause Fish Hatchery (Warm Springs Fish Hatchery) is located on Dry Creek at the base of Warm Springs Dam. This facility is operated by DFW under a cooperative agreement with USACE. The hatchery was created as part of the Warm Springs Dam Project to compensate for loss of spawning and rearing habitat that was impounded and made inaccessible to anadromous fish by the dam.

SCWA owns and operates the Warm Springs Dam hydroelectric facility. The hydroelectric facility was completed in December 1988. SCWA operates the facility under a 50-year license issued by the Federal Energy Regulatory Commission (FERC) on December 18, 1984. The 3,000-kilowatt Francis turbine generators have a power rating of 2.6 megawatt (U.S. Army Corps of Engineers 2010b).

Sonoma County Water Agency's Transmission System

SCWA diverts water from the Russian River and delivers it to its customers through a transmission system. SCWA's diversion facilities extract Russian River underflow through six radial collector wells at production facilities adjacent to the Russian River. Two collector wells were constructed in the late 1950s, and the next three between 1975 and 1983. The sixth was completed in 2006. SCWA also operates the Russian River Well Field consisting of seven vertical wells, maintained for standby production and used as primary production facilities as needed. Three of the wells have a direct connection to the transmission system. SCWA's transmission system extends from its Russian River diversion facilities located near Forestville to the Santa Rosa, Petaluma, and Sonoma valleys. The transmission system consists of over 85 miles of pipelines. The major pipelines that comprise the system are known as the Santa Rosa Aqueduct (built in 1959), the Sonoma Aqueduct (built in 1963), the Petaluma Aqueduct (built in 1962), and the Russian River to Cotati Intertie (built in 1977). SCWA also owns the northern portion of the North Marin Aqueduct that extends from the terminus of the Petaluma Aqueduct to a booster station located near the border of Marin County with Sonoma County. The remainder of the North Marin Aqueduct is owned and maintained by the North Marin Water District, which transfers water to its service area and to Marin Municipal Water District. SCWA's costs to operate and maintain system facilities are paid by SCWA's main customers: the cities of Santa Rosa, Petaluma, Rohnert Park, Cotati, and Sonoma, the Town of Windsor and the Valley of the Moon and North Marin Water Districts. The Marin Municipal Water District also contracts for SCWA transmission system water.

More information on SCWA's water supply operations can be found in SCWA's 2010 Urban Water Management Plan available at http://www.scwa.ca.gov/files/docs/FINAL%202010%20UWMP.pdf.

R.W. Matthews Dam, Ruth Lake, and Mad River

R.W. Matthews Dam forms Ruth Lake in southern Trinity County. It impounds runoff from the upper quarter of the Mad River Basin, an area of approximately 121 square miles. The lake capacity is 48,030 af.

A portion of the water stored in Ruth Lake is released each summer and fall to satisfy the Humboldt Bay Municipal Water District's (HBMWD) downstream diversion requirements, as well as maintain minimum bypass flow requirements in the Mad River below Essex. Although the HBMWD impounds water at Ruth Lake and diverts water at Essex, the operations do not significantly affect the natural flow regime in the Mad River. (Essex is located on the Mad River 3.5 miles northeast of Arcata at an elevation of 75 feet.)

The total volume of water impounded and diverted by HBMWD represents a small percentage of the natural yield of the Mad River watershed. The Mad River's average annual discharge into the Pacific Ocean is just over 1 maf. Ruth Lake, in its entirety, represents less than 5 percent of the total average annual runoff from the Mad River basin. The entire 48,030-af capacity of Ruth Lake is not drawn down each year so the amount of winter-season runoff captured in the reservoir is yet a smaller percentage of the total runoff. With respect to diversions, the current withdrawal rate at Essex is approximately 25 mgd to 30 mgd (28,000 to 34,000 af/yr.), which is 3 percent of the total annual average runoff of the Mad River watershed. The full diversion capacity of 75 mgd (84,000 af/yr.) is 8 percent of the total annual average runoff of the watershed.

Tributaries downstream of Matthews Dam contribute significantly to, and are a major influence on, resulting flow rates in the Mad River. A former USGS gage station near Forest Glen was located 9 miles below the dam prior to the confluence of any major tributaries. Annual mean flow at the Forest Glen gage station increased by an average of 22 percent compared to the mean flows just below Ruth Lake. The more significant tributaries on the Mad River are located downstream of this former gage station. These tributaries contribute significantly to Mad River discharge and also provide a "buffering effect" during the few times the HBMWD is releasing from Ruth Lake less than the natural flow (e.g. during the first winter storms).

There is no out-of-basin transfer in the upper watershed, as occurs on some river systems. The water released by HBMWD flows down the main stem Mad River channel and augments flows, which would not occur naturally during the summer and fall. Flow augmentation has many beneficial effects, including expanding river habitat for the benefit of aquatic species and improving water quality in the summer and fall (Humboldt Bay Municipal Water District 2012).

Iron Gate Dam and Klamath River

Iron Gate Dam (Iron Gate Reservoir) is operated within the constraints of the Klamath Basin Operations Plan. The plan for the USBR's Klamath Project, which is located within the upper Klamath River Basin in southern Oregon and northern California, describes project operations on an annual basis from April 1 of one year through March 31 of the next, based upon current and expected hydrologic conditions.

USBR develops this plan annually to serve as a planning aid for agricultural water users, Klamath Basin tribes, national wildlife refuges, and other interested parties. The plan provides an estimated project water supply to the following areas:

- West Side delivery area: This area includes lands in southern Oregon and northern California that receive project water primarily from Upper Klamath Lake (UKL) and/or the Klamath River. This area also includes the Tule Lake and Lower Klamath National Wildlife Refuges.
- East Side delivery area: This area includes lands within Langell Valley Irrigation District and Horsefly Irrigation District (both in Oregon) on the east side of the project area. This area receives water from Clear Lake Reservoir (California), Gerber Reservoir (Oregon), and the Lost River (California and Oregon).

In response to both the 2010 National Marine Fisheries Service (NMFS) biological opinion (BO), and the 2008 U.S. Fish and Wildlife Service (USFWS) BO, the USBR developed a Variable Base Flow (VBF) procedure to be used for operations. The VBF procedure was developed based on the following objectives: (1) provide certainty in compliance with the UKL minimum elevations, as outlined in Table 2-1 of the 2008 USFWS BO and (2) provide a procedure that tracks the flows outlined in Table 18 of the 2010 NMFS BO and Reasonable and Prudent Alternatives. These objectives were designed to help meet the needs of coho salmon during critical periods of the year. For more information on the Klamath Basin Operations Plan, refer to the reference material listed at the end of this chapter (National Marine Fisheries Service 2010; U.S. Bureau of Reclamation 2012; U.S. Department of Interior 2008).

Iron Gate, Copco, and Dwinnell Reservoirs

Iron Gate and Copco reservoirs are operated for hydropower, water supply, and recreation. The Copco Reservoirs are located in the northern portion of Shasta Valley, upstream of Iron Gate Reservoir while Dwinell Reservoir is located in the southern portion of the valley. All of the reservoirs are important to the residences surrounding the lakes. Dwinnell reservoir (Lake Shastina) is for municipal water for the city of Montague, irrigation supply for the Montague Irrigation District, and recreation.

Trinity Dam and Exports from Trinity River to Central Valley

Trinity Dam stores water from the Trinity River in the Trinity Reservoir (Trinity Lake, formerly Clair Engle Lake). Water that is released from Trinity Dam is regulated by Lewiston Dam (directly downstream), which provides a forebay for diversion flows to the Clear Creek Tunnel. From the Clear Creek Tunnel, water then enters Whiskeytown Lake through Judge Francis Carr Powerhouse. Some of the water diverted from Whiskeytown Lake flows into the Clear Creek Unit South Main Aqueduct to irrigate lands in the Clear Creek Unit. The rest flows through the Spring Creek Power Conduit and Power Plant into Keswick Reservoir. From there, water goes through Keswick Power Plant to the Sacramento River. Exports from the TRD contribute to meeting minimum flow requirements in the Trinity and Sacramento rivers, help to maintain reservoir storage levels, and facilitate other CVP operating requirements such as compliance with the winter-run BO, which requires that certain temperature requirements be met in the Sacramento River below Keswick Dam.

Prior to construction of the TRD, average annual discharge at Lewiston was approximately 1.2 maf. Peak flows in excess of 100,000 cfs were recorded at the town of Lewiston, and daily average flows greater than 70,000 cfs occurred three times between 1912 and 1963. Following construction, instream flow releases were set at 120,500 ace-feet per year (10 percent of the average unimpaired inflow). From 1964 to 1996, TRD exports accounted for 14 percent of Keswick releases. In the period of 1986 through 1996, the TRD exports accounted for 12 percent of Keswick releases.

An outcome of TRD operations and the reduced instream Trinity River flows was degraded fish habitat and drastic reductions in anadromous fish populations. By 1980, it was estimated that fish populations had been reduced by 60 to 80 percent due to inadequately regulated harvest, excessive streambed sedimentation, and insufficient streamflows. The loss of fishery habitat was estimated to be 80 to 90 percent. To help address these problems, Congress passed the Trinity River Stream Rectification Act in 1980 (addressing sedimentation issues) and passed the Trinity River Basin Fish and Wildlife Management Act in 1984. The 1984 act directed efforts to restore fish and wildlife populations to levels that existed prior to TRD construction.

One of the provisions of the 1992 Central Valley Project Improvement Act was the establishment of a minimum flow volume of 340,000 af for the Trinity River. The CVPIA also directed the completion of the 12-year study (Trinity River Flow Evaluation Study - TRFES) to establish permanent instream fishery flow requirements, TRD operating criteria, and procedures for restoration and maintenance of the fishery. The TRFES report recommended specific annual flow released, sediment management, and channel rehabilitation to provide necessary habitat. The subsequent Trinity River Environmental Impact Statement (EIS)/Environmental Impact Report (EIR) and ROD in 2000 identified the annual water allocation for specific water year types (see the section below for more information about the Trinity River Restoration Program Restoration Flows).

USBR Flow Releases to the Trinity and Sacramento Rivers

USBR releases to the Trinity and Sacramento rivers include two types of releases, namely, Safety of Dams and Other releases.

- **Safety of Dams:** During the winter, USBR maintains lower levels in Trinity Lake to provide a buffer in the event of an extremely large winter storm. The quantity of that buffer is based on several factors and primarily references many years of hydrologic record for the basin. Maintaining storage space is a very important aspect of flood control operations and is fundamental in protecting areas downstream of Trinity Dam, as well as the dam itself. As winter storms fill Trinity Lake, USBR may need to increase releases to maintain the lower lake levels. Because these elevated winter releases help protect the dam, they are commonly called "Safety of Dams releases" and may or may not occur in conjunction with actual winter storms. These releases are made independently from the ROD releases for river restoration. Safety of Dams releases are scheduled by USBR in response to current conditions and typically have no more advance warning than a few days. USBR uses a combination of increased releases to the Trinity River through Lewiston Dam and trans-basin diversions to the Sacramento River through the Clear Creek Tunnel to lower the water level in Trinity Lake (see http://www.trrp.net/background/ops/). Consequently, releases from Trinity Dam to Lewiston Reservoir may be higher than releases from Lewiston Dam to the Trinity River. Safety of Dams releases from Lewiston Dam to the Trinity River are typically no greater than 6,000 cfs, but may go higher if conditions warrant.
- **Other Releases:** USBR occasionally makes flow releases from Lewiston Dam to the Trinity River for other purposes such as tribal releases or to mitigate late summer conditions in the Lower Klamath River for fish health purposes. USBR coordinates these releases with

the Trinity River Restoration Program and usually provides several weeks' public notice. Such releases are independent from the ROD releases for river restoration (Trinity River Restoration Program 2012; U.S. Department of Interior 2000).

Trinity River Restoration Program – Restoration Flows

The ROD (U.S. Department of Interior 2000) directs USBR to provide annual instream flows below Lewiston Dam deemed necessary to restore and maintain the Trinity River's fishery resources. These restoration flows link two essential purposes: (1) flows to provide physical fish habitat (i.e., appropriate depths and velocities and suitable temperature regimes for anadromous salmonids); and (2) flows to restore the riverine processes that create and maintain the structural integrity and spatial complexity of the fish habitats. The ROD provides recommended daily release schedules for each of the five water year types (critical dry to extremely wet — Table NC-13). The ROD stipulates that "the daily schedule for releasing water for a given water year may be adjusted based on monitoring and studies guided by the Trinity Management Council but the associated annual water volume allocation may not be changed." A water year is the 12-month period from any October 1 through September 30 of the following calendar year. The 2012 water year extends from October 1, 2011, to September 30, 2012.

The predicted water year type is based on the April 1 forecast for the annual river runoff of the Trinity River at Lewiston, California. The annual runoff forecast is jointly developed by the National Weather Service and DWR for the entire state of California, including the Trinity River. Identical forecasts are published in the "Water Supply Outlook for California and Northern Nevada" (http://www.cnrfc.noaa.gov/water_supply.php) produced by the National Weather Service and in "Bulletin 120 Water Conditions in California" produced by DWR.

The finalized water-year forecast determines the water year type (e.g. wet, dry), and the ROD describes the volume of water available to the Trinity River Restoration Program for restoration releases for the different water year types. The Trinity River Restoration Program develops annual flow release recommendations through a collaborative process to meet ROD objectives for specific water year types. Trinity River Release and Diversion Summary since 2000 is listed in Table NC-14.

The Trinity Management Council makes the final flow recommendation that is then forwarded to the U.S. Department of Interior for consideration (Trinity River Restoration Program 2012; U.S. Department of Interior 2000).

Gravel Mining

Historical gravel mining along many of the North Coast rivers and streams has presented a particular problem concerning sediment transport. Many (if not all) of the waterways have been affected by silt and clay deposition causing a negative impact on local and regional fish spawning areas. Several major gravel mining operations along the Russian River have been curtailed in recent years. Improvements such as settling basins have been implemented to control the amount of sediment outflow from these mining areas to help improve downstream water quality. The issuance of 401 water quality certifications is the primary mechanism for regulating water quality impacts from instream gravel mining. Some of the counties in this region (Humboldt and Sonoma) have gravel regulation programs in place that also play a significant role.

Table NC-13 Trinity River ROD Water Year Types

Water Year Type	Frequency of Occurrence	Volume (af)	Peak Release (cfs)
Critically dry	(12%)	369,000	1,500
Dry	(28%)	453,000	4,500
Normal	(20%)	647,000	6,000
Wet	(28%)	701,000	8,500
Extremely wet	(12%)	815,000	11,000

Notes:

af = acre-feet

cfs = cubic feet per second

In the northern portions of the region — particularly in the Van Duzen River, Eel River, and Mad River watersheds — an interagency regulatory group has focused efforts to improve aquatic habitat, primarily for salmonid species, through the gravel extraction process. An example would be the need to manage aggraded areas at the confluence of the Eel and Van Duzen rivers to allow adequate fish passage. Another example is the inclusion of riparian restoration as compensatory mitigation. Therefore, in some instance gravel extraction activities could be performed in an integrated water management fashion that produces positive benefit for both the environment and the economy. However, a key factor is to understand a watershed's current baseline of gravel deposition and how stream equilibrium would relate to a sediment budget that supports beneficial uses. Additionally, considering stream conditions and functions are critical components of managing resources in a way that support beneficial uses. NCRWQCB staff recommends that watershed assessment precede significant land use decisions, as a way of identifying the overlapping priorities of multiple parties.

Statewide Instream Mining (Suction Dredge Mining)

Instream mining (specifically, suction dredge mining) has been curtailed in California as of 2008 with no set ending date on the moratorium. The Legislature and governor enacted Senate Bill 1018 (2012). A part of this legislation applies to suction dredge mining. Suction dredging, including the method known as "booming," is prohibited within 100 yards of any California river, stream or lake (Fish & Game Code, Section 5653 subd. (d)).

The current moratorium originally established by SB 670 and extended by Assembly Bill 120 and SB 1018 does not prohibit or restrict nonmotorized recreational mining activities, including panning for gold. It also does not prohibit or restrict some other forms of mining, including, for example, practices known as high banking, power sluicing, sniping, or using a gravity dredge so long as gravel and earthen materials are not vacuumed with a motorized system from the river or stream. It is important to know that other environmental laws may apply to some of these mining practices. In addition, these activities may be subject to the authority of the appropriate RWQCB.

Small-scale suction dredge mining activity in California began in the 1960s and peaked during high gold prices in the late 1970s and early 1980s. The existing regulatory framework governing

Table NC-14 Trinity River Release and Diversion Summary Since 2000

Water Year	Forecast Water Year Type	Actual Water Year Type	Restoration Water Allocation	Actual Restoration Release	Safety of Dams Releases	Ceremonial Releases	Other Releases	Total Release to Trinity River	Peak Release Magnitude	Total Diversion through Carr Tunnels	Total Inflow into Trinity Reservoir	
					(acre-feet)				(cfs)	(acre-feet)		
	[G]	[I]		[A]	[A,B]	[A,B]	[A,B]	[A]	[A]	[C]	[C,F]	Notes
2000	Wet	Wet	340,000	359,600	200,400	-	-	560,000	5,310	1,108,600	1,660,200	[D]
2001	Dry	Dry	369,000	379,600	-	4,200	-	383,800	1,760	669,400	786,700	[E]
2002	Normal	Normal	470,000	482,700	-	-	-	482,700	6,040	629,000	1,243,800	[E]
2003	Wet	Wet	453,000	448,100	68,300	5,700	34,000	556,100	2,610	857,600	1,795,700	[E]
2004	Wet	Wet	646,900	651,000	81,100	-	36,200	768,300	6,200	987,500	1,443,000	[E]
2005	Normal	Wet	647,000	647,600	-	3,600	-	651,200	6,970	466,700	1,412,400	[H]
2006	Ex. Wet	Ex. Wet	815,000	809,900	406,300	-	-	1,216,200	10,100	1,350,600	2,396,500	[H]
2007	Dry	Dry	453,000	453,700	-	4,100	-	457,800	4,750	614,400	715,300	[H]
2008	Normal	Dry	647,000	648,700	-	-	-	648,700	6,470	555,000	835,800	[H]
2009	Dry	Dry	453,000	445,500	-	11,100	-	456,600	4,410	539,200	797,200	[H]
2010	Normal	Wet	647,000	656,700	-	-	-	656,700	6,840	274,700	1,538,000	[H]
TOTAL			**5,293,900**	**5,326,400**	**756,100**	**28,700**	**70,200**	**6,181,400**		**7,778,000**	**13,086,600**	

Notes: All water volume values are rounded to the nearest 100 acre-feet.

A – Computed from daily average flow record reported by the US Geological Survey for the Trinity River at Lewiston Streamgage # 11525500.
The accuracy of the flow records ranges from +/- 5 percent to +/- 15 percent on a time variable basis.

B – Volume estimate for flows above the summer or winter baseflow release for restoration.

C – Computed from daily average record provided by the U.S. Bureau of Reclamation. Reported negative daily inflow values included "as is" in calculations.

D – Water allocation prior to implementation of the 2000 Trinity River Mainstem Fishery Restoration Record of Decision.

E – Water allocation limited by Court order 2001-2004. Court ordered volumes varied by year.

F – Long-term average annual inflow to Trinity Reservoir (acre-feet/year) from 1911-2007 as provided by the U.S. Bureau of Reclamation = 1,254,000.

G – Water year type based on the April forecast (50% exceedance) from the Bulletin 120 – Water Conditions in California by the California Department of Water Resources.

H – Restoration water allocation as prescribed by the Trinity River Mainstem Fishery Restoration 2000 Record of Decision.

I – Actual water year type based on total inflow into Trinity Reservoir.

the activity as administered by DFW is rooted in statutory amendments to the Fish and Game Code that took affect originally in the late 1980s. Under the statute and regulations, any California resident or nonresident could (i.e., before the current moratorium) obtain a suction dredge mining permit from the DFW upon payment of a fee required by statute. On average, DFW issued approximately 3,200 suction dredge mining permits a year to California residents, and another 450 a year to nonresidents, from 1995 through 2009.

DFW's recent effort to amend the regulations and comply with the California Environmental Quality Act (CEQA) was required by a court order issued in a lawsuit brought against DFW by the Karuk Tribe of California. The lawsuit focused on the Klamath, Scott, and Salmon River watersheds in Northern California; included allegations regarding impacts to various fish species, including coho salmon; and contended that DFW's administration of the suction dredging program violated CEQA and various provisions of the Fish and Game Code.

Agricultural Lands Discharge Program

Staff of the NCRWQCB are developing an Agricultural Lands Discharge Program to address water quality impacts associated with irrigated agricultural lands in the North Coast region. Agricultural lands have the potential to contribute to water quality problems through the over-application of fertilizers and pesticides, human-caused erosion of sediment, pollutants in tailwater return flows, and the removal and suppression of riparian vegetation. The NCRWQCB staffs are developing the program to address these water quality issues and to meet the requirements of the CWC, the State Nonpoint Source Policy, and the Klamath River TMDLs.

While the scope of the program has not been finalized, it will include certain types of agricultural lands in the North Coast region and address discharges of waste. Staff expects the program to address, at minimum, waste discharges from agricultural lands such as row crops, vineyards, orchards, medicinal marijuana farms, nurseries, forage crops, and irrigated pasture. Dairies and dryland grazing are not included in the program as dairies are being addressed through a separate RWQCB program, and dryland grazing is likely to be addressed through a statewide effort that is currently under development. Additionally, this effort will be coordinated with existing RWQCB programs, such as the TMDL programs in the Scott, Shasta, and Garcia watersheds and grazing on USFS allotments. For more information on the Agricultural Lands Discharge Program, see: http://www.waterboards.ca.gov/northcoast/water_issues/programs/agricultural_lands/.

Tribal Water Rights

Water rights in California have a long and complicated history. The interplay between State water law and tribal water rights is especially complex in California for several reasons. First, while other western states operate under a prior appropriation system, California maintains a system of both property-based rights and prior appropriation rights. Second, over 100 federally recognized Native American tribes are located in California — by far, more tribes than in any other state. A tribe's individual history plays an important role in defining their water rights, thus requiring a review of each tribe's history in order to accurately quantify each tribe's rights. No historical reviews have been completed for the majority of California's Native American tribes. Third, California contains over 300 individual Native American allotments, located both on reservations and in the public domain. Each of these requires its own historical review, but to date there have been very few reviews of individual allotments.

Federally reserved waters on Native American reservations are governed by the Winters doctrine, which has evolved over more than a century in federal courts, and since 1955 in state courts as well. Two landmark U.S. Supreme Court cases, *Winters v. U.S.5 and U.S. v. Rio Grande Dam & Irrigation Co.,6* established several key principles: (1) federally reserved lands have a right to use sufficient water to fulfill the "primary purpose" of the reservation, and (2) these water rights cannot be destroyed by state water law or by water users acting in accordance with state law. Evaluation of a tribe's water rights requires a determination of two factors: (1) the date on which the land became federally reserved (the "priority date"), and (2) the amount of water needed to fulfill the "primary purpose" for which the land was federally reserved (California Tribal Water Submit 2009).

Tribal Water Rights on the Klamath and Trinity Rivers

Interconnection of the Trinity and Sacramento rivers adds federally reserved Native American water and fishing rights to California's Central Valley water Issues. Historically, the fishery resources of the Klamath and Trinity rivers have been the mainstay of the life and culture of the Hoopa Valley Tribe. The fishery was "not much less necessary to the existence of the Indians than the atmosphere they breathed." *Blake v. Arnett,* 663 F.2d 906, 909 (9th Cir. 1981). The salmon fishery is central to Hoopa culture and its economy. The lower 12 miles of the Trinity River and a stretch of the Klamath River flow through the Hoopa Valley Reservation, established in 1864.

The Trinity River Division of the CVP was authorized in 1955 and completed in 1963. The Trinity River Division Act authorized the TRD (Trinity River Diversion). The TRD is the only source of water imported by the CVP to the Central Valley from within the region. Congress included area-of-origin protections for the Trinity River, including one establishing flow release procedures for Trinity River fish and wildlife preservation and propagation. The USBR informed Congress that it would divert approximately 50 percent of Trinity River water into the Sacramento River. However, until the 1992 enactment of the CVPIA, Pub. L. 102-575, the USBR consistently diverted 90 percent of the Trinity River water. That procedure not only created undue reliance on water resources in the Central Valley, but it also devastated the Trinity River fishery (Hoopa Valley Indian Tribe, California Tribal Water Summit 2009). Please see Box NC-2, "Tribal Water Rights on the Klamath and Trinity Rivers," for more information.

In March of 2013, the state of Oregon backed the Klamath Tribes' claim to have the oldest water rights in the upper Klamath Basin (Oregon). The findings (although not directly applicable to California) filed with the Klamath County Circuit Court in Klamath Falls gives the tribes a new dominant position in the long-standing battles over sharing scarce water between fish and farms in the Upper Klamath Basin. Farmers and ranchers who draw irrigation water from rivers where the tribes now have the oldest claim could be restricted in drought years. As of the writing of this report, the impact of this for California water users is unclear (Scott-Goforth and Barnard 2013). It is important to note that the Klamath Tribe water rights apply only to the state of Oregon where they have a system of prior appropriations — the Klamath Tribe being the oldest water user in Oregon in the Upper Klamath River subbasin.

Box NC-2 Tribal Water Rights on the Klamath and Trinity Rivers

Tribal water rights on the Klamath and Trinity rivers have had a long and complicated history. This history as it relates to tribal water rights has been well documented in a briefing paper presented at the 2009 California Tribal Water Summit by the Hoopa Valley Tribe (2009). This paper describes the legal history of the Klamath and Trinity rivers with details on the impacts of the Trinity River Diversion for the Central Valley Project and issues of sustainable water quantity and quality in the Klamath River. It further describes the provisions of the Trinity River Restoration Program, which was enacted under the Central Valley Project Improvement Act.

The paper also details three potential adverse effects of the proposed Klamath River Restoration Agreement (KRRA) and the Klamath Hydroelectric Settlement Agreement (KHSA) on the success of the Trinity River Restoration Program. The three potential adverse effects are the cost of implementing the KBRA of over $1 billion, the KBRA's guaranteed irrigation diversions of water for the Klamath Irrigation District Project in Oregon on water availability, and the lengthy dam removal planning process authorized by the KHSA which will delay any restoration for many years.

The conclusion made by the briefing paper is that Native American tribes have a key role in the sustainable use of water both in terms of quantity and quality. Tribes must be accorded the respect due to a government and dealt with on a government-to-government basis if successful accommodation of the competing interests is to be achieved.

Water Quality

Surface Water Quality

In the North Coast region, there are a number of impaired water bodies due to excess sediment, elevated water temperatures, and excess nutrients that impact aquatic ecosystems, especially salmon and steelhead. These water quality conditions are the result of point-source and non-point-source of pollution and other controllable factors (e.g., landscape alteration, road building, etc.) and are exacerbated by hydrologic modification, water withdrawal, and the loss of competent riparian zones and floodplains to development, agriculture, and logging. Besides harming aquatic life, excess sediment can limit the use of water for municipal and domestic consumption, agriculture, industry, wildlife, fishing, and recreation; and it can cause or contribute to flooding. In the region, 10 out of the 14 hydrologic units include water bodies that are impaired by excess sediment.

There are many local issues, as well. For example, surface water monitoring indicates a problem with pathogens in the Bodega Bay Hydrologic Area, Hare Creek and Pudding Creek beaches on the Mendocino Coast, several coastal beaches in the Trinidad Hydrologic Unit, riverfront beaches on the Russian River and its tributaries, and the Laguna de Santa Rosa and its tributaries. In addition, several of the region's water bodies are impaired by mercury from past gold mining operations. Exotic species are present in Bodega Bay; and dioxin and polychlorinated biphenyl (PCB) are a water quality problem in Humboldt Bay.

Non-Point-Source Pollution

Non-point-source pollution in the region includes contamination of surface water due to non-point-source pollution from stormwater runoff; erosion and sedimentation (roads, agriculture, and timber harvest); failing septic tanks; channel modification; gravel mining; dairies; chemical contaminants (e.g., methyl tertiary butyl ether [MTBE] and dioxin); and urban runoff. In areas where people can come into contact with contaminated waters, the SWRCB, NCRWQCB, and California Coastal Commission have the responsibility to protect the people. One of the highest priorities of the NCRWQCB Basin Plan is to develop a freshwater beach program in cooperation with the Sonoma County Health Department for the Russian River. Sediment, temperature, and nutrients are the items of primary focus in the RWQCB 303(d) list of impaired water bodies. Along the coast, non-point-source pollution can cause microbial contamination of shellfish (and in particular, oyster) growing areas. In rivers, lakes, and reservoirs in the Klamath Basin, extreme growths of blue green algae and accompanying microcystin neurotoxins have been found in high concentrations, leading to issuance of a health advisory by the State. More information on the NCRWQCB's NonPoint Source Pollution Prevention Program is available at: http://www.waterboards.ca.gov/northcoast/water_issues/programs/non_point_source/.

Mercury

Mercury in fish tissue is a water quality concern in Lake Pillsbury (Eel River), Lakes Mendocino and Sonoma (Russian River), and Trinity Lake (Trinity River); health advisories for mercury have been issued for Lake Pillsbury and Trinity Lake.

Erosion and Sedimentation

In the North Coast, 10 out of the Region's 14 hydrologic units include water bodies that are impaired by excess sediment, or approximately 61 percent of the region's area. To begin to address the issue, the NCRWQCB in 2008 prepared a Work Plan to Control Excess Sediment in Sediment-Impaired Watersheds. The plan describes actions and tasks that staff is doing or intends to do over a 10-year period (as resources allow) to control human-caused excess sediment transport in the sediment-impaired water bodies of the region. Besides harming aquatic life, excess sediment can limit the use of water for municipal and domestic consumption, agriculture, industry, wildlife, fishing, and recreation; and it can cause or contribute to flooding. When sediment transport and increased runoff do occur, they cause changes in the downstream channels. These changes include gravel and sand deposition creating gravel bars, degrading spawning habitat, and scouring of stream channels due to higher flows. Additional information on the NCRWQCB's sediment control work plan is available at: http://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/sediment_workplan/.

Groundwater Quality

As part of California's GAMA program, the USGS in conjunction with the SWRCB, has completed data summary reports for the following study units that partially or entirely reside within the North Coast region.

- Cascade Range and Modoc Plateau
- Northern Coast Ranges
- North San Francisco Bay
- Klamath Mountains (final report to be available in 2014)

These reports along with additional groundwater quality information are available at: http://ca.water.usgs.gov/gama/.

In 2009, the USGS sampled 58 groundwater wells in the North Coast Ranges study unit. The wells were selected from the CDPH database and are located within 34 groundwater basins and subbasins in Lake, Mendocino, Glenn, Humboldt, and Del Norte counties. All detected concentrations of organic constituents, nutrients, major and minor ions, and radioactive constituents were less than health-based benchmarks for the 30 wells sampled in coast basins. There were a few detections of arsenic, boron, and barium that exceed health-based standards in the 28 wells in the interior basins, which are likely related to the area's geology. The results of this study indicate that community drinking water systems drawing from primary aquifer systems in the North Coast region generally provide safe drinking water, with the exceptions noted.

Because the North Coast region is predominantly rural, many people rely on shallow wells, which are susceptible to contamination, for their drinking water. Therefore shallow-groundwater cleanup remains a high priority in the region.

In addition, there may be contributions of nutrients and pesticides to shallow groundwater resulting from the continued conversion of land to vineyards in Sonoma and Mendocino counties and other widespread farming activities in the Upper Klamath River Basin and the Smith River Plain, among other disperse locations of the region. Aging wastewater treatment ponds and leaking septic tanks may play a part in shallow groundwater contamination in these areas as well (Mathany et al. 2011).

Drinking Water Quality

In general, drinking water systems in the region deliver water to their customers that meet federal and State drinking water standards. Recently, the Water Boards completed a statewide assessment of community water systems that rely on contaminated groundwater. The report identified 15 community drinking water systems in the region that rely on at least one contaminated groundwater well as a source of supply (Table NC-15). Arsenic is the most prevalent groundwater contaminant affecting community drinking water wells in the region (Table NC-16). The majority of the affected systems are small water systems which often need financial assistance to construct a water treatment plant or alternate solution to meet drinking water standards.

Groundwater Conditions and Issues

Groundwater Occurrence and Movement

Aquifer conditions and groundwater levels change in response to varying supply, demand, and climate conditions. During dry years or periods of increased groundwater use, seasonal groundwater levels tend to fluctuate more widely and, depending on annual recharge conditions, may result in a long-term decline in groundwater levels, both locally and regionally. Depending on the amount, timing, and duration of groundwater level decline, nearby well owners may need to deepen wells or lower pumps to regain access to groundwater.

As groundwater levels fall, they can impact the surface water–groundwater interaction by inducing additional infiltration and recharge from surface water systems, thereby reducing the groundwater discharge to surface water base flow and wetlands areas. Extensive lowering of groundwater levels can also result in land subsidence due to the dewatering, compaction, and loss of storage within finer grained aquifer systems.

Table NC-15 Summary of Community Drinking Water Systems in the North Coast Hydrologic Region that Rely on One or More Contaminated Groundwater Well that Exceeds a Primary Drinking Water Standard

Community Drinking Water Systems and Groundwater Wells Grouped by Water System Population	Number of Affected Community Drinking Water Systems	Number of Affected Community Drinking Water Wells
Small System ≤ 3,300	11	14
Medium System 3,301 – 10,000	2	4
Large System > 10,000	2	3
Total	**15**	**21**

Source: *Communities That Rely on a Contaminated Groundwater Source for Drinking Water.* State Water Resources Control Board 2013.

Table NC-16 Summary of Contaminants Affecting Community Drinking Water Systems in the North Coast Hydrologic Region

Principal Contaminant (PC)	Community Drinking Water Systems where PC exceeds the Primary Maximum Contaminant Level (MCL)	Number of Community Drinking Water Wells where PC exceeds the Primary MCL
Arsenic	12	16
Trichloroethylene (TCE)	2	2
Nitrate	1	3
1,1-Dichloroethylene (1,1-DCE)	1	1

Source: *Communities That Rely on a Contaminated Groundwater Source for Drinking Water.* State Water Resources Control Board 2013.

During years of normal or above normal precipitation, or during periods of low groundwater use, aquifer systems tend to recharge and respond with rising groundwater levels. As groundwater levels rise, they reconnect to surface water systems, contributing to surface water base flow or wetlands, seeps, and springs.

The movement of groundwater is from areas of higher hydraulic potential to areas of lower hydraulic potential, typically from higher elevations to lower elevations. The direction of groundwater movement can also be influenced by groundwater extractions. Where groundwater extractions are significant, groundwater may flow towards the extraction point. Rocks with low permeability can restrict groundwater flow through a basin.

Depth to Groundwater and Groundwater Elevation Contours

The depth to groundwater has a direct bearing on the costs associated with well installation and groundwater extraction operations. Knowing the local depth to groundwater can also provide a better understanding of the local interaction between the groundwater table and the surface water systems, and the contribution of groundwater aquifers to the local ecosystem.

Depth-to-groundwater data for some of the groundwater basins in the region are available online via DWR's Water Data Library (http://www.water.ca.gov/waterdatalibrary/), DWR's CASGEM system (http://www.water.ca.gov/groundwater/casgem/), and the USGS National Water Information System (http://waterdata.usgs.gov/nwis). In addition, basin-specific information may be obtained from the following sources. Please note that although a reference for Sonoma Valley is provided below, groundwater basins encompassing the southern portion of Sonoma County are discussed in the regional report for the San Francisco Hydrologic Region.

- Ground-Water Hydrology of the Upper Klamath Basin: USGS, 2010 Scientific Investigations Report 2007-5050. (http://pubs.usgs.gov/sir/2007/5050/)
- Santa Rosa Valley: Sonoma County Water Agency (http://www.scwa.ca.gov/srgroundwater/)
- Alexander Valley: (http://pubs.usgs.gov/sir/2006/5115/pdf/sir2006-5115.pdf)
- Scott Valley Groundwater: University of California, Davis: (http://groundwater.ucdavis.edu/Research/ScottValley/)
- Sonoma Valley: USGS, 2006. (http://pubs.usgs.gov/sir/2006/5092/pdf/sir2006-5092.pdf)

The above links also may provide groundwater elevation contour maps for some areas of the region. Groundwater elevation contours can help estimate the direction, gradient, and the rate of groundwater flow.

Groundwater Level Trends

Groundwater levels within groundwater basins in the region can be highly variable because of the physical variability of aquifer systems, the variability of surrounding land use practices and the variability of annual groundwater availability and recharge. Plots of depth-to-water measurements in wells over time (groundwater level hydrographs) allow analysis of seasonal and long-term groundwater level variability and trends. The hydrographs presented in Figures NC-15A to NC-15D help explain how local aquifer systems respond to changing groundwater pumping quantities and to resource management practices. The hydrograph name refers to the well location (township, range, section, and tract).

Figure NC-15A shows hydrograph 48N04E31N002M, which is from a deep irrigation well located along the western edge of the Tule Lake subbasin and that draws water from a fractured basalt portion of the aquifer underlying the Tule Lake subbasin. In 2001, in response to one of the driest years on record for the Klamath Basin watershed, the USBR cut off surface water deliveries from the Klamath Project to the Tule Lake subbasin area. A drought emergency was declared, and a number of new high-capacity wells were installed in the fractured-basalt portion of the Tule Lake subbasin aquifer. In subsequent years, ongoing environmental water shortages for the Klamath Project resulted in additional surface water cutbacks and the implementation of groundwater substitution water transfers in 9 of the subsequent 10 years. Due to Oregon regulations that limit groundwater pumping, the majority of groundwater substitution pumping came from the California portion of the Klamath Basin (Note: almost two-thirds of the

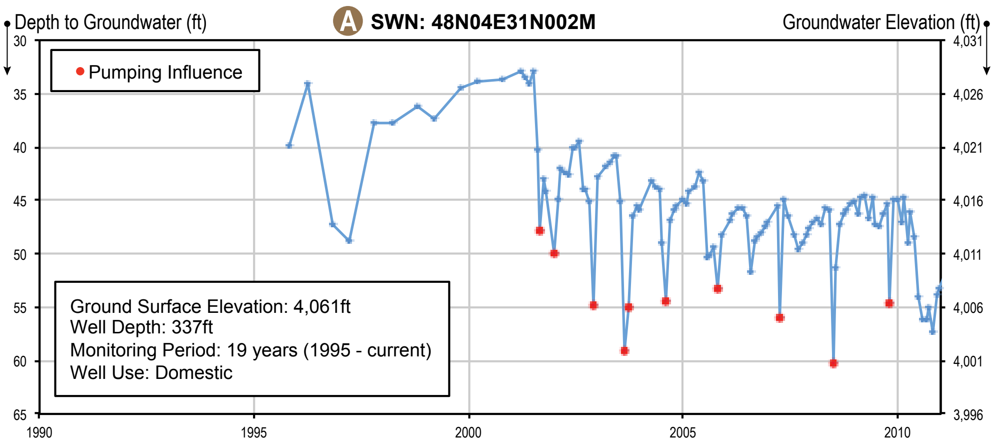
Figure NC-15 Groundwater Level Trends in Selected Wells in the North Coast Hydrologic Region

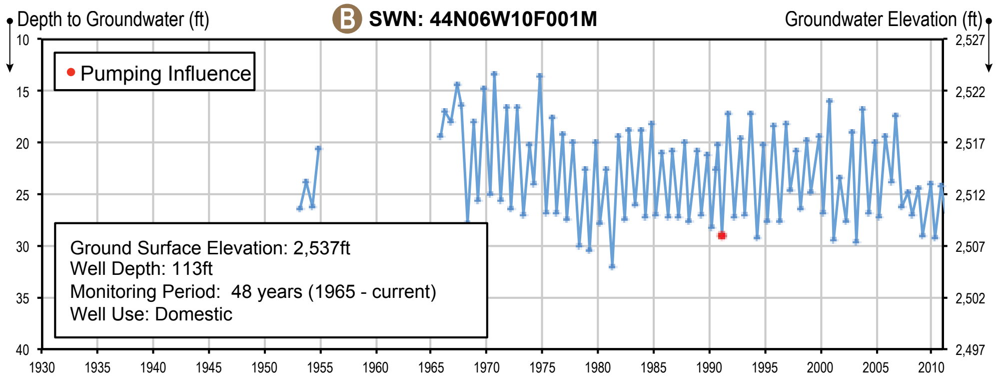
Aquifer response to changing demand and management practices

Hydrographs were selected to help tell a story of how local aquifer systems respond to changing groundwater demand and resource management practices. Additional detail is provided within the main text of the report.

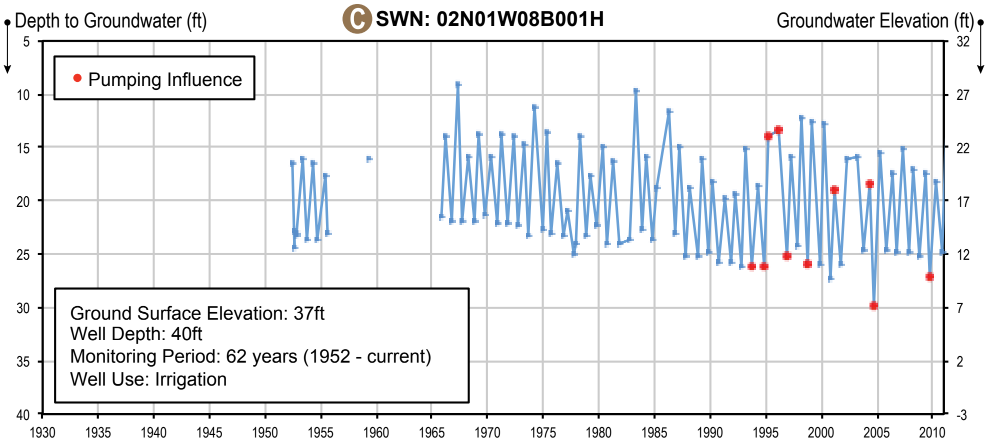
Regional locator map

A Hydrograph 48N04E31N002M: shows the impact of deep high capacity pumps, fluctuating surface water deliveries, and long-term drought conditions.

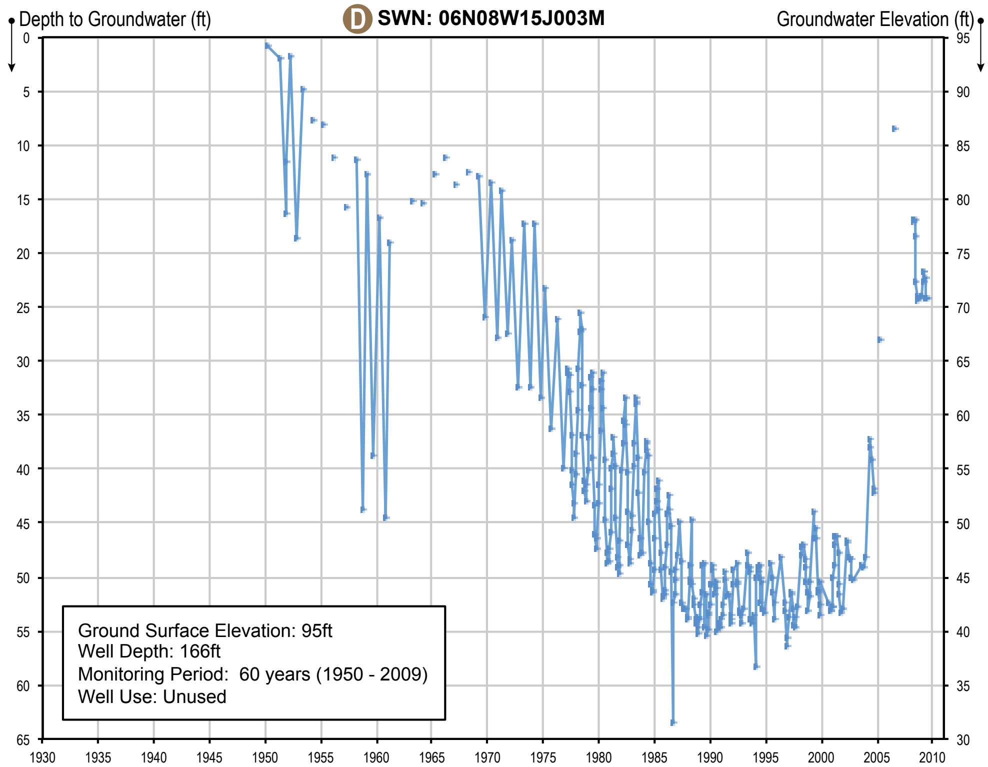




B Hydrograph 44N06W10F001M: illustrates the interplay between the groundwater aquifer and the nearby surface water conveyance. The unconfined aquifer is replenished in summer and fall when the canal runs full and vice-versa in winter and spring. Sudden drop in the seasonal variation corresponds with the lining of canal in 2007.



C Hydrograph 02N01W08B001H: highlights the close interaction between perennial surface water systems and the shallow groundwater wells in aquifers along the California coast where the groundwater levels have more interaction with the surface water system in wet rather than dry years.



D Hydrograph 06N08W15J003M: Illustrates stabilization of and recovery in the groundwater levels as a result of increased surface water delivery, use of recycled water supplied in lieu of pumping groundwater and water conservation.

210,000 irrigated acres in the Klamath Project service area is in Oregon). In 2000, prior to the groundwater substitution pumping, groundwater supply required from the Tule Lake subbasin was estimated to be 8,500 af. Over the next couple of years, transfer operations resulted in groundwater extraction of 70,000 af in 2001 and about 22,000 af/yr. for 2002 and 2003 (California Department of Water Resources 2004). Groundwater pumping increased to 32,000 af in 2004 and then declined to an average of about 14,000 af a year for 2005 and 2006. No pumping amounts were recorded for 2007 and 2008. No groundwater substitution transfers took place in 2009; however, non-transfer related pumping of 8,500 af was estimated. But in 2010, groundwater extraction volume jumped to 51,000 af.

Although there is considerable annual variation in groundwater levels between 2001 and 2010, the hydrograph shows that the overall rate of basin recharge has not been able to keep pace with the post 2001 increases in groundwater extraction. After the initial drop of 7 feet between 2001 and 2002, the hydrograph shows a slow but steady trend of declining groundwater levels until 2006, a period of relatively stable levels from 2006 through 2009, and then another drop from 2009 to 2012. The period of somewhat stable groundwater levels from 2006 to 2009 indicates that the annual rate of aquifer recharge was likely sufficient to offset the average annual groundwater pumping volume of about 14,000 af. Conversely, the post-2009 decline in groundwater levels associated with the increase in groundwater extraction to 51,000 in 2010 indicates that annual extraction rates of 50,000 af/yr. are not sustainable for this portion of the basin aquifer. The hydrograph also highlights the importance of implementing appropriate data collection and adaptive management practices when implementing conjunctive management via groundwater substitution — especially in areas were aquifer response to increased pumping is largely unknown. At the local level, a decline of 17 feet over 12 years in response to groundwater substitution have resulted in impacts to shallow wells, increased the risk for future subsidence within the fine-grained lakebed deposits above the fractured-basalt aquifer, and are bringing into question the sustainability of land use practices that require greater than about 40,000 af of groundwater extraction.

Uncertainties associated with the operation of the Klamath Project Water have led to the development of the Klamath Water and Power Agency (KWAPA) to help align water supply and use. An On-Project Plan is being implemented by KWAPA to help align long-term water supply and demand for the local service area. In addition, conservation and management practices are currently being implemented by the Tule Lake Irrigation District to help increase water supply reliability (Tulelake Irrigation District 2011).

Figure NC-15B shows hydrograph 44N06W10F001M, which is from a 113-foot-deep domestic well that draws water from shallow aquifer that consists of sand, gravel, clay and volcanic deposits and is located near Grenada in Shasta Valley Groundwater Basin, about 50-feet down gradient from Montague Water District conveyance ditch. The hydrograph highlights dramatic seasonal effects of conveyance ditch losses to the underlying shallow aquifer and the wells that draw water from it. Throughout most of California, precipitation associated with Mediterranean climate conditions typically result in seasonal groundwater levels being the highest during late winter to early spring months, and the lowest during summer or early fall months. However, groundwater levels for well 44N06W10F001M are consistently 5 feet to 10 feet higher in the fall relative to that in the spring. This reversed groundwater level trend is likely due to summer recharge from conveyance ditch losses and the percolation of applied surface water for nearby agricultural water use. Once the irrigation season is over, the conveyance system is dewatered; and nearby groundwater levels decline. Prior to 2007, there were two conveyance canals located parallel to each other. In 2007, one of the two canals was replaced with an underground pipe system to reduce conveyance losses. This resulted in the overall lowering of the groundwater level by more than 5 feet, as shown in the hydrograph. The reversed trend of seasonal fluctuation continued, but at a lower elevation — indicating that the leakage from the remaining conveyance ditch is still occurring.

Figure NC-15C shows hydrograph 02N01W08B001H, which is from a very shallow irrigation well constructed in the aquifer consisting of unconfined sand and gravel deposits in the Eel River Valley Groundwater Basin. The hydrograph highlights the close interaction between surface water systems and the numerous shallow groundwater wells that draw water from thin alluvial river plain aquifers along the California coast. Land use surrounding the well is predominantly rural pasture and dairy cattle. The hydrograph shows seasonal fluctuations in groundwater levels of about 6 to 8 feet during normal and drought years, and approximately 12 to 13 feet during wet years. A long-term comparison of spring-to-spring groundwater levels in the well shows a very slight decline and recovery of groundwater levels associated with the 1976-77 and the 1987-92 droughts. Groundwater levels in wells that are closely connected to nearby perennial surface water systems are typically more affected by wet rather than drought years. Perennial surface water systems tend to provide a consistent source of recharge, which helps to govern the maximum seasonal decline in groundwater levels. Spring-to-spring groundwater levels in during years of normal precipitation show a trend of slightly declining groundwater levels since the late 1960s.

Figure NC-15D shows hydrograph 06N08W15J003M, which is from an inactive well constructed in upper 160 feet within the alluvial deposits and the Glen Ellen Formation of the aquifer in the Santa Rosa Plain subbasin located in southern Sonoma County. The hydrograph depicts changes in groundwater supply and conjunctive management practices and shows the relationship between groundwater elevations and increased surface water supplies. The area surrounding the well is a combination of suburban residential and commercial land use. From 1950 to 1986, the groundwater elevation in the well declined approximately 50 feet due to groundwater extraction. During this time, municipal groundwater pumping in the southern Santa Rosa Plain increased from less than 1,000 af in 1969 to more than 5,000 af in 1986, while surface water deliveries during this time averaged less than 500 af/yr., with some years having no surface water supply to the area.

SCWA began increasing its municipal surface water deliveries in 1986 from approximately 1,000 af/yr. to more than 4,000 af/yr. in 2003, and then to 6,000 af/yr. in 2005. Between 1986 and 2000, groundwater continued to be pumped at a volume between 5,000 and 6,000 af/yr.. As shown on Figure NC-15D, groundwater elevations did not start to recover until 2003 when groundwater pumping was reduced to less than 2,000 af in 2003 and about 500 af in 2005. The 40-foot groundwater level recovery between 2003 and 2005 was also the result of increased surface water deliveries from 4,000 af/yr. to 6,000 af/yr.. The conjunctive management efforts in the Santa Rosa Plain Groundwater subbasin not only reflect the connection between groundwater extraction and surface water availability, but also the positive effects of water conservation and the use of recycled water supplies for irrigation.

Change in Groundwater Storage

Change in groundwater storage is the difference in stored groundwater volume between two time periods. Examining the annual change in groundwater storage over a series of years helps identify the aquifer response to changes in climate, land use, or groundwater management over time. If the change in storage is negligible over a period represented by average hydrologic and land use conditions, the basin is considered to be in equilibrium under the existing water use scenario and current management practices. However, declining storage over a relatively short period characterized by average hydrologic and land use conditions does not necessarily mean that the basin is being managed unsustainably or subject to conditions of overdraft. Utilization of groundwater in storage during years of diminishing surface water supply, followed by active recharge of the aquifer when surface water or other alternative supplies become available, is a recognized and acceptable approach to conjunctive water management.

Because of resource and time constraints, changes in groundwater storage estimates for basins within the North Coast Hydrologic Region were not developed as part of the groundwater content enhancement for Update 2013. It is unknown if any of the local groundwater management agencies within the region have developed change in groundwater storage estimates.

Additional information regarding the risks and benefits of conjunctive management are presented in *California Water Plan Update 2013*, Volume 3, Chapter 9, "Conjunctive Management and Groundwater Storage Resource Management Strategy."

Flood Management

Traditional flood management has been focused on flood control infrastructure projects. These infrastructures alter or confine natural watercourses — hydromodification — which are intended to reduce the chance of flooding thereby minimizing damage to lives and property. This traditional approach is based on the flood control principle of conveying floodwaters rapidly to a discharge point. A more current understanding of floods and flooding takes into account the role of watershed management, floodplain and river functions, and providing multiple resource management and societal benefits. Activities under traditional flood management include physical modification of stream channels, dam and surface impoundments, levees, and other structures.

Today, water resources and flood planning involves additional demands and challenges, such as multiple regulatory processes and permits, coordination with multiple agencies and stakeholders, and increased environmental awareness. These additional complexities call for an integrated water management approach, incorporating natural hydrologic, geomorphic, and ecological processes to reduce flood risk by influencing the cause of the harm, including the probability, extent, or depth of flooding (flood hazard). State policy directs State agencies to implement integrated water management and other federal, regional, and local agencies are transitioning to this approach. Integrated water management changes the implementation approach based on the understanding that water resources are an integral component for sustainable ecosystems, economic growth, water supply reliability, public health and safety, and other interrelated elements. Additionally, it acknowledges that a broad range of stakeholders might have interests and perspectives that could positively influence planning outcomes.

Projects that combine flood and ecosystem restoration also can provide areas of active- and passive-use recreation, increase open space, and provide scenic value, all of which result in economic and societal benefits. For example, in Humboldt County, the Rohner Creek Flood Control and Riparian Habitat Improvement project is a watershed-based, channel corridor-scale project with multiple objectives. The project is taking a channel corridor approach in identifying opportunities to integrate habitat enhancement elements with flood reduction improvements through the 1-mile project corridor within the City of Fortuna (California Department of Water Resources and U.S. Army Corps of Engineers 2013).

Flood Hazard Exposure

Historically in the North Coast Hydrologic Region, flooding originates principally from melting of the Coastal Ranges snowpack and from rainfall. Flooding from snowmelt typically occurs in the spring and has a lengthy runoff period. Flooding from rainfall occurs in the winter and early spring, generally when large bands of moisture-laden air arrive from the tropics. These systems are known as Atmospheric Rivers. This pattern also creates coastal storms that drive waves resulting in coastal flooding and erosion. In addition, offshore earthquakes have caused tsunamis along the coast in the hydrologic region.

Flood exposure in the North Coast Hydrologic Region occurs along the coastline, Eel River, Elk River, Lower Russian River, Scott River, around Crescent City Harbor, and Humboldt Bay (see also Box NC-1 “Near-Coastal Issues”). Flood exposure identifies who and what is impacted by flooding. In the North Coast Hydrologic Region, more than 43,000 people and over $4.2 billion in assets are exposed to the 500-year flood event. Figures NC-16 and NC-17 provide a snapshot of people, structures, crops, infrastructure, and sensitive species exposed to flooding in the region. Throughout the region, 320 State and federal threatened, endangered, listed, or rare plant and animal species are exposed to flood hazards.

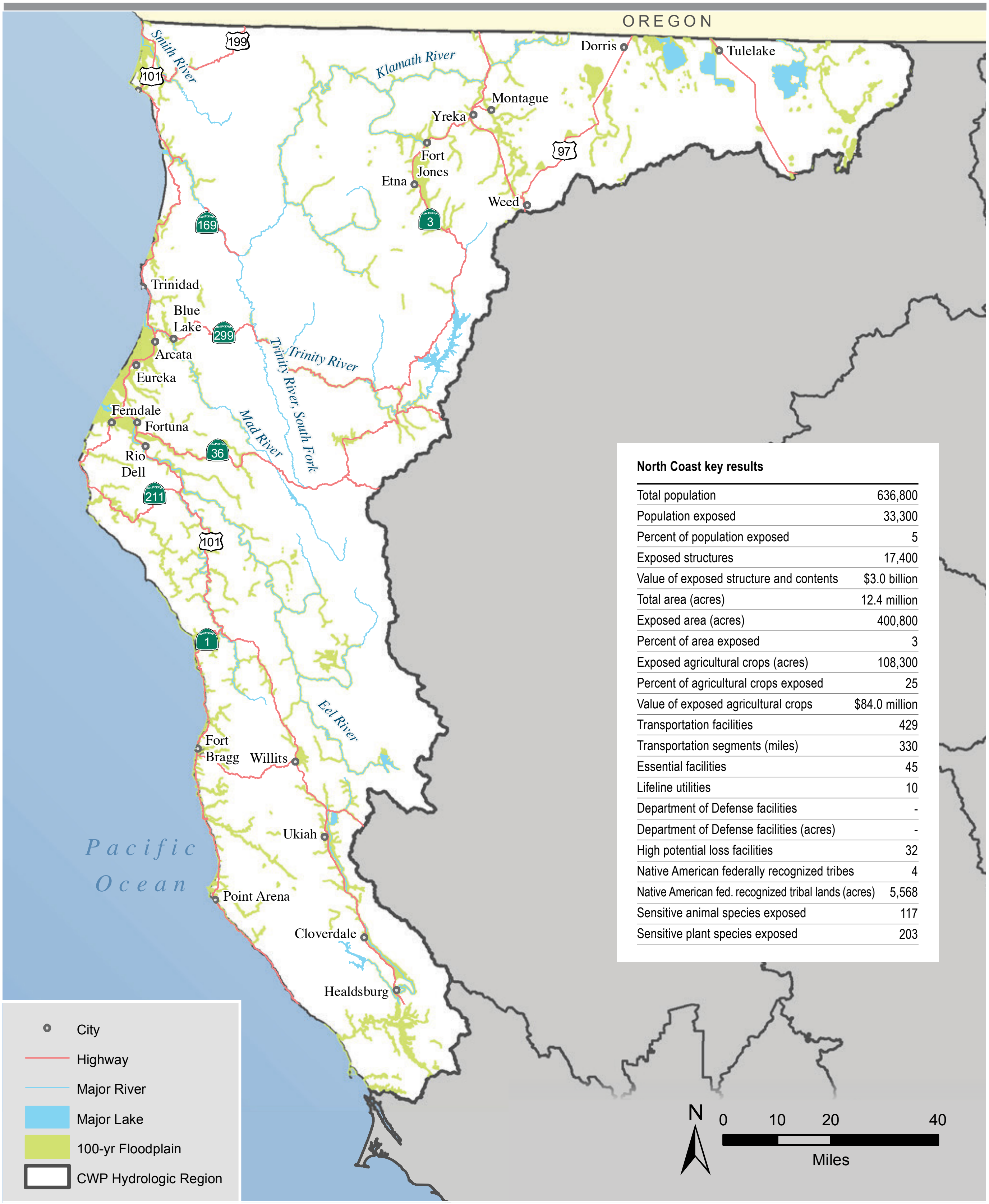
Sea Level Rise

During the coming decades, sea level will continue to rise, bringing with it progressive flooding and inundation of low-lying areas as well as increased cliff and bluff erosion. North Coastal areas will be challenged to adapt to this rise especially in urban and rural coastal developed areas and ports, harbors and marinas with commercial and recreational facilities. It is imperative to minimize damage and losses through adaptation. Coastal managers are relying on historical coastal hazard-vulnerability data and projecting the types of hazards and risk associated with sea level rise. While the types of hazards may not change, their frequencies and magnitudes are changing, which will increase community vulnerability and risk.

Sea level rise will affect and threaten coastal communities, facilities and infrastructure through more frequent flooding and gradual inundation, as well as increased erosion of coastal bluffs, and river surges affecting local flooding. This will affect roads, utilities, wastewater treatment plants, outfalls and storm water facilities and systems as well as large wetland areas in addition to towns and cities. Where land is rising — tectonic effects — the rate of sea level rise may be exceeded by the rate of coastal uplift. In the North Coastal areas the rate of tectonic uplift is greater than current rate of sea level rise. For example, at Humboldt Bay’s North Spit, sea level is rising by 18.6 inches per century (4.73 millimeters per year), the highest rate in California. At Crescent City, 80 miles north, sea level is dropping relative to the coastline by 2.5 inches per century. The shoreline at Humboldt Bay is subsiding, whereas Crescent City’s coastline is rising.

The risk assessment for flooding is incorporating the vulnerability of the North Coast region based on the rate and magnitude of sea level rise and its impacts. Those communities and facilities at risk are incorporating hazard mitigation measures into planning and management strategies. As the “California Flood Futures” report identifies, the first strategy is to identify

Figure NC-16 Flood Exposure to the 100-Year Floodplain, North Coast Hydrologic Region

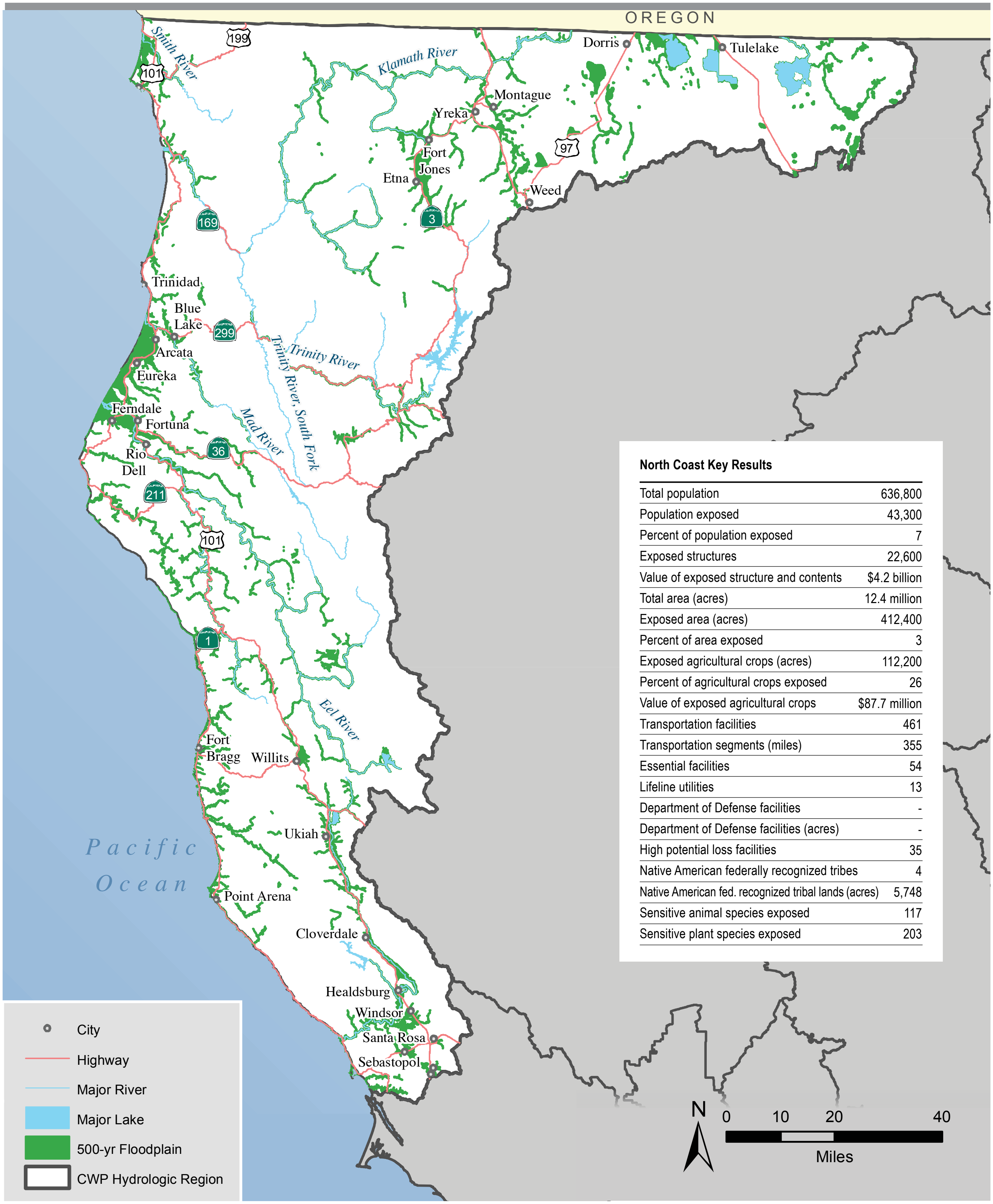


North Coast key results

Total population	636,800
Population exposed	33,300
Percent of population exposed	5
Exposed structures	17,400
Value of exposed structure and contents	$3.0 billion
Total area (acres)	12.4 million
Exposed area (acres)	400,800
Percent of area exposed	3
Exposed agricultural crops (acres)	108,300
Percent of agricultural crops exposed	25
Value of exposed agricultural crops	$84.0 million
Transportation facilities	429
Transportation segments (miles)	330
Essential facilities	45
Lifeline utilities	10
Department of Defense facilities	-
Department of Defense facilities (acres)	-
High potential loss facilities	32
Native American federally recognized tribes	4
Native American fed. recognized tribal lands (acres)	5,568
Sensitive animal species exposed	117
Sensitive plant species exposed	203

Source: California's Flood Future Report 2013

Figure NC-17 Flood Exposure to the 500-Year Floodplain, North Coast Hydrologic Region



North Coast Key Results

Total population	636,800
Population exposed	43,300
Percent of population exposed	7
Exposed structures	22,600
Value of exposed structure and contents	$4.2 billion
Total area (acres)	12.4 million
Exposed area (acres)	412,400
Percent of area exposed	3
Exposed agricultural crops (acres)	112,200
Percent of agricultural crops exposed	26
Value of exposed agricultural crops	$87.7 million
Transportation facilities	461
Transportation segments (miles)	355
Essential facilities	54
Lifeline utilities	13
Department of Defense facilities	-
Department of Defense facilities (acres)	-
High potential loss facilities	35
Native American federally recognized tribes	4
Native American fed. recognized tribal lands (acres)	5,748
Sensitive animal species exposed	117
Sensitive plant species exposed	203

Source: California's Flood Future Report 2013 and evaluate sea level rise risks and determine those areas most vulnerable to future flooding, inundation, erosion, and wave impacts and to develop hazard mitigation and adaptation plans.

Where coastal bluff erosion is high, coastal cliff retreat is dramatic with collapsed roadways, undermined foundations, dangling decks and stairways and structures. Coastal erosion tends to be episodic, with long-term cliff and bluff failure occurring during a few severe storm events. Scientists consider the probability that these events will increase in frequency and intensity. The California Coastal Commission database for coastal erosion is a valuable resource and available on CD. A key component to coastal management is understanding the adaptive capacity of the affected areas. This capacity is the ability to prepare for, respond to, and recover from sea level rise impacts.

As described earlier, the general principles of integrated water management includes adaptation planning to embrace sustainability (i.e., meeting the needs of the present without compromising the needs of future generations) with consideration given to equitable distribution and apportionment of costs and benefits of adaptation measures; and adaptation strategies should account for the distinct vulnerability of potentially affected DACs.

Levee and Channel System

The North Coast Hydrologic Region has four major flood management reservoirs — Lake Mendocino on the East Fork Russian River, Lake Sonoma on Dry Creek, Spring Lake off Santa Rosa Creek, and Matanzas Creek Reservoir on Matanzas Creek; two smaller flood management reservoirs on Paulin Creek and Middle Fork Brush Creek; and seven other reservoirs providing nondedicated flood-retention space. Other flood management projects include levees in the Eel River delta, levees and channel modifications on East Weaver Creek, Redwood Creek, the Klamath River, and the Mad River, and channel modifications on streams running through Santa Rosa, Rohnert Park, Cotati, and Windsor. Measures to mitigate the effects of tsunamis were part of Humboldt Harbor improvements, the Crescent City project, and Crescent City Harbor improvements.

Levee Performance and Risk Studies

In the North Coast Hydrologic Region, 26 local flood management projects or planned improvements have been identified. Fourteen of these projects have costs totaling more than $108 million while the remaining projects do not have costs associated with them at this time. Fifteen local planned projects use an integrated water management approach with a flood component. Examples of these local projects include the Mattole Integrated Watershed Management Initiative and the Big River Main Haul Road Phase I Restoration Project. For a complete list of these projects refer to *California's Flood Future Report,* Attachment F: "Information Gathering Technical Memorandum."

Recent Tsunamis on the California Coast

In March 2011, a tsunami generated off the coast of Japan and recorded throughout the California coast, struck Crescent City Harbor with an 8.1-foot wave, destroying much of the harbor and resulting in one death near Klamath. There was also major damage to docks and boats at Noyo Harbor. Estimated damage in the region was $24 million.

Redwood Coast Tsunami Work Group

The Redwood Coast Tsunami Work Group (RCTWG) is an organization of local, State, and federal agencies, tribes, relief and service groups, land managers, and businesses from Del Norte, Humboldt and Mendocino counties. The group was formed in July 1996 to define the needs of local jurisdictions to mitigate the North Coast earthquake and tsunami hazard and to promote a coordinated, consistent mitigation program for all coastal areas. (See "Recent Tsunamis on California Coast" section in this report.)

In 2006, Humboldt County participated in the Federal Emergency Management Agency (FEMA) first ever tsunami response training exercise. In 2007, RCTWG helped the community of Samoa prepare for and conduct the first full-scale tsunami evacuation drill in California. In 2008, RCTWG members working with the State Office of Emergency Services planned and coordinated the first test of the tsunami warning communications system using actual (live) codes outside of Alaska. Additional drills have been conducted in schools and other North Coast communities. For more information on RCTWG, see the California State University, Humboldt's Web page at http://humboldt.edu/rctwg/site/about/.

Water Governance

The North Coast region contains water service providers of all types — from small, private facilities that provide water for just a few neighboring residences to large municipal suppliers and wastewater treatment facilities. Private water districts include those representing counties or portions of counties, municipalities, irrigation districts, or particular water bodies. The only federal water management agency in the region is USBR located in Redwood Valley in Mendocino County and in the Klamath Lake and Tule Lake area as part of the Klamath Project. A large number of North Coast residences are in rural areas with no water service and rely on groundwater wells or personal surface-water treatment facilities and on-site wastewater disposal systems, usually septic systems (North Coast Integrated Regional Water Management Plan, Phase III 2012). For a list of North Coast region's water management agencies, see Table NC-17.

In 2009, State lawmakers passed four policy bills — the Safe, Clean, and Reliable Drinking Water Supply Act of 2010 — as a comprehensive water package (Water Conservation Act of 2009, SB X7-X). For more information on SB X7-X, please see Volume 4, *Reference Guide*.

AB 2409

AB 2409 amends CWC Section 10632 (Urban Water Management Planning Act) to require urban water suppliers to prepare and adopt water shortage contingency plans including the identification and treatment of artificially supplied water features (i.e., ponds, lakes, waterfalls and fountains, separately from swimming pools and spas).

California Water Code Section 1259.4 AB 2121

CWC Section 1259.4 AB 2121 requires the SWRCB to adopt principles and guidelines for maintaining instream flows in Northern California coastal streams for the purposes of water right administration. The geographic scope of the policy includes all coastal streams from the Mattole River to San Francisco and coastal streams entering San Pablo Bay, and extends to five counties: Marin and Sonoma and portions of Napa, Mendocino, and Humboldt counties.

Table NC-17 North Coast Hydrologic Region Water Management Agencies

Name	County	Statutory authority
Albion Mutual Water Company	Mendocino	WS
Alderpoint County Water District	Humboldt	WS
Alexander Valley Acres Water Company	Sonoma	WS
Arcata City Wastewater Treatment Plant	Humboldt	WT
Armstrong Valley Water Company	Sonoma	WS
Austin Acres Mutual Water Company	Sonoma	WS
Austin Creek Mutual (Springhill)	Sonoma	WS
Belmont Terrace Mutual Water Company	Sonoma	WS
Benbow Water Corporation	Humboldt	WS
Bennett Ridge Mutual Water Company	Sonoma	WS
Bertsch-Oceanview Community Services District	Del Norte	WS
Big Lagoon Community Services District	Humboldt	WS
Big Lagoon Park Water Company	Humboldt	WS
Big River Vista Mutual Water Company	Mendocino	WS
Big Springs Irrigation District	Siskiyou	WS, IWS
Blue Lake City Publicly Owned Treatment Works	Humboldt	WT
Bodega Bay Public Utilities District	Sonoma	WS
Bodega Bay Wastewater Recharge Facility	Sonoma	WT
Bodega Water Company	Sonoma	WS
Branger Mutual Water Company, Inc.	Sonoma	WS
Brooktrails Township Community Services District	Mendocino	WS
Bucher Water Company	Sonoma	WS
Bucktail Mutual Water Company	Trinity	WS
Butte Valley Irrigation District	Siskiyou	WS
California American Water	Humboldt / Sonoma	WS
California Water Service Company	Sonoma	WS
Calpella County Water District	Mendocino	WS
Calpella County Water District - Wastewater Treatment Plant	Mendocino	WT
Carmel By the Sea Water Company	Sonoma	WS
Cazadero Water Company	Sonoma	WS

Name	County	Statutory authority
California Department of Corrections and Rehabilitation Pelican Bay Prison Wastewater Treatment Plant	Del Norte	WT
Church Tree Community Services District	Del Norte	WS
City of Arcata	Humboldt	WS
City of Blue Lake Water Study Area	Humboldt	WS
City of Cloverdale Water Study Area	Sonoma	WS
City of Cotati	Sonoma	WS
City of Cotati	Sonoma	WT
City of Dorris	Siskiyou	WS
City of Eureka Water Study Area	Humboldt	WS
City of Fort Bragg Water Study Area	Mendocino	WS
City of Fortuna Water Study Area	Humboldt	WS
City of Healdsburg Water Study Area	Sonoma	WS
City of Rohnert Park	Sonoma	WT
City of Rohnert Park Water Study Area	Sonoma	WS
City of Santa Rosa	Sonoma	WS
City of Sebastopol Water Study Area	Sonoma	WS
City of Trinidad Community Services District	Humboldt	WS
Clear Lake National Wildlife Refuge	Modoc	WS
Cloverdale City Wastewater Treatment Plant	Sonoma	WT
College of The Redwoods, Publicly Owned Treatment Works	Humboldt	WT
Colonial Realty Irrigation District	Siskiyou	WS
Copco Lake Municipal Water Company	Siskiyou	WS
Covelo Community Services District; Covelo City Publicly Owned Treatment Works	Mendocino	WT
Crescent City Wastewater Treatment Plant	Del Norte	WT
Crescent City Water District	Del Norte	WS
CSU, Sonoma Wastewater Equalization Tank	Sonoma	WT
Del Norte County Flood Control District	Del Norte	FC
Del Oro Water Company - Ferndale	Humboldt	WS
Dorris City Sewage Treatment Plant	Siskiyou	WT
Elk County Water District	Mendocino	WS
Etna Community Services District	Siskiyou	IWS

Name	County	Statutory authority
Etna Sewage Treatment Plant	Siskiyou	WT
Eureka City Elk River Wastewater Treatment Plant	Humboldt	WT
Ferndale City Publicly Owned Treatment Works	Humboldt	WT
Fieldbrook Community Services District	Humboldt	WS
Forestville County Water District	Sonoma	WS
Forestville Water District	Sonoma	WS
Fort Bragg City Wastewater Treatment Plant	Mendocino	WT
Fort Jones City Wastewater Treatment Plant	Siskiyou	WT
Fortuna City Wastewater Treatment Plant	Humboldt	WT
Francis Land and Water Company	Humboldt	WS
Garberville Publicly Owned Treatment Works	Humboldt	WT
Garberville Water Company	Humboldt	WS
Gasquet Community Services District	Del Norte	WS
Geyserville Water Works	Sonoma	WS
Gill Creek Mutual Water Company	Sonoma	WS
Graton Community Service District	Sonoma	WS
Grenada Irrigation District	Siskiyou	WS, IWS
Grenada Sewage District Sewage Treatment Plant	Siskiyou	WT
Happy Camp Community Services District	Siskiyou	WS
Happy Camp Wastewater Treatment Plant	Siskiyou	WT
Hayfork Wastewater Facilities	Trinity	WT
Healdsburg City Wastewater Treatment Plant	Sonoma	WT
Hidden Valley Lake Community Services District	Humboldt	WS
Hoopa Valley Community Services District	Humboldt	WT
Hopland Public Utility District	Mendocino	WS
Hornbrook Community Services District	Siskiyou	WS
Humboldt Bay Municipal Water District	Humboldt	WS
Humboldt Bay Recreation and Conservation District	Humboldt	WS
Humboldt Community Services District	Humboldt	WS
Humboldt County Flood Control District	Humboldt	FC

Name	County	Statutory authority
Hydesville County Water District	Humboldt	WS
Irish Beach Water District	Mendocino	WS
Klamath Community Services District	Del Norte	WS
Klamath Sewage Treatment Plant	Del Norte	WT
Lake Shastina Community Service District Sewage Treatment Plant	Siskiyou	WT
Lake Shastina Mutual Water District	Siskiyou	WS
Laytonville Water District	Mendocino	WS
Lewiston Valley Water Company Publicly Owned Treatment Works	Trinity	WT
Loleta Community Services District	Humboldt	WS
Loleta Publicly Owned Treatment Works	Humboldt	WT
Lower Klamath National Wildlife Refuge	Siskiyou	WS
Lower Tule River Irrigation District	Siskiyou	WS
Macdoel Water Works	Siskiyou	WS
Manila Community Service District Wastewater Treatment Plant	Humboldt	WT
Mayacama Golf Club, Limited Liability Corporation	Sonoma	WS
McKinleyville Community Services District	Humboldt	WS
McKinleyville Wastewater Treatment Plant	Humboldt	WT
Mendocino City Community Service District and High School	Mendocino	WT
Mendocino County Russian River Flood Control and Water Conservation Improvement District	Mendocino	FC
Mendocino County Water Agency	Mendocino	WS
Mendocino County Water Works District, Gualala Community Services District, Gualala Wastewater Treatment Plant	Mendocino	WT
Mendocino Inland Water and Power Commission	Mendocino	WS
Millview County Water District	Mendocino	WS
Miranda Community Services District	Humboldt	WS
Miranda Publicly Owned Treatment Works	Humboldt	WT
Montague Sewage Treatment Plant	Siskiyou	WT
Montague Water Conservation District	Siskiyou	WS
Montair Subdivision, Sewage Treatment Plant	Siskiyou	WT
Myers Flat Mutual Water System	Humboldt	WS

Name	County	Statutory authority
Shelter Cove Publicly Owned Treatment Works	Mendocino	WT
Siskiyou County Flood Control and Water Conservation District	Siskiyou	FC
Smith River Community Services District	Del Norte	WS
Sonoma County Mutual Water Company	Sonoma	WS
Sonoma County Water Agency	Sonoma	WS
Sonoma County Water Agency	Sonoma	FC
Sweetwater Springs County Water District - Guerneville	Sonoma	WS
Tennant Community Service District	Siskiyou	WT
Town of Windsor Water Study Area	Sonoma	WS
Trinity County Water Works District #1	Trinity	WT
Trinity Village Water Company	Trinity	WS
Tulelake City Wastewater Treatment Plant	Siskiyou	WT
Tulelake Irrigation District	Siskiyou/Modoc	WS
Tulelake National Wildlife Refuge	Siskiyou/Modoc	WS
Ukiah City Wastewater Treatment Plant	Mendocino	WT
Ukiah Water District	Mendocino	WS
U.S. Forest Service Orleans Ranger Station Sewage Treatment Plant	Humboldt	WT
Weaverville Community Services District	Trinity	WS
Weaverville Sewage District Wastewater Treatment Plant	Trinity	WT
Weed Shastina Wastewater Treatment Plant	Siskiyou	WT
Weed Wastewater Treatment Plant	Siskiyou	WT
Wendell Water Company	Sonoma	WS
Weott Community Services District	Humboldt	WS
Weott Wastewater Treatment Plant	Humboldt	WT
Wesewage Treatment Plant Land App For Biosolid	Mendocino	WT
Wesewage Treatment Plantort County Water District	Mendocino	WT
West Water Company	Sonoma	WS
Westhaven Community Services District	Humboldt	WS
Westport County Water District	Mendocino	WS

Name	County	Statutory authority
Willits City Wastewater Treatment Plant	Mendocino	WT
Willow County Water District	Mendocino	WS
Willow Creek Community Services District	Humboldt	WS
Windsor, Town of Wastewater Treatment Plant	Sonoma	WT
Yokayo Water System	Mendocino	WS
Yreka City Wastewater Treatment Plant	Siskiyou	WT
Yulupa Mutual Water Company	Sonoma	WS
Yurok Tribe Public Utilities District	Humboldt	WS

Source: County of Humboldt, Community Development Services, Integrated Regional Water Management Region Acceptance Process.

Notes: WS = water supply, WT = wastewater treatment, IWS = irrigation water supply, FC = flood control

Fish and Game Code Section 5653

Because instream dredging is a popular activity in this region, it should be noted that there have been changes to rules that affect these activities. On April 27, 2012, the Office of Administrative Law approved updated regulations governing suction dredge mining under Fish and Game Code Section 5653 et seq., CEQA, and the Administrative Procedures Act. DFW has closed suction dredging for the next several years. However, the closures are moot, as a statewide moratorium has been in place since 2008 and is planned to expire in 2016 after a planned court decision on the issue. For more information on Suction Dredging, see DFW Web page located at: http://www.dfg.ca.gov/suctiondredge/ and "Statewide Instream Mining (Suction Dredging)" section in this document.

California Water Code Division 5, Sections 8,000 - 9,651

CWC Division 5, Sections 8,000-9,651, has special significance to flood management activities and is summarized in *California's Flood Future Report*, Attachment E: "Information Gathering Technical Memorandum."

AB 70 (2007) Flood Liability

AB 70 (2007) provides that a city or county might be responsible for its reasonable share of property damage caused by a flood, if the State liability for property damage has increased due to approval of new development after January 1, 2008.

AB 162 (2007) General Plans

AB 162 (2007) requires annual review of the land use element of general plans for areas subject to flooding, as identified by FEMA or DWR floodplain mapping. The bill also requires that the safety element of general plans provide information on flood hazards. Additionally, AB 162 requires the conservation element of general plans to identify rivers, creeks, streams, flood corridors, riparian habitat, and land that might accommodate floodwater for purposes of groundwater recharge and stormwater management.

Fish and Game Code Section 1602 Streambed Alteration Permits

California Fish and Game Code Section 1602 requires that any water user that alters a streambed, stream bank or undertakes any other stream alteration to file for a permit with the DFW prior to performing any work. On December 24, 2012, the Siskiyou County Superior Court issued an opinion granting declaratory relief for the Siskiyou County Farm Bureau in a case challenging the DFW attempt to require farmers to obtain streambed alteration permits for all agricultural water diversions. The court found that Fish and Game Code Section 1602 ("Section 1602") does not require notification to DFW for the act of diverting water pursuant to a valid water right where there is no alteration to the bed, bank, or stream. Although a Superior Court case, this opinion has important potential statewide implications. This became effective January 1, 2013.

Potter Valley Project FERC License

The Potter Valley Project was first licensed as a hydroelectric power plant in 1922 by the Federal Power Commission. The original 50-year license expired in 1972. From 1972 until 1982, the project was operated with a license that was granted annually while discussions regarding the operation were undertaken by PG&E, FERC, Fishery agencies, and stakeholders. In 1978 a final EIS was issued by FERC. Several years of discussion ensued until, in 1983, the project was relicensed for 50 years (from the original expiration date of 1972). The 1983 settlement agreement was signed by PG&E; DFW; the counties of Humboldt, Mendocino and Sonoma; SCWA; and the Mendocino County Russian River Flood Control and Water Conservation Improvement District. Part of the new license was Article 39, which requires a 10-year study be undertaken to determine what the new project flows impact was on salmon and steelhead and to adjust them accordingly.

A Fisheries Review Group (FRG) was formed which consisted of scientists from PG&E, USFWS, DFW, and the NMFS. In March of 1998, following the 10 years of study, the FRG completed its findings, and a report was filed with FERC recommending flow modifications. FERC began its EIS process. Over the next year, two other entities, including the Round Valley Indian Tribes (RVIT) and SCWA, submitted proposals to FERC for minimum flow releases. FERC held public scoping meetings; and many organizations, municipalities, water districts, environmental groups, and governmental agencies joined as interveners in the process. A draft EIS was completed by FERC in February 1999. After further public meetings, many comments, additional proposed alternatives, and new modeling inputs, FERC issued its final EIS in May 2000.

The FERC recommendation was based predominately on the FRG proposal prepared by the scientists with the most history and knowledge of salmon and steelhead populations specifically in the section of the main stem of the Eel River impacted by the project. The resulting complex flow regimes were calculated in such a way as to make the project nearly invisible to the environment by releasing flows below Cape Horn Dam to mimic natural flows as closely as possible.

After a lengthy Section 7 Consultation between NMFS, PG&E and FERC, under the Endangered Species Act, NMFS produced a BO and Reasonable and Prudent Alternative (RPA) for the project flows and submitted it to FERC in November 2002. The NMFS RPA generated extensive discussion between the agencies and stakeholders that had been involved in the license amendment proceedings since 1983. Ultimately, FERC issued a Final Order Amending the License for the Project January 28, 2004. The project license expires April 14, 2022 (Potter Valley Irrigation District 2012).

Between 1922 and 1983, Potter Valley Project diversions averaged 154,000 af/yr.. Between 1983 and 2006, diversions averaged approximately 131,000 af/yr.. In 2006, however, PG&E concluded that its amended FERC license did not authorize that level of diversions and between 2007 and 2013 diversions have averaged 70,000 af/yr.

Russian River Biological Opinion

Two salmonid species inhabiting the Russian River watershed (Chinook salmon and steelhead) have been listed as “threatened” under the federal Endangered Species Act (ESA), and one species — coho salmon — has been listed as “endangered” under the federal ESA and under the California ESA. Because SCWA’s water supply facilities and operations have the potential to adversely affect the three listed species, NMFS issued what is commonly referred to as the Russian River Biological Opinion on September 24, 2008. The Russian River Biological Opinion is in effect until September 2023, and it is anticipated that SCWA will engage in a new Section 7 consultation with NMFS and the USACE and that a new biological opinion will be issued prior to the expiration of the existing one.

The Russian River Biological Opinion concluded that artificially high summertime flows in the Russian River and Dry Creek make it difficult for juvenile steelhead and coho to grow and thrive and that the practice of “breaching” the sandbar at the Russian River estuary negatively affects the estuary’s habitat for young steelhead by allowing more saltwater than is natural to flow into it and by keeping the amount of fresh water artificially low. As a result of these findings, the Russian River Biological Opinion requires SCWA and USACE to implement a series of actions to modify existing water supply and flood control activities that, in concert with habitat enhancement, are intended to minimize impacts to listed salmon species and enhance their habitats within the Russian River and its tributaries. Among other things, the Russian River Biological Opinion requires SCWA to adaptively manage the Russian River estuary with the goal of maintaining a freshwater lagoon in which young steelhead can grow; petition SWRCB to modify (by lowering) minimum instream flows in the Russian River and Dry Creek; and engage in habitat enhancement and restoration activities to provide hiding places and refuge along 6 miles of Dry Creek for young coho salmon and steelhead trout.

The Estuary Management Project was approved in August 2011 and is being implemented. In September 2009, SCWA filed a petition with the SWRCB asking for changes to Decision 1610 and is preparing an EIR required by CEQA. Because the process to permanently change minimum instream flows could take several years, the Russian River Biological Opinion requires that SCWA annually petition the SWRCB for interim changes to lower the flows required by Decision 1610, and SCWA has annually filed the required temporary urgency change petitions since 2010. Finally, with respect to Dry Creek habitat enhancement, the first mile of enhancements, which includes logs, boulders, and thousands of native plants, is currently under way and must be complete by 2014. The second and third miles of habitat enhancement must be complete by 2017, with the final three miles constructed by 2023.

More information regarding the Russian River Biological Opinion, including relevant documents and implementation status, can be found at http://www.scwa.ca.gov/rrifr/.

Hydropower, a Renewable Energy

In 2013, the California Public Utilities Commission is considering accepting large hydropower facilities as qualified "renewable energy" resources. This would allow power generating utilities in California to include these large hydropower sources in their list of renewable energy resources helping them to meet the requirement of 33 percent by 2020 goal set by the California Public Utilities Commission (CPUC), i.e., Renewables Portfolio Standard (RPS) (Public Utilities Code 399.11 et seq.). Until 2013, large hydropower facilities (producing over 30 megawatts) were not allowed to be considered renewable energy due to environmental concerns over the use of dams and their effect on fisheries. However, this new legal development may have a short-term benefit to the region's counties (particularly utilities in Siskiyou County) because plans are to remove the hydroelectric dams on the Klamath River (Iron Gate, and both Copco dams) pursuant to the Klamath Basin Restoration Agreement, Klamath Facilities Removal Environmental Impact Statement/Environmental Impact Report 2011 (U.S. Bureau of Reclamation 2011b).

State Funding Received

DWR and SWRCB administer planning grants intended to foster development or completion of IRWM plans or components thereof, to enhance regional planning efforts, and to assist more applicants to become eligible for implementation grant funding (Table NC-18).

Flood Governance

California's water resource development has resulted in a complex, fragmented, and intertwined physical and governmental infrastructure. Although primary responsibility might be assigned to a specific local entity, aggregate responsibilities are spread among more than 85 agencies in the North Coast Hydrologic Region with many different governance structures. Agency roles and responsibilities can be limited by how the agency was formed, which might include enabling legislation, a charter, a memorandum of understanding with other agencies, or facility ownership.

The North Coast Hydrologic Region is the site of many flood management infrastructure including floodwater storage facilities and channel improvements funded and/or built by the State and federal agencies. Flood management agencies are responsible for operating and maintaining approximately 1,200 miles of levees, more than 110 dams and reservoirs, and other facilities within the North Coast Hydrologic Region.

For a list of the entities that have responsibilities or involvement in flood and water resources management, and a list of major infrastructure, refer to *California's Flood Future Report*, Attachment E: "Information Gathering Technical Memorandum." See http://www.water.ca.gov/sfmp/ for more information on this report.

Surface Water Ambient Monitoring Program (SWAMP)

Surface Water Ambient Monitoring Program (SWAMP) is a program administered by the SWRCB. SWAMP is tasked with assessing water quality in all of California's surface waters. The program conducts monitoring directly and through collaborative partnerships and provides

Table NC-18 State Funding Received

Funding Received	Description
$3,394,652 $500,000	Prop 1E 2011 City of Fortuna Rohner Creek Flood Control and Riparian Habitat Improvement Project Prop 50 2011 planning grant for NCIRWM DAC Pilot Project to Humboldt County to administer for region
$24,831,579	Prop 50 2009 Round 1 Implementation Grant (State Water Resources Control Board) for Humboldt County to administer for Region; 21 projects in 7 counties
$2,176,860	Prop 50 2010 Supplemental for Coastal Implementation Projects administered by Humboldt County for Region
$160,000	Prop 50 2007 Scott River IRWM Implementation Grant (delayed due to economic constraints at State level)
$50,000 $1,000,000	Prop 50 2007 Local Groundwater Assistance grant to Ukiah for groundwater management plan development Prop 84 2010 planning grant for NCIRWMP Phase III work on plan
$500,000	Prop 84 2011 DAC Pilot Project administered by Humboldt County for Region
$8,221,061	Prop 84 2011 Round 1 Implementation grant for 19 projects in region

numerous information products, all designed to support water resource management in California. SWRCB works on this program in cooperation with several statewide and local work groups including the Klamath Basin Water Quality Monitoring Coordination Group. Recent programs in the North Coast region (Regional Work plans), as of the writing of this document, include the Russian River-Freshwater Beaches Program (2012), Water Quality Status and Trends (2012), Garcia River Watershed Condition Monitoring (2012), Toxicity in California Waters-North Coast Region (2012), and the Regional Work plan for 2006 and 2007 (2007).

The Russian River, Redwood Creek (Humboldt County), and Klamath basins have long-term water quality data sets, which is necessary to evaluate water quality changes over time. The current SWAMP sampling will contribute to these data sets (State Water Resources Control Board 2012).

Groundwater Governance

California does not have a statewide management program or statutory permitting system for groundwater. However, one of the primary vehicles for implementing local groundwater management in California is a GWMP. Some local agencies manage groundwater through adoption of groundwater ordinances, and others manage groundwater through authorities granted by special acts of the Legislature. Additional avenues of groundwater management include basin adjudication, IRWMPs, urban water management plans, and agricultural water management plans.

A summary assessment of some of the GWMPs in the North Coast region is presented below, while a detailed assessment of the same is available online from *California Water Plan Update 2013,* Volume 4, *Reference Guide*, in the article, "California's Groundwater Update 2013." The assessment was based on a GWMP inventory developed through a joint DWR/Association of California Water Agencies (ACWA) online survey and follow-up communication by DWR in 2011 and 2012.

Groundwater Management Assessment

Table NC-19 lists some of the GWMPs in the region, while Figure NC-18 shows the location and distribution of the GWMPs. GWMPs prepared in accordance with the 1992 AB 3030 legislation, as well as those prepared with the additional required components listed in the 2002 SB 1938 legislation are shown. (Note: Sonoma County is split between the North Coast and San Francisco Bay Hydrologic regions. The GWMP for the Sonoma Valley Groundwater Basin is presented in the regional report of the San Francisco Bay Hydrologic Region in Update 2013. SCWA has convened a Basin Advisory Panel to develop a GWMP for the Santa Rosa Plain Groundwater basin.)

The GWMP inventory shows GWMPs in the North Coast Hydrologic Region, two of which are fully contained within the region, while the other two plans include portions of the adjacent Sacramento River Hydrologic Region. All four GWMPs were developed or updated to include the SB 1938 requirements and are considered active for the purposes of the GWMP assessment. As of August 2012, none of the eight basins identified as medium priority under the CASGEM Basin Prioritization were covered by an active GWMP. Recent efforts currently under way to develop additional GWMPs in the region need to be further strengthened to develop and implement CWC-compliant GWMPs. In the Santa Rosa area, stakeholders have been meeting since December 2011 to develop a GWMP for the Santa Rosa Plain watershed, which includes the medium priority Santa Rosa subbasin.

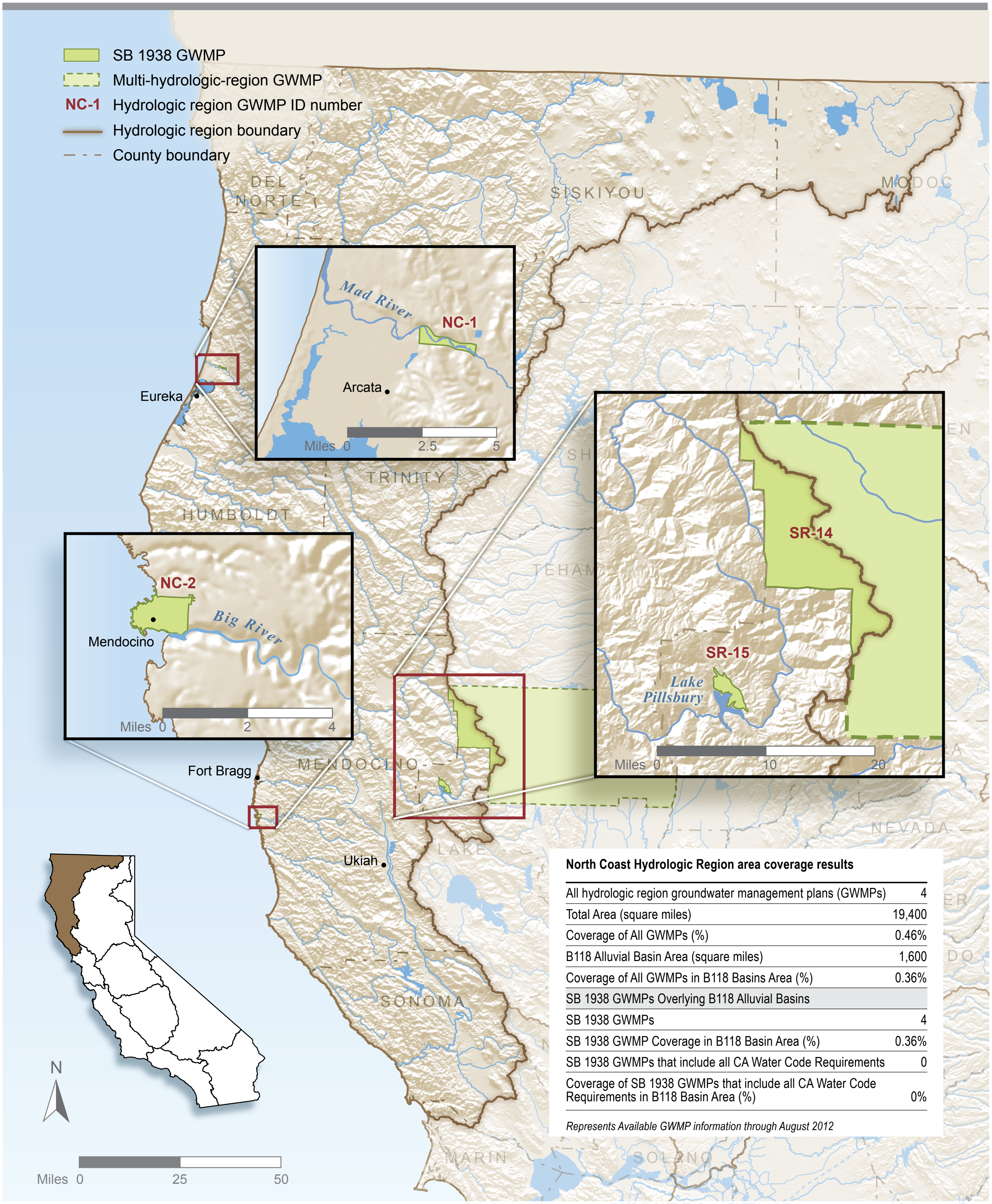
CWC Section 10753.7 requires that six components be included in a GWMP for an agency to be eligible for State funding administered by DWR for groundwater projects, including projects that are part of an integrated regional water management program or plan. The requirement associated with the 2011 AB 359 (Huffman) legislation, applicable to groundwater recharge mapping and reporting, did not take effect until January 2013 and was not included in the current assessment. In addition, the requirement for local agencies outside of recognized groundwater basins is noted, as applicable for any of the GWMPs in the region.

In addition to the six required components, CWC Section 10753.8 provides a list of 12 components that may be included in a GWMP. Bulletin 118-2003 (California Department of Water Resources 2003), Appendix C provides a list of seven recommended components related to management development, implementation, and evaluation of a GWMP, which should be considered to help ensure effective and sustainable GWMP.

As a result, the GWMP assessment was conducted using the following criteria:

- How many of the post SB 1938 GWMPs meet the six required components included in SB 1938 and incorporated into CWC Section 10753.7?

Figure NC-18 Location of Groundwater Management Plans in the North Coast Hydrologic Region



North Coast Hydrologic Region area coverage results

All hydrologic region groundwater management plans (GWMPs)	4
Total Area (square miles)	19,400
Coverage of All GWMPs (%)	0.46%
B118 Alluvial Basin Area (square miles)	1,600
Coverage of All GWMPs in B118 Basins Area (%)	0.36%
SB 1938 GWMPs Overlying B118 Alluvial Basins	
SB 1938 GWMPs	4
SB 1938 GWMP Coverage in B118 Basin Area (%)	0.36%
SB 1938 GWMPs that include all CA Water Code Requirements	0
Coverage of SB 1938 GWMPs that include all CA Water Code Requirements in B118 Basin Area (%)	0%

Represents Available GWMP information through August 2012

Table NC-19 Groundwater Management Plans in the North Coast Hydrologic Region

			Coverage Area		
MAP LABEL	AGENCY NAME	DATE	COUNTY	BASIN NUMBER	BASIN NAME
NC-1	**Humboldt Bay Municipal WD**	2006	Humboldt	1-8.01	Mad River Lowland Subbasin
	No signatories on file				
NC-2	**Mendocino City CSD**	2007	Mendocino	1-21	Fort Bragg Terrace Area Basin
	No signatories on file			–	Non-B118 Basin
SR-14	**Glenn County**	2009	Glenn	5.21.52	Colusa Subbasin
	Provident ID			5-21.58	West Butte Subbasin
	Glide WD			5.21.51	Corning Subbasin
	Willow Creek MWC			5.61	Chrome Town Basin
	California Water Service			5-62	Elk Creek Area Basin
	Princeton-Codora-Glenn ID, Provident ID			5-63	Stonyford Town Area
	Kanawha WD			5-88	Stony Gorge Reservoir Basin
	Glenn-Colusa ID			5-89	Squaw Flat Basin
	Orland-Artois WD			5-90	Funks Creek Basin
	Western Canal			–	Non-B118 Basin
SR-15	**Lake County Watershed Protection District**	2006	Lake	5-13	Upper Lake Valley
	No signatories on file			5-14	Scotts Valley
				5-16	High Valley
				5-17	Burns Valley
				5-18	Coyote Valley
				5-19	Collayomi Valley
				5-30	Lower Lake Valley

			Coverage Area		
MAP LABEL	AGENCY NAME	DATE	COUNTY	BASIN NUMBER	BASIN NAME
				5-31	Long Valley
				5-66	Clear Lake Cache Formation
				5-94	Middle Creek
				1-48	Gravelley Valley (NC)

Notes:

Table represents information as of August, 2012.

Sonoma County is split between the North Coast and San Francisco Bay hydrologic regions. The Groundwater Management Plan (GWMP) for the Sonoma Valley Groundwater Basin is presented in the regional report of the San Francisco Bay Hydrologic Region. Sonoma County Water Agency has also convened a Basin Advisory Panel to develop a GWMP for the Santa Rosa Plain Groundwater basin.

- How many of the post SB 1938 GWMPs include the 12 voluntary components included in CWC Section 10753.8?
- How many of the implementing or signatory GWMP agencies are actively implementing the seven recommended components listed in Bulletin 118-2003 (California Department of Water Resources 2003)?

A summary of the GWMP assessment is provided in Table NC-20.

Factors Contributing to Success and Impediment to Groundwater Management

The survey participants were also asked to identify key factors that promoted or impeded successful groundwater management. Only one survey respondent identified data collection and sharing, developing an understanding of common interest, sharing of ideas and information, broad stakeholder participation, and having adequate surface water supplies as key factors for successful GWMP implementation. Having adequate funding and the time necessary to develop the GWMP were also identified as important factors.

The single survey respondent pointed to a lack of adequate funding as an impediment to GWMP implementation. Funding is a challenging factor for many agencies because the implementation and the operation of groundwater management projects are generally expensive and because funding typically is limited to locally raised money or to State and federal grants. Limited access to planning tools and unregulated groundwater pumping were also identified as factors that impede successful implementation of GWMPs.

The single survey respondent felt long-term sustainability of their groundwater supply was possible.

More detailed information on the DWR/Association of California Water Agencies (ACWA) survey and assessment of the GWMPs are available online from *California Water Plan Update 2013,* Volume 4, *Reference Guide*, in the article “California’s Groundwater Update 2013.”

Table NC-20 **Assessment for SB 1938 GWMP Required Components, SB 1938 GWMP Voluntary Components, and Bulletin 118-03 Recommended Components**

SB 1938 GWMP Required Components	Percent of Plans That Meet Requirement
Basin Management Objectives	25
BMO: Monitoring/Management Groundwater Levels	100
BMO: Monitoring Groundwater Quality	100
BMO: Inelastic Subsidence	75
BMO: SW/GW Interaction & Affects to Groundwater Levels & Quality	50
Agency Cooperation	50
Map	75
Map: Groundwater basin area	100
Map: Area of local agency	100
Map: Boundaries of other local agencies	75
Recharge Areas (1/1/2013)	Not Assessed
Monitoring Protocols	0
MP: Changes in groundwater levels	100
MP: Changes in groundwater quality	75
MP: Subsidence	50
MP: SW/GW Interaction & Affects to Groundwater Levels & Quality	25
SB 1938 Voluntary Components	**Percent of Plans That Include Component**
Saline Intrusion	50
Wellhead Protection & Recharge	50
Groundwater Contamination	75
Well Abandonment & Destruction	75
Overdraft	75
Groundwater Extraction & Replenishment	50
Monitoring Groundwater Levels and Storage	100
Conjunctive Use Operations	25
Well Construction Policies	75
Construction and Operation	75
Regulatory Agencies	75
Land Use	25

Bulletin 118-03 Recommended Components	Percent of Plans That Include Component
GWMP Guidance	50
Management Area	75
BMOs, Goals, & Actions	50
Monitoring Plan Description	75
IRWM Planning	25
GWMP Implementation	75
GWMP Evaluation	75

Notes:

BMO=basin management objective, IRWM=integrated regional water management, GWMP=groundwater management plan, MP=monitoring rotocols, SW/GW= surface water/groundwater

Groundwater Ordinances

Groundwater ordinances are laws adopted by local authorities, such as cities or counties, to manage groundwater. In 1995, the California Supreme Court declined to review a lower court decision (*Baldwin v. Tehama County)* that says that State law does not occupy the field of groundwater management and does not prevent cities and counties from adopting ordinances to manage groundwater under their police powers. Since 1995, the *Baldwin v. Tehama County* decision has remained untested; thus the precise nature and extent of the police power of cities and counties to regulate groundwater is still uncertain.

A number of counties in the region have adopted groundwater ordinances. The most common ordinances regulate well construction, abandonment, and destruction. However, none of the ordinances provide comprehensive groundwater management.

Special Act Districts

Special acts of the Legislature have granted greater authority to manage groundwater to a few local agencies or districts. These agencies generally have the authority to (1) limit export and extraction (upon evidence of overdraft or threat of overdraft) or (2) require reporting of extraction and to levy replenishment fees.

There are many Special Act Districts established by the California State Legislature consisting of different authorities that may or may not have groundwater management authority.

Court Adjudication of Groundwater Rights

Another form of groundwater management in California is through the courts. There are currently 24 groundwater adjudications in California. The North Coast Hydrologic Region contains one of those adjudications. In Scott River watershed of the region, all surface water rights and much of the groundwater rights (excluding the tributaries below Scott Valley) have been adjudicated. In

1950, court decree was issued by Siskiyou County Superior Court for Shackleford Creek and then in 1958, for French Creek. The remainder of the valley's water claims (including some of the groundwater) was established in 1980 through the Scott River Stream System Decree. The CWC was amended in 1970 to allow the Scott River Stream System's surface water and supporting underflow and groundwater to be considered interconnected. As indicated in Figure NC-19 and Table NC-21, the Scott Valley groundwater basin in the region is included in this adjudication. To ensure that water rights distribution set forth in the adjudication is followed, watermaster service is provided by the Scott and Shasta Valley Watermaster District for distributing and monitoring groundwater pumping and surface water diversions according to the court decree. (State Water Resources Control Board 1980)

A landmark case focusing on water management and regulation in Scott River Valley is currently being reviewed by the courts and has the potential to significantly alter the way groundwater is managed in other parts of California. A 2010 lawsuit (*Environmental Law Foundation, et al. v. State Water Resources Control Board and Siskiyou County*) alleges that the State and the county are not exercising their authority under the public trust doctrine to manage and regulate groundwater extractions which contribute to important base flows in the Scott River. The lawsuit claims that years of approving well drilling permits have seriously depleted the local aquifer, creating severe water depletion in the Scott River, which was once an important salmon-bearing tributary to the Klamath River and is still home to federally and State-protected coho salmon. The lawsuit focuses on the groundwater aquifer areas outside the interconnected groundwater–surface water zone identified in the 1980 adjudication. The courts have not yet ruled if the public trust doctrine applies to groundwater depletion and the effect it has on nearby surface water systems — which is a critically important issue for many of California's groundwater basins.

The pending lawsuit has great potential significance because the public trust doctrine has not previously been applied toward regulation and management of groundwater use, and "percolating" groundwater has not previously been subject to regulation by SWRCB. If successful, the lawsuit could result in precedent setting changes in the way groundwater is managed in California. If the State is required to take the public trust doctrine into account for allocation and use of interconnected surface water–groundwater resources, then many of California's groundwater users could expect to see an increase in State management and regulation of groundwater, and increased oversight of local groundwater management practices.

Other Groundwater Management Planning Efforts

Groundwater management also occurs through other avenues such as IRWM plans, urban water management plans, and agricultural water management plans. Box NC-3 summarizes groundwater management aspects included in these planning efforts.

Current Relationships with Other Regions and States

Klamath Basin

As shown on the region map (see Figure NC-1), the Klamath River Basin straddles the border with Oregon, such that water from the upper basin flows into Oregon and eventually returns to California above Iron Gate Reservoir. On the Oregon side of this interstate basin, two surface water diversions export an average of 29,600 af/yr. from Klamath River tributaries into the Rogue

Figure NC-19 Groundwater Adjudications in the North Coast Hydrologic Region

Table NC-21 Groundwater Adjudications in the North Coast Hydrologic Region

Court Judgment	North Coast HR Basin/Subbasin	Basin Number	County	Judgment Date
Scott River Stream System	Scott River Valley Basin	1-5	Siskiyou	1980

Note: Table represents information as of April 2013.

River system in Oregon. The Klamath River Basin also receives a small amount of imported water (about 2,000 af/yr.) from the upper reaches of the Sacramento River Hydrologic Region through a canal called the North Fork Ditch within Shasta Valley in Siskiyou County.

The Klamath Basin Restoration Agreement and the Klamath Hydroelectric Settlement Agreement (KHSA) are companion agreements between Klamath Basin tribes, irrigators, fishermen, conservations, counties, states of Oregon and California, federal agencies, and dam owners. The agreements aim to restore Klamath Basin fisheries and sustain local economies. They include removal of four dams in the upper Klamath River, increased flows for fish; greater reliability of irrigation water deliveries, reintroduction of salmon above the dams and into and above Upper Klamath Lake, investment in comprehensive and coordinated habitat restoration, an electrical power program for basin farmers and ranchers, mitigation to counties for the effects of dam removal, and investment in tribal economic revitalization. The first dam is scheduled to be removed in 2020, pending CEQA and National Environmental Policy Act (NEPA).

Trinity River

The North Coast region exports a large volume of water from the upper reaches of the Trinity River into the Sacramento River region through the USBR's CVP at Lewiston Dam and the Clear Creek Tunnel. In 1998, a wet year, Trinity River exports (by water year) were 851,610 af; in 2000, an above normal water year, 1.110 maf; and in 2001, a dry year, 670,530 af showing the variability of flows related to changing hydrology. In contrast, when looking at flows for years since the ROD was implemented (see "Trinity River Watershed" under "Settings" section of this document), in 2006, a wet year, exports were 1.353 maf, in 2008, a critical dry year, exports were 555,929 af and in 2010, a below normal water year, 275,202 af. These examples show how hydrology plays an important part in the decision of how much water to export. However, current year hydrology is only part of the decision. Instream requirements for fisheries downstream on the Trinity River, past year hydrology, current year estimated hydrology, water quality concerns in the Delta and Trinity River, reservoir levels and operational needs are all considered when setting export quantities (U.S. Geological Survey 2012).

The Trinity River Restoration Program was founded in 2000, based on three comprehensive foundational documents: the landmark Trinity River Flow Evaluation Final Report (TRFEFR) prepared by the USFWS and the Hoopa Valley Tribe in consultation with the USGS, USBR, NMFS, and DFW (U.S. Fish and Wildlife Service and Hoopa Valley Tribe 1999); the Trinity River Environmental Impact Statement (TREIS) prepared by USFWS et al. 2000; and the U.S. Department of the Interior Record of Decision 2000.

Box NC-3 Other Groundwater Management Planning Efforts in the North Coast Hydrologic Region

The integrated regional water management (IRWM) plans, urban water management plans, and agricultural water management plans in the North Coast Hydrologic Region that also include components related to groundwater management are briefly discussed below.

Integrated Regional Water Management Plans

The North Coast Hydrologic Region is unique in that it is fully covered by one IRWM plan. Although the North Coast IRWM plan addresses groundwater resources in its goals and objectives, similar to other IRWM plans throughout the state, it does not actively manage local groundwater resources. Instead the plan defers groundwater management to local entities with groundwater management plans and identifies county, State, federal, and tribal entities that address groundwater management issues, such as county general plans, the California Water Plan, the Environmental Protection Agency's Underground Injection Control Program, and tribal/reservation plans. Regional prioritization of groundwater management plan development and implementation of local groundwater management planning is one of the goals of this IRWM region.

Urban Water Management Plans

Urban water management plans are prepared by California's urban water suppliers to support their long-term resource planning and to ensure adequate water supplies are available to meet existing and future water uses. Urban use of groundwater is one of the few uses that meter and report annual groundwater extraction volumes. The groundwater extraction data are currently submitted with the urban water management plan and then manually translated by California Department of Water Resources staff into a database. Online methods for urban water managers to directly enter their water use along with their plan updates is currently under evaluation and review by DWR. Because of the timeline, the plans could not be reviewed for assessment for *California Water Plan Update 2013.*

Agricultural Water Management Plans

Agricultural water management plans are developed by water and irrigation districts to advance the efficiency of farm water management while benefitting the environment. New and updated agricultural water management plans addressing several new requirements were submitted to DWR by December 31, 2012, for review and approval. These new or updated plans provide another avenue for local groundwater management; but because of the time-line, the plans could not be reviewed for assessment for *California Water Plan Update 2013*.

The program is administered by the USBR and USFWS, both bureaus of the U.S. Department of the Interior, as co-leads. Other partner agencies make up and share in the decision-making process of the Trinity Management Council: the Hoopa Valley Tribe (HVT), the Yurok Tribe (YT), Trinity County, the California Resources Agency (consisting of DWR and DFW), USFS, and the NMFS.

The river was dammed, and most of the flow was diverted to the Sacramento Valley beginning in 1963, as part of the Trinity River Division of the CVP. (As a note: The Trinity River Division Act of 1955 authorized the Trinity River Diversion or TRD.) The diverted water enters the Sacramento River near Redding, California, and provides for a variety of uses such as agriculture, industry, drinking water, recreation, electrical power generation, and habitat. According to the Trinity River Restoration Program Annual Report (2011), in 1970 it was believed that this diversion of water to the CVP was causing a population decline in the Trinity River fishery. Federal legislation at that time and in subsequent years has called for a variety of protections to the river, including protection of pre-dam levels of fisheries and of Native American tribal rights for access to Trinity River fish. For more information on the Trinity River Watershed and Trinity River Division, see section on Setting; sub-section, Trinity River Watershed, in this document. For further information concerning the Trinity River Restoration Program, go to http://www.trrp.net (Trinity River Restoration Program 2012).

PG&E's Potter Valley Project

The Russian River Basin began receiving Eel River water through the Potter Valley Project in 1908 (http://www.pottervalleywater.org/history.html) and with several modifications was diverting 154 taf per year into the basin at its peak. Communities grew up based upon the available supply in the augmented river system. However, with the FERC license amendments, the diversion has been cut. Between 1922-1983, the diversion averaged approximately 154 taf a year; between 1983-2006, the diversions averaged approximately 131 taf/year; and between 2007-2013, the diversion has averaged approximately 70 taf/year.

Communities like Redwood Valley County Water District (RVCWD), are in an almost annual summertime water shortage condition. In addition to diversion changes for the Potter Valley Project, 2007 through 2010 were low water years. RVCWD gathered most of the attention, but several small community service districts and county water districts began having severe water supply problems. The loss of supply also affected the reliability of SCWA to meet its demands, which affected supplies into the San Francisco Bay Region.

SCWA Transmission System

In the most southern part of the region, a smaller export of roughly 25,000 af/yr. is transported from the lower Russian River system into the northern portion of the San Francisco Bay Hydrologic Region through SCWA's transmission system, to supply communities in northern Marin County and southern Sonoma County.

Regional Water Planning and Management

The focus of regional planning activities varies significantly from north to south across the North Coast region because of the diversity of water issues and involved water agencies. In the far north interstate Klamath River watershed, much of the planning is being done by federal agencies such as the USBR, the Natural Resources Conservation Service, and the USFWS, among others. These federal agencies are working to balance the needs of the federal Klamath Project with water for fish, tribal interests, and interests of communities affected by the federal project. Planning and issue resolution for the Trinity River also have a significant federal lead role because of the federal CVP at Trinity and Lewiston reservoirs. In general, many of the Northern California counties lack funding at the level available to federal agencies to conduct regional planning.

In the central portion of the region, the communities and water issues in Humboldt, Trinity, and Mendocino counties tend to be organized at the local or county levels, partly because these areas are geographically separated from other developed regions. Planning activities of Humboldt Bay Municipal Water District and the Humboldt County general plan update are one of the primary forums for regional planning for the Arcata and Eureka areas. The Mendocino Council of Governments and the Mendocino Community Services District are among the lead water planning agencies for the county, which includes Ukiah and portions of the upper Russian River wine country.

Sonoma County is the southernmost county in the North Coast Hydrologic Region, and water planning is closely associated with those of the adjoining San Francisco Bay region. Water planning is strongly focused on meeting the urban needs of Santa Rosa and the surrounding communities served by SCWA while balancing the needs of the environment, fisheries, and recreation. SCWA coordinates with and is a member of several North Coast and San Francisco Bay area regional planning groups. Much of Sonoma County regional planning also focuses on the competing uses of the Russian River, which is the largest river in this part of the North Coast region.

Integrated Regional Water Management Coordination and Planning

In the North Coast region, the North Coast Regional Water Management Group (NCRWMG) was formed to coordinate planning within the region. The group, now known as the North Coast Resource Partnership (NCRP) is a consortium of counties working together on water management planning and project prioritization and implementation for the North Coast region. Currently, the member counties of the NCRP are responsible for implementation of the North Coast Integrated Regional Water Management Plan (NCIRWMP), with individual project proponents responsible for project implementation. More information about the authorizing resolutions for the existing institutional structure (Appendix I "Authorizing Documentation and Eligible Applicant Documentation") can be found in the North Coast IRWM Plan Phase I at: http://www.northcoastirwmp.net/docManager/1000006298/NCIRWMP_Phase_I_2007.pdf.

You can read more about how the counties participate in the NCRP at the same Web site. Some counties have expressed reservations about joining any collaborative planning effort that might conflict with their local authority. See Figure NC-20 for integrated regional water management planning areas in the North Coast Region.

Accomplishments

Local Tribes Cooperation

Recently, a tribal group was formed, although informal, as a collaboration of tribes in the North Coast led by the Cher-Ae-Heights Indian Community of the Trinidad Rancheria. This group was formed to assist local tribes interested in collaborating to develop an environmental assessment and implementation plan for improving ecosystems and water quality in order to meet or exceed federal and State regulations regarding water quality. Tribes currently involved in this collaboration include the Trinidad Rancheria in Trinidad, Blue Lake Rancheria Tribe in Blue Lake, Bear River Tribe in Loleta, and Big Lagoon Rancheria in Arcata. One main function of the cooperation is to assist the members in obtaining grant funding for local water quality infrastructure improvements.

Figure NC-20 Integrated Regional Water Management Planning Areas in the North Coast Region

Notes:

1) Hatch symbols are shown where there is a boundary overlap.
2) Numbers shown are for reference purposes only and correspond to internal DWR RAP submittal indentifications.
3) Region boundaries shown are those submitted by each applicant as part of the RAP submittal.
   – RAP 2009 = ID No's 1 – 46
   – RAP 2011 = ID No's 47 – 49

Ecosystem Restoration

Nearly 49 percent of the North Coast region is permanently protected as open space and includes parks, reserves, recreation areas, national monuments, national forests, State forests, and other protected areas. Over a million acres in the region have been designated as National Wilderness Areas. The North Coast region also includes 21 areas listed as Critical Coastal Areas, 12 Marine Protected Areas, and 8 areas of Special Biological Significance.

DFW recommends that priority be given to the following actions be taken in relation to water supply in the North Coast region:

- Restoration projects that facilitate the improvement of aquatic habitat, including deep and shallow open water.
- Actions that will offset, mitigate-for, or accommodate climate change-related environmental issues such as sea water rise, temperature shifts, potential regime changes, etc.
- Acquisition of conservation easements on lands.
- Protect or restore fish habitat through the improvement of fish passage conditions, gravel augmentation, hydrology, fish screens, min/max flow, etc.
- Development, collection and publication of instream flow data, including recommended instream flow levels and minimum instream flow requirements.
- Prevent or reduce negative impacts from invasive non-native species including those associated with water supply and conveyance projects such as quagga and zebra mussels, *Egeria densa* (dense waterweed, Brazilian waterweed, elodea), water hyacinth, and others.
- Restoration projects that facilitate the increase of populations and improvement of habitat for salmon, especially coho.
- Restoration projects that improve upon existing wetlands, or create new wetlands in appropriate areas.
- Improvements in the transparency and availability of environmental data.
- Acquisition of water for wildlife areas to assure health of the area.
- Water quality improvements (sediment, oxygen saturation, pollution, temperature, etc.) to support healthy ecosystems.
- Improvements in coordination, management and implementation of watersheds.

Restoration efforts that support or are undertaken in conjunction with projects related to water supply contribute to the protection and sustainability of ecosystems in the region. Presently, there are many efforts to restore ecosystems in the region; to list them all is beyond the scope of this regional report. This section describes a few representative projects that are being implemented in the region. They are notable in that they are collaborative undertakings, involving State, federal, local agencies, and communities in the North Coast region.

Five Counties Salmonid Conservation Program (5C Program)

In 1997, the northwestern California counties of Del Norte, Humboldt, Mendocino, Siskiyou, and Trinity agreed to collaborate on a proactive, positive response to the federal listing of coho salmon as a threatened species by forming the Five Counties Salmonid Conservation Program (the 5C Program). Its primary goal is “to strive to protect the economic and social resources of northwestern California by providing for the conservation and restoration of salmonid populations to healthy and sustainable levels and to base decisions on watershed rather than county boundaries."

In February 2009, the 5C Program transferred from Trinity County administration to the Northwest California Resource Conservation & Development Council whose mission is to enhance the ability of area residents to develop diverse opportunities through the utilization of available resources. The program maintains its relationship with all five counties and will continue to build on the watershed restoration and planning work that has been integral to the program over the past years.

The 5C Program's specific objectives include:

1. Improve county policies and road maintenance practices with a strong emphasis on training.
2. Identify potential restoration opportunities through inventories of fish passage barriers and potential sediment sources on county maintained roads.
3. Increase the amount of salmonid habitat by replacing stream crossings that are barriers to migration with structures that provide for passage. Improve water quality by treating identified sources of road-related sediment.
4. Devise methods to streamline permitting procedures, specifically under the State and federal ESAs, the Clean Water Act, and California Fish and Game Code.
5. Collaborate with other organizations, agencies, and regional groups on restoration and conservation.
6. Develop model regulations only where other means cannot be utilized to address land use activities regulated by the counties.
7. Secure grant program and project funding from a variety of federal, State, and local sources.

The 5C Program is highly effective in promoting and sustaining collaborative efforts that capitalize on technical assets of participants and in leveraging financial support from numerous sources. It recognizes that taking on these challenges will lead to a healthier environment, sustainable fisheries, and better county facilities, all of which contribute to a more robust economy (Five Counties Salmonid Conservation Program 2013).

Sage Steppe Ecosystem Restoration

Restoration efforts in the upper Klamath Basin include the eradication of juniper within the sage steppe ecosystem and associated vegetative communities of northeastern California. The effort began with a series of information discussions between the Modoc National Forest, the BLM and local resource agencies in the region. In April of 2008, the final EIS was issued for the Sage Steppe Ecosystem Restoration Strategy. The restoration strategy EIS affects Modoc, Lassen, Shasta, and Siskiyou counties as well as a portion of Washoe County in Nevada.

The action was undertaken because of the loss of sage steppe ecosystem processes and vegetation conditions where the density of western juniper has created a shift in dominant vegetation in the region. The purpose of the restoration strategy is to improve watershed function and condition, restore biodiversity and productivity, manage fire fuel loads, and to implement where appropriate national renewable energy directives. Projects have been completed recently to implement this strategy. A similar effort is under way in southern Oregon as well.

Klamath Basin National Wildlife Refuge Complex

The Klamath Basin National Wildlife Refuge Complex is a wildlife refuge operated by the USFWS located in the Klamath Basin in southern Oregon and Northern California. The complex consists of Lower Klamath NWR (National Wildlife Refuge), Clear Lake NWR, Upper Klamath NWR, Tule Lake NWR, Klamath Marsh NWR, and the Bear Valley NWR. Klamath Basin habitats include freshwater marshes, open water, grassy meadows, coniferous forests, sagebrush grasslands, agricultural lands, and rocky cliffs and slopes. These habitats support large numbers of resident and migratory wildlife. The refuge also serves as a major stopping point for fall concentrations of Pacific Flyway waterfowl. See the following section, "River Restoration - Klamath River" for information relating to the effect of the Klamath Basin Restoration Agreement on the refuges.

River Restoration

Klamath River

The Klamath Basin Restoration Agreement (KBRA) when implemented contains as its name implies, strategies for restoring the fisheries and associated habitats for the Klamath River watershed. The agreement is the result of a collaborative effort of a large group of stakeholders who have worked together to find solutions to water conflicts in the region. The plan was adopted by most parties in January 2010 (see below) and will implement fisheries restoration with the removal of four dams that were constructed in the early 1900s as part of USBR's Klamath Reclamation Project.

The KBRA is intended to result in effective and durable solutions which:

1. In concert with the removal of four dams, will restore and sustain natural production and provide for full participation in ocean and river harvest opportunities of fish species throughout the Klamath Basin;
2. Establish reliable water and power supplies which sustain agricultural uses, communities, and National Wildlife Refuges; and
3. Contribute to the public welfare and the sustainability of all Klamath Basin communities.

According to the agreement, the dam removal would begin in 2020. Although the agreement has been mostly adopted, it has not passed into law as there are controversial issues and highly charged reactions to this plan. In particular, Siskiyou County has not agreed to the plan. Siskiyou County believes the plan was based on poor "piecemeal" scientific discovery and has requested both KBRA and KHSA be reviewed by the Secretary of the Interior. In addition, Siskiyou County is predominantly a DAC, does not have the tax base to meet the terms of the agreement, and believes the agreement would not contribute to the welfare of the Siskiyou County communities affected. Until KBRA has been approved by Congress and funding is obtained, the dams will stay, and the Klamath Basin Coordinating Council has no authority to make any binding decisions regarding the Klamath River.

Issues surrounding the Klamath Dam removal include probable lower flows in the rivers during droughts which increase water temperatures downstream; affecting fisheries. Upon dam removal, the release of over 30 million tons of sediment behind the dams would occur, also affecting fisheries. In addition, the spread of invasive weed species from around the de-watered lakes and the loss of property taxes to the counties would cause further problems.

In addition, the Scott and Shasta rivers are medium- to low-flow streams in the middle of long flat valleys with air temperatures over 100 degrees in the summer. Slow-moving shallow water during high summer air temperatures causes the temperature of the water to increase (which is a natural state). Many consider the Klamath to be a warm water system, and attempts to make it cold may be fruitless.

Shasta and Scott Rivers

During the past 20 years, extensive restoration has been completed by the Shasta Resource Conservation District and Coordinated Resource Management Program in the Shasta Valley and by the Siskiyou RCD and Watershed Council in the Scott Valley. There are also water trusts in both valleys with Scott River Water Trust beginning in 2007 and Shasta River Water Trust beginning in 2012.

Every water diversion accessible by coho has a fish screen. Diversions have headgates and most are managed by a watermaster. Ninety percent (plus) of the main stem Scott River is fenced to keep cattle from entering the stream. There have been numerous riparian plantings, bank stabilizations and hundreds of projects on both rivers. As part of the Five County Salmonid Conservation program, hundreds of miles of barriers to fish passage have been removed; road culverts and conditions have been inventoried and treated to improve overall habitat and migration (Scott River Water Trust 2013; Shasta River Water Trust 2013; Shasta River Water Association 2013; Five Counties Salmonid Conservation Program 2013).

Shasta River

Recent projects in the Shasta River area include projects that are designed to reduce agricultural tailwater runoff to the river. Other efforts are considering the feasibility of providing water users in the Shasta River watershed with an incentive-based approach that relieves certain regulatory pressures in exchange for leaving water instream to support the fishery.

Salt River

The Salt River Ecosystem Restoration Project is a collaborative effort to restore fish habitat, improve water quality, and provide for flood protection. The project affects restoration of the Salt River, Francis Creek, and Williams Creek near the City of Ferndale in Humboldt County. Sediment monitoring is also conducted to provide guidance on how much suspended sediment can be expected to enter the Salt River from Francis Creek watershed. The data will be used to enhance sediment routing and provide planning data for future dredging downstream. The project is considered to be of an ecosystem scale that includes the restoration of a large tidal wetland that will create a succession of biologically rich and diverse tidal wetland habitats, including transitional wetlands and adjacent uplands as part of a sustainable estuary system. The mission of the project is to restore natural hydrologic function to the Salt River for the improvement of water quality, wastewater treatment, flood control, wetlands and fisheries enhancement.

Big River

The Big River Program undertaken by Mendocino Land Trust and California State Parks seeks to provide permanent protection of the estuarine, wetlands, wildlife, and associated seral-stage forest of the Big River Units of the Mendocino Headlands State Park. Activities that contribute to these goals include invasive plant control, greenhouse development for seed collection, trails and road monitoring, research and resource monitoring, outreach and education.

In 2002, most of the Big River Estuary and some associated upland areas were added to the California State Park System. The Big River Parcel consists of 7,334 acres, which when added to the surrounding State Park system creates a 74,000-acre wildlife corridor linking coastal and inland habitats into the largest piece of connected public land contained entirely within Mendocino County.

Coho, steelhead, and Chinook inhabit the Big River watershed, but population numbers are low compared to historical levels. The estuary and lower river provide critical habitat for spawning, rearing, and staging for adult, juvenile, and smolting salmonids.

Salmon Creek

Another collaborative effort to address the decline of salmonid runs on the North Coast includes restoration projects on Salmon Creek in Sonoma County. This restoration project provides for the instream placement of large woody debris at critical locations in the Salmon Creek estuary. Post-construction monitoring on a similar project on the Mattole River indicated high utilization by juvenile salmonids and lower water temperatures contributing to project success.

Russian River

The Russian River watershed encompasses 1,485 square miles (approximately 950,000 acres) within Sonoma and Mendocino counties. Multiple restoration efforts are taking place or are planned in the Russian River watershed, primarily centered on tributaries of the Russian River. One key restoration effort is a result of the Russian River Biological Opinion (issued in 2008 by National Marine Fisheries Service). The Russian River Biological Opinion requires SCWA and USACE to provide improved habitat and refugia in Dry Creek for young coho salmon and steelhead trout. While the cold, clean water in Dry Creek is ideal for salmon and steelhead, the water velocity is often too fast for young fish to thrive. The Russian River Biological Opinion requires that six miles of habitat be constructed in the 14-mile long creek. The first mile of enhancements, which includes logs, boulders and thousands of native plants, is currently underway and must be complete by 2014. The second and third miles of habitat enhancement must be complete by 2017, with the final three miles constructed by 2023. More information regarding the Russian River Biological Opinion, including relevant documents and implementation status, including the most recent Russian River Biological Opinion Status and Data Report can be found at: http://www.scwa.ca.gov/rrifr/.

Laguna de Santa Rosa

The Laguna de Santa Rosa (a tributary to the Russian River and a subset of the Russian River watershed), in Sonoma County is a biologically rich freshwater wetland complex that has retained much of its wildland character even as its surrounding neighborhoods have been converted to agriculture, commerce, and housing. The “Laguna” has remained relatively strong and resilient in the face of severe pressures from habitat fragmentation, water pollution, floodplain encroachment, and urban development. Meanwhile, the general public perception of the area as a "wetlands jewel" has resulted in a widespread outpouring of public sentiment in support of its protection and restoration.

But a deeper look at the wetlands reveals a long list of ecological imbalances that portend a darker future. The need for enhancing the Laguna becomes clearer when the historical record is examined — most notably the record of the land's great fertility and its former abundance of wildlife and diversity of plant life. The disconnection of upstream watershed processes result in a large increase in the amount of sediment reaching and settling out in the Laguna. This increased sediment load has caused significant change to the Laguna. When compared to today's remaining, simpler, less-diverse, plant and animal communities, the contrast is sharp.

Enhancing the Laguna by removing invasive plants, planting native plants, re-contouring human-made water channels, and reducing water pollutants is a fundamental goal of the area's citizens. Caring for the Laguna includes monitoring for changes, stewarding the land, educating the generations, studying the ecological processes of the Laguna, and enacting public policy. Restoring and managing the Laguna are complementary sets of activities that together will strengthen its ability to reach a balanced state of flux and resiliency.

Mattole River

Restoration efforts on the Mattole River include the replacement of poorly designed and installed culverts to improve fish passage and stabilize sediment. The Mattole Integrated Water Management program is a watershed-wide effort to meet water supply, water quality, and fish habitat goals for the coastal Mattole River. Benefits of the project will include increased water supply in a drought-prone area, reduction in sediment load, invasive plant eradication, and riparian ecosystem restoration at 47 sites.

Trinity River Restoration Program

The Trinity River Restoration Program is a collaborative effort of federal, State, tribal, and local stakeholders who are working together to restore the physical processes of the Trinity River as a foundation for the recovery of the fishery. Methods of restoration include the management of flows through releases from Lewiston Dam, construction of channel rehabilitation sites, spawning gravel augmentation, watershed projects to control fine sediments, infrastructure improvements, environmental compliance, and science based adaptive management. More information about the Trinity River can be found in the setting and watershed sections of this regional report.

Challenges

The region faces many water quality and water supply challenges. The NCRWQCB's water quality priorities highlight the need for control of non-point-source runoff from logging, rural roads, agriculture, and urban areas. In fact, sediment, temperature, and nutrients are the primary focus of the RWQCB's 303(d) list of impaired water bodies. Along the coast, non-point-source pollution can cause microbial contamination of shellfish growing areas, especially oysters. Much of the region is characterized by rugged, steep, forested lands, with highly erodible, loosely consolidated soils; taken together with wildfires, extensive timber harvesting, and heavy precipitation primarily in the form of rain, the watershed is highly susceptible to erosion and landslides. Such heavy runoff in turn causes stream sedimentation that impacts habitat for spawning and rearing of anadromous fish. Channel modifications and water diversions have radically changed water-quality conditions in many water bodies in the region, reducing natural flows that dilute contaminant concentrations and lessen their impacts. In the southern portion of the region, the development of new hillside vineyards is an increasing source of erosion and pesticides. Fortunately, many of the streams in Siskiyou County that feed the Klamath River below Iron Gate Dam come from roadless wilderness areas that bring clean, cold, non-impaired water to the Klamath.

Fisheries can be adversely affected by a number of factors related to both water quality and water quantity. The Eel, Mad, Trinity, Klamath and Russian rivers, as well as many other streams, suffer from sedimentation, which can smother salmonid spawning areas. The NCRWQCB Basin Plan sets turbidity restrictions to control erosion impacts from logging and related activities, such as road building. The basin plan also specifically establishes temperature objectives for the Trinity River, in which reduced flows have disrupted temperature and physical cues for anadromous fish runs. Because of water diversions, summer temperatures in the Trinity as well as the Klamath can be lethal to salmonids. Fisheries can be further affected by the lack of woody debris for pool habitat and sediment metering. If the dams on the Klamath River in California are removed, millions of tons of sediment currently behind the dams will be released to the river, causing increased sedimentation problems downstream.

The NCRWQCB Basin Plan requires tertiary treatment of wastewater discharges to the Russian River, a major source of domestic water for the area, and establishes limits on bacteriological contamination of shellfish-growing areas along the coast. The plan also prohibits or strictly limits waste discharges to the Klamath, Trinity, Smith, Mad, and Eel rivers, as well as estuaries and other coastal waters. non-point-source runoff, especially after heavy precipitation, has resulted in contamination and closure of shellfish harvesting beds in Humboldt Bay. In the lower Russian River watershed storm water runoff also might be contributing to high ammonia and low dissolved oxygen levels in Laguna de Santa Rosa, which is threatening aquatic life. Mercury in fish tissue is a water quality concern in Lakes Pillsbury, Mendocino, and Sonoma; a health advisory for mercury has been issued for Lake Pillsbury.

Groundwater quality problems in the North Coast region include contamination from seawater intrusion and nitrates in shallow coastal groundwater aquifers; high total dissolved solids and alkalinity in groundwater associated with the lake sediments of the Modoc Plateau basins; and iron, boron, and manganese in the inland groundwater basins of Mendocino and Sonoma counties. Septic tank failures in western Sonoma County, at Monte Rio and Camp Meeker, and along the Trinity below Lewiston Dam, are a concern because of potential impacts to groundwater wells and recreational water quality.

Other water quality concerns include the impacts of boating fuel constituents such as MTBE to recreational water use at Trinity, Lewiston, and Ruth lakes. Abandoned mines, forest herbicide application, and historical discharge of wood treatment chemicals at lumber mills, including Sierra Pacific Industries near Arcata and Trinity River Lumber Company in Weaverville, are also regional issues of concern. Of note, the Klamath basin, Redwood Creek watershed, and the Russian River basin all have long-term water quality data sets, which are necessary to evaluate water quality changes over time.

Even though the North Coast region produces a substantial share of California's surface water runoff, only about 10 percent of this runoff occurs in the summer; and water supplies are limited throughout much of the area. Small surface-water supply projects generally have limited carryover capacity that cannot supply adequate water during extended months of low rainfall. The drinking water for many of the communities on the North Coast, such as Klamath, Smith River, Crescent City, and most of the Humboldt Bay area, is supplied by Ranney collectors (horizontal wells adjacent to or under the bed of a stream).

Erosion is undercutting some of these collectors, such as those in the Mad River supplying the Humboldt Bay Municipal Water District (which serves Eureka, Arcata, and McKinleyville). As such, these "wells" may actually be under the direct influence of surface water, which would then require filtration. The city of Willits has had chronic problems with turbidity, taste, and odor with water from Morris Reservoir, and high arsenic, iron, and manganese levels in its well supply. Organic chemical contamination has closed municipal wells in the cities of Sebastopol and Santa Rosa. The town of Mendocino typifies the problems related to groundwater development in the shallow marine terrace aquifers; surveys in the mid-1980s indicate about 10 percent of wells go dry every year and up to 40 percent go dry during droughts.

The Klamath River Basin is an interstate watershed with surface storage facilities in both California and Oregon, with competing water needs for agriculture, Indian tribal rights, waterfowl refuges, and endangered fish. The primary water storage facilities belong to the federal Klamath Project, which is operated by USBR, in conjunction with other dams and diversion structures operated by local irrigation districts, wildlife management agencies, and electric power companies. In 2001, the lack of rainfall generated a severe drought, which aggravated water disputes and caused harsh effects to agriculture, waterfowl refuges and the downstream fisheries. The endangered fish populations include listed species such as the Lost River and shortnose suckers, coho salmon, and steelhead trout. During 2001, USBR was able to deliver only about 75,000 af of water to agriculture in California, which is about 25 percent of normal. In the Tule Lake and Lower Klamath Lake subbasins, this translated to a drought disaster for both agriculture and the wildlife refuges. In 2002, about 33,000 adult salmon died due to water quality and quantity problems while trying to swim up the Klamath.

The Eel River and its tributaries are the largest river system draining to the coast of Humboldt County, and it is characterized by significant water quality problems during winter storm events due to massive sediment loads from unstable soils. The Eel River is also host to Humboldt County's largest fisheries of salmon and steelhead, which depend on access to upstream tributaries for spawning. The only major water storage in the upper reaches of the Eel River is the Potter Valley Project, which consists of Lake Pillsbury and a downstream diversion dam and tunnel to the Russian River (Mendocino County). The history of this project and recent FERC license amendment is discussed in the "Project Operations" section under "Pacific Gas &Electric's Potter Valley Project" subheading.

Flood Challenges

Precipitation, coastline, terrain, and other area factors translate to frequent floods and flooding in the North Coast region. Finding solutions to reduce residual flood risk in California is a complex task that will require a mix of both old and new tools and approaches to flood management and funding, evolution of existing planning processes and policies, sustained action, and commitment from agencies at all levels to achieve the desired result of public safety, environmental stewardship, and financial stability in the state. To accomplish these goals, the public, policy-makers, and agencies at all levels must work together to address the flood risk that exists statewide. Also, flood management practices must continue to evolve toward integrated water management, and flood management agencies must be brought into the IRWM process as full partners with other water management agencies. The hazards and risks of floods and flooding are indiscriminate:

- People are exposed to flood risk. Flood hazard exposure is distributed throughout the state, with all counties having some level of exposure. In the North Coast region, 30,000 people are exposed to flood risk (5 percent of population) in a 100-year floodplain with 40,000 people (6 percent of population) exposed in a 500-year floodplain.
- Structures are at risk. Property and assets are exposed to flood hazards in all regions of California. In the North Coast region, $3 billion worth of structures (8 percent) are exposed in a 100-year floodplain with $4 billion (10 percent) exposed in a 500-year floodplain.
- California's agricultural economy is at risk. A major flood event in California has the potential to devastate regional agriculture based economies and cause serious impacts to the State economy. In the North Coast region, $80 million of crop value is exposed in a 100-year floodplain (108,000 acres or 25 percent of crop acreage). Within a 500-year floodplain in the North Coast region, $90 million in crop value from 112,000 acres (26 percent of crop land) is exposed.
- Native American tribal lands at risk. Within the North Coast Region, 5,748 acres of tribal lands are at risk in the 500-year floodplain.
- State and federal sensitive species are exposed to flood hazard. Within the North Coast region, 203 species of plants and 117 species of animals are exposed to flood risk in both the 100-year and 500-year floodplains.
- Climate change may impact flood hazard risk. Climate change could have a significant impact on the timing and magnitude of runoff in California. In addition, increasing temperatures could result in a rise in sea level, which likely would result in an increase in flood events. These changes could result in expansions of the 100-year and 500-year floodplains, thereby causing an increase in the people, property, and infrastructure exposed to flood hazards in the future.

Drought Planning

Klamath Basin Restoration Agreement Drought Plan 2011

In 2011, representatives from the State of California and Oregon, USBR, tribal organizations, and other stakeholders (Klamath Basin Coordinating Council) under Section 19.2 of the Klamath Basin Restoration Agreement developed a Drought Plan for the Upper Klamath Region. The Drought Plan identifies a number of strategies that would be used to counteract the effects of drought and extreme drought in the region. Measures that could be implemented include voluntary water conservations, additional stored water, the use of groundwater and the reduction of diversions (Klamath Basin Coordinating Council 2011).

Looking to the Future

Future Conditions

Future Scenarios

Update 2013 evaluates different ways of managing water in California depending on alternative future conditions and different regions of the state. The ultimate goal is to evaluate how different regional response packages, or combinations of resource management strategies from Volume 3, perform under alternative possible future conditions. The alternative future conditions are described as future scenarios. Together, the response packages and future scenarios show what management options could provide for sustainability of resources and ways to manage uncertainty and risk at a regional level. The future scenarios are composed of factors related to future population growth and climate change. Growth factors for the North Coast Hydrologic Region are described below. Climate change factors are described in general terms in Volume 1, Chapter 5, "Managing an Uncertain Future."

Water Conservation

Update 2013 scenario narratives include two types of water use conservation. The first is conservation that occurs without policy intervention (called background conservation). This includes upgrades in plumbing codes and end user actions such as purchases of new appliances and shifts to more water efficient landscape absent a specific government incentive. The second type of conservation expressed in the scenarios is through efficiency measures under continued implementation of existing best management practices in the California Urban Water Conservation Council's Memorandum of Understanding Regarding Urban Water Conservation in California (last amended in September 2011). These are specific measures that have been agreed upon by urban water users and are being implemented over time. Any other water conservation measures that require additional action on the part of water management agencies are not included in the scenarios, and would be represented as a water management response.

North Coast Growth Scenarios

Future water demand in North Coast Hydrologic Region is affected by a number of growth and land use factors, including population growth, planting decisions by farmers, and size and type of urban landscapes. Table NC-22 has a conceptual description of the growth scenarios used in *California Water Plan Update 2013*. The Water Plan quantifies several factors that together provide a description of future growth and how growth could affect water demand for the urban, agricultural, and environmental sectors in North Coast Hydrologic Region. Growth factors are varied among the scenarios to describe some of the uncertainty faced by water managers. For example, it is impossible to predict future population growth accurately, so the Water Plan uses three different, but plausible population growth estimates when determining future urban water demands. In addition, the Water Plan considers up to three different alternative views of future development density. Population growth and development density will reflect how large the urban landscape will become in 2050 and are used by the Water Plan to quantify encroachment into agricultural lands by 2050 in North Coast Hydrologic Region.

Table NC-22 Conceptual Growth Scenarios

Scenario	Population Growth	Development Density
LOP-HID	Lower than Current Trends	Higher than Current Trends
LOP-CTD	Lower than Current Trend	Current Trends
LOP-LOD	Lower than Current Trends)	Lower than Current Trends
CTP-HID	Current Trends	Higher than Current Trends
CTP-CTD	Current Trends	Current Trends
CTP-LOD	Current Trends	Lower than Current Trends
HIP-HID	Higher than Current Trends	Higher than Current Trends
HIP-CTD	Higher than Current Trends	Current Trends
HIP-LOD	Higher than Current Trends	Lower than Current Trends

For Update 2013, DWR worked with researchers at the University of California, Davis, to quantify how much growth might occur in North Coast Hydrologic Region through 2050. The UPlan model was used to estimate a year 2050 urban footprint under the scenarios of alternative population growth and development density (see http://ice.ucdavis.edu/project/uplan for information on the UPlan model). UPlan is a simple rule-based urban growth model intended for regional or county-level modeling. The needed space for each land use type is calculated from simple demographics and is assigned based on the net attractiveness of locations to that land use (based on user input), locations unsuitable for any development, and a general plan that determines where specific types of development are permitted. Table NC-23 describes the amount of land devoted to urban use for 2006 and 2050, and the change in the urban footprint under each scenario. As shown in the table, the urban footprint grew by about 20,000 acres under the low population growth scenario (LOP) by 2050 relative to 2006 base-year footprint of about 190,000 acres. The urban footprint under the high population scenario (HIP), however, grew by about 90,000 acres. The effect of varying housing density on the urban footprint is also shown.

Table NC-24 describes how future urban growth could affect the land devoted to agriculture in 2050. Irrigated land area is the total agricultural footprint. Irrigated crop area is the cumulative area of agriculture, including multiple crop area, where more than one crop is planted and harvested each year. Each of the growth scenarios shows a decline in irrigated acreage over existing conditions, but to varying degrees. As shown in the table, irrigated crop acreage declines by about 40,000 acres by year 2050 as a result of low population growth and urbanization in North Coast Hydrologic Region, while the decline under high population growth was slightly higher by about 50,000 acres.

North Coast 2050 Water Demands

This section provides a description for how future water demands might change under scenarios organized around themes of growth and climate change described earlier in this chapter. The change in water demand from 2006 to 2050 is estimated for the North Coast Hydrologic Region for the agriculture and urban sectors under 9 growth scenarios and 13 scenarios of future climate change. The climate change scenarios included the 12 Climate Action Team scenarios described

Table NC-23 Growth Scenarios (Urban) — North Coast

Scenario[a]	2050 Population (thousand)	Population Change (thousand) 2006[b] to 2050	Development Density	2050 Urban Footprint (thousand acres)	Urban Footprint Increase (thousand acres) 2006[c] to 2050
LOP-HID	763.3[d]	106.7	High	204.3	15.9
LOP-CTD	763.3	106.7	Current Trends	206.5	18.1
LOP-LOD	763.3	106.7	Low	208.5	20.1
CTP-HID	814.9[e]	14.9	High	219.4	31.0
CTP-CTD	814.9	14.9	Current Trends	221.8	33.4
CTP-LOD	814.9	14.9	Low	224.6	36.2
HIP-HID	1,185.6[f]	33.3	High	267.5	79.1
HIP-CTD	1,185.6	33.3	Current Trends	278.0	89.6
HIP-LOD	1,185.6	33.3	Low	288.6	100.2

Notes:

[a] See Table NC-22 for scenario definitions.

[b] 2006 population was 656.6 thousand.

[c] 2006 urban footprint was 188.4 thousand acres.

[d] Values modified by the California Department of Water Resources (DWR) from the Public Policy Institute of California.

[e] Values provided by the California Department of Finance.

[f] Values modified by DWR from the Public Policy Institute of California.

in Volume 1, Chapter 5, "Managing an Uncertain Future," and a 13th scenario representing a repeat of the historical climate (1962-2006) to evaluate a "without climate change" condition.

Figure NC-21 shows the change in water demands for the urban and agricultural sectors under 9 growth scenarios, with variation shown across 13 climate scenarios. The nine growth scenarios include three alternative population growth projections and three alternative urban land development densities, as shown in Table NC-23. The change in water demand is the difference between the historical average for 1998 to 2005 and future average for 2043 to 2050. Urban demand is the sum of indoor and outdoor water demand where indoor demand is assumed not to be affected by climate. Outdoor demand, however, depends on such climate factors as the amount of precipitation falling and the average air temperature.

Urban demand increased under most growth scenarios tracking with population growth. On average, it increased slightly by about 2 taf under the three low population scenarios, 17 taf under the three current trend population scenarios and about 70 taf under the three high population scenarios when compared to historical average of about 150 taf. The results show change in

Table NC-24 Growth Scenarios (Agriculture) — North Coast

Scenario[a]	2050 Irrigated Land Area[b] (thousand acres)	2050 Irrigated Crop Area[c] (thousand acres)	2050 Multiple Crop Area[d] (thousand acres)	Change in Irrigated Crop Area (thousand acres) 2006 to 2050
LOP-HID	325.1	325.1	0.0	-37.8
LOP-CTD	324.7	324.7	0.0	-38.2
LOP-LOD	324.4	324.4	0.0	-38.5
CTP-HID	322.4	322.4	0.0	-40.5
CTP-CTD	322.0	322.0	0.0	-40.9
CTP-LOD	321.4	321.4	0.0	-41.5
HIP-HID	314.4	314.4	0.0	-48.4
HIP-CTD	312.3	312.3	0.0	-50.6
HIP-LOD	310.2	310.2	0.0	-52.7

Notes:

[a] See Table NC-22 for scenario definitions.

[b] 2006 irrigated land area was estimated by the California Department of Water Resources (DWR) to be 362.9 thousand acres.

[c] 2006 irrigated crop area was estimated by DWR to be 362.9 thousand acres.

[d] 2006 multiple crop area was estimated by DWR to be 0.0 thousand acres.

future urban water demands are less sensitive to housing density assumptions or climate change than to assumptions about future population growth.

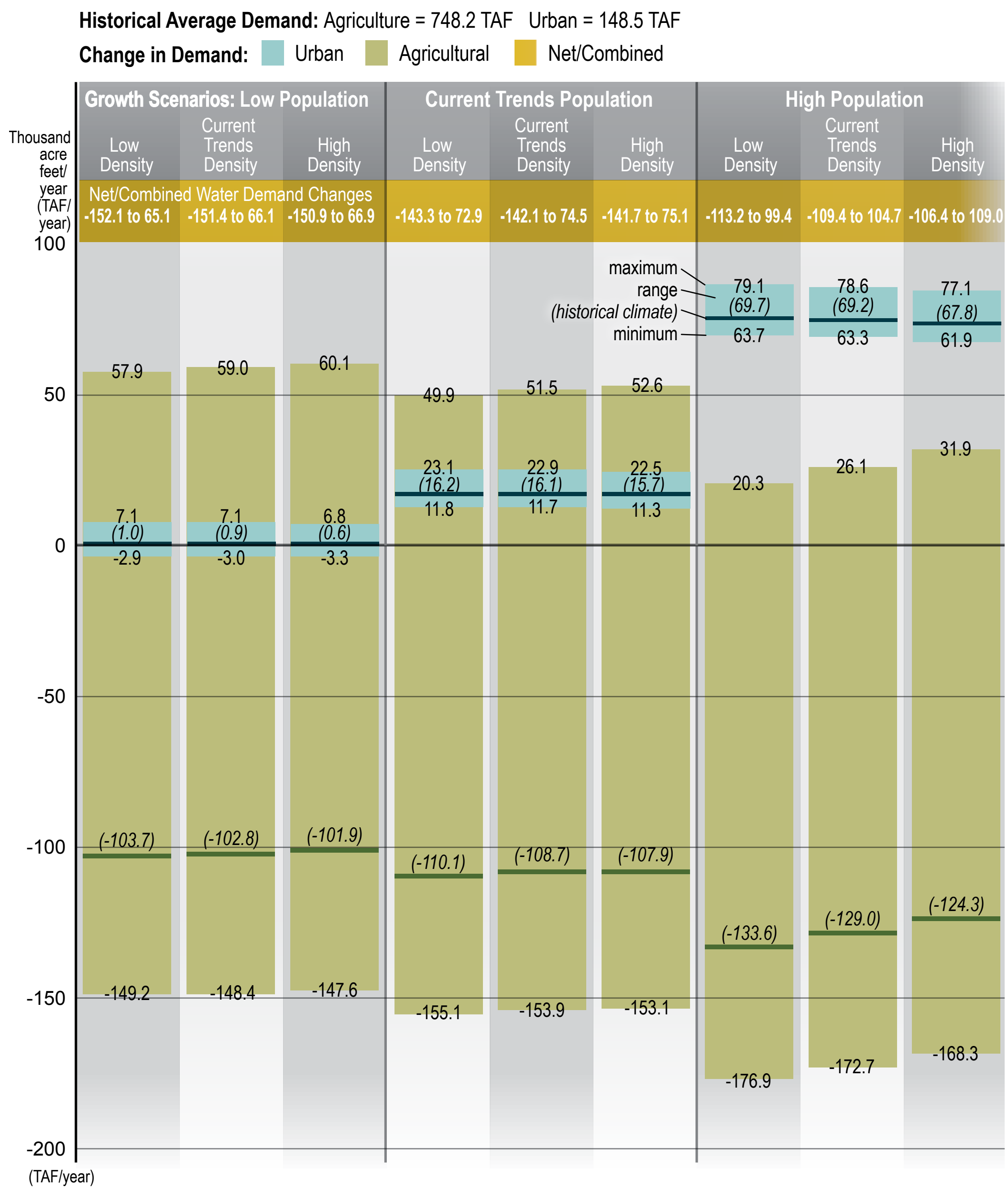
Agricultural water demand decreases under most of the future scenarios due to reduction in irrigated lands as a result of urbanization and background water conservation when compared with historical average water demand of about 750 taf. Under the three low population scenarios, the average reduction in water demand was about 60 taf while it was about 90 taf for the three high population scenarios. For the three current trend population scenarios, this change was about 70 taf. The results show that low density housing would result in more reduction in agricultural demand since more lands are lost under low-density housing than high density housing.

Integrated Regional Water Management Plan Summary

Inclusion of the information contained in IRWM plans into Update 2013 regional reports has been a common suggestion by regional stakeholders at the regional outreach meetings since the inception of the IRWM program. To this end, the California Water Plan has taken on the task of summarizing readily available IRWM plans in a consistent format for each of the regional reports. (This collection of information will not be used to determine IRWM grant eligibility.)

All IRWM plans are different in how they are organized. Therefore, finding and summarizing the content in a consistent way proved difficult. It became clear through these efforts that a process

Figure NC-21 **Change in North Coast Agricultural and Urban Water Demands for 117 Scenarios from 2006-2050**



is needed to allow those with the most knowledge of the IRWM plans, those that were involved in the preparation, to have input on the summary. It is the intention that this process be initiated following release of Update 2013 and continue to be part of the process of the update process for Update 2018. This process will also allow for continuous updating of the content of the "atlas" (described below) as new IRWM plans are released or existing IRWM plans are updated.

In addition to these summaries, all summary sheets will be provided in one IRWM Plan Summary "Atlas" as an article included in Volume 4, *Reference Guide*. This atlas will, under one cover, provide an "at-a-glance" understanding of each IRWM region and highlight each region's key water management accomplishments and challenges. The atlas will showcase how the dedicated efforts of individual RWMGs have individually and cumulatively transformed water management in California.

As can be seen in Figure NC-20, there is one RWMG in the North Coast Hydrologic Region.

Region Description

The North Coast IRWM region coincides with DWR's North Coast Hydrological Region and the region delineated by the NCRWQCB. It includes all of the counties of Del Norte, Humboldt, Trinity, and Mendocino, as well as major portions of Siskiyou and Sonoma counties. It also includes small portions of Glenn, Lake, Marin, and Modoc counties. It is made up of several watersheds that drain to the Pacific Ocean and includes 340 miles of coastline. Precipitation within the region varies widely, with some portions receiving as much as 120 inches per year and some portions getting as little as 10 inches per year.

As of late 2013, the North Coast IRWM region has received a total of about $130.5 million in funding from both State and non-State sources: $42,274,360 from the State and $88,286,683 from non-State sources. Table NC-25 provides a funding source breakdown for the region.

Key Challenges and Goals

The North Coast region faces the following challenges:

- Riparian and wetland ecosystem function
- Point-source and non-point-source discharges
- Groundwater and surface water interactions
- Water quality and quantity

To address the challenges, the North Coast region has identified the following goals/objectives:

- Conserve and enhance native salmonid population by protecting and restoring required habitats, water quality and watershed processes.
- Protect and enhance drinking water quality to ensure public health.
- Ensure adequate water supply while minimizing environmental impacts.
- Support implementation of TMDLs, the NCRWQCB Watershed Management Initiative, and the Nonpoint Source Program Plan.
- Address environmental justice issues as the relate to DACs, drinking water quality, and public health.
- Provide an ongoing, inclusive framework for efficient intra-regional cooperation, planning, and project implementation.

Water Supply and Demand

While there are a number of small, rural communities that rely on groundwater from small private wells, surface water is the primary source of supply. Because surface supplies are heavily dependent on precipitation patterns, surface storage fluctuates. There are several large water

Table NC-25 North Coast IRWM Plan Funding

IRWM Region	Prop. 50 Planning Grant	Prop. 50 Implementation Grant	Prop. 84 Planning Grant	Prop. 84 Implementation Grant[a]	Prop. 1E Stormwater Grant
North Coast Region	**$500,000** $287,000	**$29,158,647** $79,000,523	**$1,000,000** $1,335,000	**$8,221,061** $4,157,048	**$3,394,652** $3,507,112
Grand Total $130,561,043					

Notes:

This table is up-to-date as of late 2013.

Grant figures in **bold** are State-funded. Grant figures in regular type are non-State funded.

[a] Does not include Proposition 84 Implementation Grant Round 2 Awards.

supply projects in the North Coast region, including the USBR Klamath Project, the USACE Russian River Project, the Humboldt Bay Municipal Water District Ruth Reservoir, and the USBR Trinity Lake Reservoir. Surface water storage generally varies from 2,000 af to almost 3,000 af. The region generally exports more water to other regions than the volume of water consumed within the region for agriculture and urban uses. No water is imported into the region.

Water Quality

The North Coast region faces many water quality challenges. Most of the region's rivers and streams are listed as impaired. These impairments are primarily due to non-point-source pollution such as failing septic tanks, gravel mining, and agriculture. Groundwater quality issues include seawater intrusion and elevated nutrients in shallow coastal areas of the groundwater basins. High total dissolved solids and elevated mineral and heavy metal concentrations are other groundwater quality concerns within the region.

Flood Management

Due to excessive amounts of winter rains received by much of the region, damaging floods occur frequently. There are several reservoirs within the region that provide flood control including Lake Sonoma and Lake Mendocino. A number of proposed projects within the region address flood management through restoring streambeds and removing roadway water crossings that have begun to trap substantial volumes of sediment.

Groundwater Management

There are 63 groundwater basins and subbasins delineated within the North Coast region, two of which are shared with Oregon. There is limited groundwater development within the region due to the small number of significant coastal aquifers. However, groundwater is used widely for individual domestic, agricultural, and industrial water use. Groundwater is a significant water source of some small rural communities that rely on residential wells for water, but the total amount of groundwater use in the region is small compared to surface water use. In response to concern over future groundwater development, the Mendocino City Community Service District developed a GWMP that puts limits on new well development and increased withdrawals from existing wells.

Environmental Stewardship

In addition to the extensive amount of State and federal forests, the region also contains 21 areas designated as Critical Coast Areas. These areas are considered to be environmentally sensitive and in need of protection or improvement. All of the watersheds within the region support plant and animal species considered to be rare, threatened, or endangered by State and federal government agencies. Salmonid population decline within the region is of particular concern. Coho salmon abundance, including hatchery stocks, has declined by at least 70 percent since the 1960s. The region is committed to improving salmonid populations, with numerous agencies working collaboratively to implement projects that benefit salmonid habitat.

Climate Change

The North Coast IRWM region is already experiencing some of the effects of climate change, such as increased temperatures, reduced snowpack, and sea level rise. Climate change has the potential to impact the region's economy that depends on the natural environment. These changes will increase the vulnerability of natural and built systems in the region. Impacts to natural systems will challenge aquatic and terrestrial species with diminished water quantity and quality, and shifting ecoregions. Built systems will be impacted by a changing hydrology and runoff timing, loss of natural snowpack storage, and a growing dependence on surface storage in reservoirs and groundwater sources. The region has made progress on incorporating climate mitigation, adaptation, and energy independence into its planning and implementation framework, including data gathering, literature review, outreach and issues identification, as well as the successful identification and funding acquisition in support of emissions reduction projects. The region's primary focus has been in mitigation of greenhouse gas (GHG) emissions including biomass energy, alternative energy strategies, water conservation, and carbon sequestration projects.

Tribal Communities

The North Coast region has a significantly higher percentage of Native American residents than that of the state's 1 percent; about 4 percent of the region's residents identify themselves as tribal members. The two largest Native American reservations are in the North Coast region and include the Hoopa Reservation in Humboldt County and the Round Valley Reservation in Mendocino County. In total, there are 37 federally recognized Native American tribes in the region. Outreach efforts have included summit meetings between elected representatives of cities and tribes, in addition to information distribution via the Web site, workshops, conferences, and printed materials. Active involvement in the IRWM planning process includes tribal representatives from the Yurok Tribe and Hoopa Valley Tribal Protection Agency serving as IRWM plan reviewers.

Disadvantaged Communities

Of the 10 counties in the region, only Marin and Sonoma do not qualify as disadvantaged. Mechanisms for outreach and involvement of DACs in the region include the region's Web site, more than 10 public workshops held throughout the region, one-on-one technical assistance to project proponents, and direct phone, e-mail, and in-person communication with agencies and individuals. The region has a goal specifically targeted at DACs and environmental justice and further supports DAC benefits though its proposed projects list. Potential benefits to DACs from NCIRWMP project implementation include improvements to salmonid fisheries, water quality, water supply, and compliance with State and federal regulations.

Governance

The North Coast Resource Partnership (NCRP) is a consortium of counties working together on the planning, project prioritization, and implementation of the IRWM plan for the North Coast region. Formed under a Memorandum of Mutual Understanding, the NCRP includes Del Norte, Siskiyou, Trinity, Humboldt, Mendocino, and Sonoma counties. The Policy Review Panel, composed of two representatives from each county, provides direction and ultimate oversight to the IRWM planning process. The Technical Peer Review Committee is composed of county members with technical backgrounds related to water management. This committee reviews projects from a technical perspective and makes recommendations to the Policy Review Panel on project prioritization.

Resource Management Strategies

Volume 3 contains detailed information on the various resource management strategies that can be used by water managers to meet their goals and objectives. A review of the resource management strategies addressed in the North Coast IRWM Plan is summarized in Table NC-26.

Resource Management Strategies and Water Quality

The following are the resource management strategies identified by DWR with great potential to benefit water quality in the North Coast Hydrologic Region.

1. Agricultural Water Use Efficiency
2. Urban Water Use Efficiency
3. Conjunctive Management and Groundwater Storage, with the caveat that shallow groundwater use is of critical human and ecological importance in the North Coast region
4. Recycled Municipal Water
5. Groundwater and Aquifer Remediation, with the caveat that shallow groundwater use is of critical human and ecological importance in the North Coast region
6. Pollution Prevention
7. Urban Runoff Management
8. Agricultural Lands Stewardship
9. Ecosystem Restoration
10. Forest Management
11. Land Use Planning and Management

Table NC-26 Resource Management Strategies Addressed in the North Coast IRWM Plan

Resource Management Strategy	North Coast Region
Agricultural Water Use Efficiency	X
Urban Water Use Efficiency	X
Flood Management	
Conveyance – Delta	
Conveyance – Regional/Local	
System Reoperation	
Water Transfers	
Conjunctive Management and Groundwater	
Desalination – Brackish Water and Seawater	
Precipitation Enhancement	
Recycled Municipal Water	X
Surface Storage – CALFED	
Surface Storage – Regional/Local	
Drinking Water Treatment and Distribution	X
Groundwater/Aquifer Remediation	
Match Water Quality to Use	
Pollution Prevention	X
Salt and Salinity Management	
Urban Stormwater Runoff Management	
Agricultural Lands Stewardship	
Ecosystem Restoration	X
Forest Management	
Land Use Planning and Management	X
Recharge Areas Protection	
Watershed Management	X
Economic Incentives – Loans, Grants, and Water Pricing	
Water-Dependent Recreation	

12. Recharge Areas Protection, with the caveat that shallow groundwater use is of crucial human and ecological importance in the North Coast region

13. Water-dependent Recreation

14. Watershed Management

The following are resource strategies identified by DWR that address issues of importance in the North Coast Hydrologic Region but may not accurately capture the issues as they express themselves on the North Coast.

1. **Surface Storage** — Regional/Local. Instream impoundments in the North Coast Hydrologic Region often alter the natural pattern and range of flows in a river, reduce a water body's assimilative capacity for other perturbations, and sometimes result in unintended water quality consequences (e.g., nuisance algal blooms, including the production of toxic algae; elevated temperatures; alteration of downstream sediment delivery and sorting, etc.). The RWQCB is supportive of efforts to provide off-channel storage for summer agricultural use as an alternative to summer instream withdrawals. But, the construction of instream impoundments is not viewed, in most cases, as supportive of water quality goals.

2. **Flood Risk Management** — The North Coast Hydrologic Region has experienced increased flooding as a result of several interacting factors. These include historical land uses that have resulted in massive deliveries of sediment to water bodies; alterations to channel form and hydrology via roads, dams, armoring, and loss of riparian and floodplain habitat; reduction in baseflows due to surface and groundwater withdrawals; and increase in runoff rate and volume from landscape alterations. The RWQCB is supportive of efforts to address these causes of increased flood potential. The further reduction in natural hydrologic functioning via the construction of hardened flood control channels is not viewed, in most cases, as supportive of water quality goals.

Conjunctive Management and Groundwater Storage

Conjunctive management, or conjunctive use, refers to the coordinated and planned use and management of both surface water and groundwater resources to maximize the availability and reliability of water supplies in a region to meet various management objectives. Managing both resources together, rather than in isolation, allows water managers to use the advantages of both resources for maximum benefit.

Conjunctive use of surface water and groundwater has been utilized for decades by numerous coastal and inland basins throughout the North Coast Hydrologic Region. Some basin examples include Eureka Plain, Eel River Valley, Santa Rosa Valley, Smith River Plain, Wilson Grove, Big Valley, Tule Lake Valley, Scott Valley, and Shasta Valley. Many agencies have erected systems of barriers to allow more efficient percolation of ephemeral runoff from surrounding mountains.

A DWR/ACWA survey was undertaken in 2011 and 2012 to inventory and assess conjunctive management projects in California. Box NC-4 is a summary of the inventory effort.

Although 89 conjunctive management programs were identified in California as part of the DWR/ACWA survey and although incidental and planned conjunctive management is known to occur in many basins in the North Coast Hydrologic Region, no agencies in the region responded to the survey. The lack of survey response from agencies in the region could be due to confusion over what constitutes a conjunctive management program. Confusion of the terminology and meaning of conjunctive management is not uncommon.

Box NC-4 Statewide Conjunctive Management Inventory Effort in California

The effort to inventory and assess conjunctive management projects in California was conducted through literature research, personal communication, and documented summary of the conjunctive management projects. The information obtained was validated through a joint survey by the California Department of Water Resources and the Association of California Water Agencies (ACWA). The DWR/ACWA survey requested the following conjunctive use program information:

- Location of conjunctive use project;
- Year project was developed;
- Capital cost to develop the project;
- Annual operating cost of the project;
- Administrator/operator of the project; and
- Capacity of the project in units of acre-feet.

To build on the DWR/ACWA survey, DWR staff contacted by telephone and e-mail the entities identified to gather the following additional information:

- Source of water received;
- Put and take capacity of the groundwater bank or conjunctive use project;
- Type of groundwater bank or conjunctive use project;
- Program goals and objectives; and
- Constraints on development of conjunctive management or groundwater banking (recharge) program.

Statewide, a total of 89 conjunctive management and groundwater recharge programs were identified. Conjunctive management and groundwater recharge programs that are in the planning and feasibility stage are not included in the inventory.

The survey results, a statewide map of the conjunctive management projects and additional details are available online from *California Water Plan Update 2013*, Volume 4, *Reference Guide*, in the article “California’s Groundwater Update 2013.” Also information on conjunctive management in California including benefits, costs, and issues can be found online from *California Water Plan Update 2013*, Volume 3, Chapter 9, “Conjunctive Management and Groundwater Storage Resource Management Strategy.”

Climate Change

For over two decades, the State and federal governments have been preparing for climate change effects on natural and built systems with a strong emphasis on water supply. Climate change is already impacting many resource sectors in California, including water, transportation and energy infrastructure, public health, biodiversity, and agriculture (U.S. Global Change Research Program 2009; California Natural Resources Agency 2009). Climate model simulations based on the Intergovernmental Panel on Climate Change’s 21st century scenarios project increasing temperatures in California, with greater increases in the summer (Intergovernmental Panel on Climate Change 2013). Projected changes in annual precipitation patterns in California will result in changes to surface runoff timing, volume, and type (Cayan 2008). Recently developed computer downscaling techniques (model simulations that refine computer projections to a scale smaller than global models) indicate that California flood risks from warm-wet, atmospheric river-type storms may increase beyond those that have been known historically, mostly in the form of occasional more-extreme-than-historical storm seasons (Dettinger 2011).

Currently, enough data exist to warrant the importance of contingency plans, mitigation (reduction) of GHG emissions, and incorporation of adaptation strategies — methodologies and infrastructure improvements that benefit the region at present and into the future. While the State is taking aggressive action to mitigate climate change through GHG reduction and other measures (California Air Resources Board 2008), global impacts from carbon dioxide and other GHGs that are already in the atmosphere will continue to impact climate through the rest of the century (Intergovernmental Panel on Climate Change 2013).

Resilience to an uncertain future can be achieved by implementing adaptation measures sooner rather than later. Because of the economic, geographical, and biological diversity of California, vulnerabilities and risks from current and future anticipated changes are best assessed on a regional basis. Many resources are available to assist water managers and others in evaluating their region-specific vulnerabilities and identifying appropriate adaptive actions. (U.S. Environmental Protection Agency and California Department of Water Resources 2011; California Emergency Management Agency and California Natural Resources Agency 2012). The most comprehensive report to date on climate change observations, impacts, and projections for the southwestern United States, including California, is the *Assessment of Climate Change in the Southwestern United States* (Garfin et al. 2013).

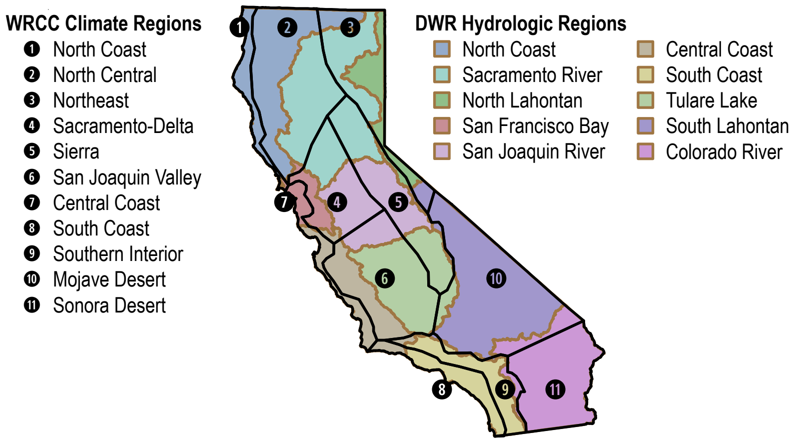
Observations

The region's observed temperature and precipitation vary greatly due to complex topography and relation to the Pacific Ocean. Regionally specific air-temperature data was retrieved through the Western Regional Climate Center (Western Region Climate Center 2013). The WRCC acts as a repository of historical climate data and information. Air temperature records for the past century were summarized by the WRCC into distinct climate regions (Abatzoglou et al. 2009). Although having some similarities, DWR's hydrologic regions do not correspond directly to WRCC's climate regions (see Figure NC-22). A particular hydrologic region may overlap more than one climate region and, hence, have different climate trends in different areas. For the purpose of this regional report, however, climate trends of the major climate regions are considered to be relevant trends for respective portions of the hydrologic region.

Locally in the North Coast region within the WRCC Northern Coastal climate region, mean temperatures have increased by about 0.4 to 1.3 °F (0.2 to 0.7 °C) in the past century, with minimum and maximum temperatures increasing by about 0.3 to 1.3 °F (0.2 to 0.7 °C) and 0.3 to 1.4 °F (0.2 to 0.8 °C), respectively. Within the WRCC North Central climate region, mean temperatures have increased by about 0.8 to 1.7 °F (0.4 to 0.9 °C) in the past century, with minimum and maximum temperatures increasing by about 1.2 to 2.1 °F (0.7 to 1.2 °C) and by 0.1 to 1.5 °F (0.1 to 0.8 °C), respectively. Within the WRCC North East climate region, mean temperatures have increased by about 0.8 to 2.0 °F (0.5 to 1.1 °C) in the past century, with minimum and maximum temperatures increasing by about 0.9 to 2.2 °F (0.5 to 1.2 °C) and by 0.5 to 2.1 °F (0.3 to 1.2 °C), respectively (Western Regional Climate Center 2013).

The Klamath River Basin has been affected by these climate trends with a decline in spring snowpack, less precipitation falling as snow, and earlier snowmelt runoff (Knowles et al. 2007). Water year runoff trends over the past century have increased in the Klamath, Salmon, Eel, and Russian River basins; the largest increase was in the Eel River Basin with an additional 12 taf per year more on average (California Department of Water Resources 2006).

Figure NC-22 DWR Hydrologic and Western Region Climate Center Climate Regions



The Western Region Climate Center (WRCC) divides California into 11 separate climate regions and generates historic temperature time-series and trends for these regions (http://www.wrcc.dri.edu/monitor/cal-mon/frames_version.html). The California Department of Water Resources (DWR) maintains 10 hydrologic regions, with the Sacramento-San Joaquin Delta and Mountain Counties areas being overlays of other DWR hydrologic regions. Each DWR hydrologic region spans one or more of the WRCC climate regions.

Historical sea level trends in this region are conflicting. A tide gage at North Spit, California, operating since 1977, shows mean sea level (MSL) to be increasing at a rate equivalent to 1.55 feet (0.47 meters) over the past century. A different tide gage at Crescent City, California, operating since 1933 shows MSL to be decreasing at a rate equivalent to 0.21 feet (0.06 meters) over the past century (National Oceanic and Atmospheric Administration 2012). Although MSL is expected to rise with climate change, MSL at Crescent City is trending lower due to the Cascadia Subduction Zone, where the buildup of interseismic strain is causing coastal uplift north of Cape Mendocino. Most gages south of Cape Mendocino show relative sea-level rise, consistent with land subsidence. When adjusted for vertical land motions and for atmospheric pressure effects, the rates of relative sea-level rise along the U.S. West Coast are lower than the rate of global MSL rise (National Research Council 2012).

Shifts in coastal fog patterns have been making conditions less favorable for coastal ecosystems. The North Coast redwoods are currently experiencing drought stress under changing climate conditions (Johnstone and Dawson 2010).

Projections and Impacts

While historical data is a measured indicator of how the climate is changing, it cannot project what future conditions may be like under different GHG emissions scenarios. Current climate science uses modeling methods to simulate and develop future climate projections. A recent study by Scripps Institution of Oceanography uses the most sophisticated methodology to date and indicates that by 2060-2069 temperatures will be 3.4-4.9 °F (1.9-2.7 °C) higher across the state than they were from 1985 to 1994 (Pierce et al. 2012). Annual mean temperature of the North

Coast region by 2060-2069 is projected to increase by 3.4 °F (1.9 °C) for the WRCC Northern Coastal climate region, with increases of 2.7 °F (1.5 °C) during the winter months and 4.3 °F (2.4 °C) during summer. The WRCC North Central climate region has similar projections with annual mean temperatures increasing by 4.0 °F (2.2 °C), winter temperatures increasing by 3.1 °F (1.7 °C), and summer temperatures increasing by 5.2 °F (2.9 °C). The WRCC North East climate region projections have annual mean temperatures increasing by 4.7 °F (2.6 °C), winter temperatures increasing by 3.4 °F (1.9 °C), and summer temperatures increasing by 6.5 °F (3.6 °C) Climate projections for this region, from Cal-Adapt indicate that temperatures between 1990 and 2100 will increase by 5 °F (2.8 °C) in the winter and 6 °F (3.3 °C) in the summer (California Emergency Management Agency and California Natural Resources Agency 2012).

Changes in precipitation across California due to climate change could result in changes in type of precipitation (rain or snow) in a given area, in timing or total amount, and in surface runoff timing and volume. Most climate model precipitation projections for the state anticipate drier conditions in Southern California, with heavier and warmer winter precipitation in Northern California. More intense wet and dry periods are anticipated, which could lead to flooding in some years and drought in others. In addition, extreme precipitation events are projected to increase with climate change (Pierce et al. 2012). Because there is less scientific detail on localized precipitation changes, there is a need to adapt to this uncertainty at the regional level (Qian et al. 2010).

Climate model precipitation projections for Northern California are not all in agreement; simulated future monthly average precipitation was found to be higher in the high Sierra and lower in the northern drainage basins (Georgakakos et al. 2012). Rainfall and snowmelt dominated watersheds in the region will each have a unique climate response and corresponding runoff, depending on the amount of warming that occurs. With warmer temperatures and changes in precipitation patterns, the Klamath River Basin may experience December-March runoff increases in streamflow and decreased April-June streamflow by 2100 (Markstrom et al. 2011).

While future precipitation and runoff is somewhat uncertain, greater flood magnitudes are anticipated as more frequent atmospheric river storm events encounter the region. Recent computer downscaling techniques indicate that California flood risks from warm-wet, atmospheric river type storms may increase beyond those that have been known historically, mostly in the form of occasional more-extreme-than-historical storm seasons (Dettinger 2011). These are periods of increased water vapor transported toward the poles across the mid-latitudes within narrow, intense filamentary bands of moist air. A higher proportion of precipitation falling as rain instead of snow and increased storm frequency would impact the system's ability to provide effective flood protection.

Additionally, sea level is projected to continue to rise along California's coast. For the California coast south of Cape Mendocino, the National Research Council (2012) projects sea level rise of 1.5 to 12 inches (3.8 to 30 cm) by 2030, 4.5 to 24 inches (11.4 to 61 cm) by 2050, and 16.5 to 66 inches (41.9 to 168 cm) by 2100. For the Washington, Oregon, and California coast north of Cape Mendocino, sea level is projected to change between falling 1.5 inches (3.8 cm) to rising 9 inches (23 cm) by 2030, falling 1 inch (2.5 cm) to rising 19 inches (48 cm) by 2050, and rising between 4 to 56 (10 to 142 cm) inches by 2100.

Projected climate changes are likely to upset the ecosystem balance, impacting sensitive fish and wildlife species (Janetos et al. 2008). Warmer water temperatures would result in stress to fisheries, reducing coldwater habitat for native species such as coho salmon, while potentially benefitting invasive species such as quagga and zebra mussels. Increased water temperatures and nutrient loading will potentially exacerbate toxic algae problems in the Klamath River with increases in extent, duration, toxicity, and concentration of blue-green algal blooms (U.S. Bureau of Reclamation 2011a).

A further shift in coastal fog patterns along with temperature and precipitation changes may lead to range shifts in vegetation. While a shift in vegetation patterns along the coast may decrease wildfire risk (Lenihen et al. 2006), the non-coastal areas in the region are projected to be at much higher risk of wildfire, with some having four times more risk than current levels by the end of the century (Westerling et al. 2009; California Emergency Management Agency and California Natural Resources Agency 2012).

Adaptation

Climate change has the potential to impact the region, which the state depends upon for its economic and environmental benefits. These changes would increase the vulnerability of natural and built systems in the region. Impacts to natural systems will challenge aquatic and terrestrial species with diminished water quantity and quality, and shifting ecoregions. Built systems would be impacted by changing hydrology and runoff timing, loss of natural snowpack storage, making the region more dependent on surface storage in reservoirs and groundwater sources. Increased future water demand for both natural and built systems may be particularly challenging with less natural storage and less overall supply.

Water managers and local agencies must work together to determine the appropriate planning approach for their operations and communities. While climate change adds another layer of uncertainty to water planning, it does not fundamentally alter the way water managers already address uncertainty (U.S. Environmental Protection Agency and California Department of Water Resources 2011). However, stationarity (the idea that natural systems fluctuate within an unchanging envelope of variability) can no longer be assumed, so new approaches will likely be required (Milly et al. 2008).

IRWM planning is a framework that allows water managers to address climate change on a smaller, more regional scale. Climate change is now a required component of all IRWM plans (California Department of Water Resources 2010; California Department of Water Resources 2012). IRWM regions must identify and prioritize their specific vulnerabilities and identify adaptation strategies that are most appropriate for their sub-regions. Planning strategies to address vulnerabilities and adaptation to climate change should be both proactive and adaptive, starting with strategies that benefit the region in the present-day while adding future flexibility and resilience under uncertainty.

Local agencies, as well as federal and State agencies, face the challenge of interpreting climate change data and information to determine which adaptation methods and approaches are appropriate for their planning needs. The *Climate Change Handbook for Regional Water Planning* (U.S. Environmental Protection Agency and California Department of Water Resources 2011) provides an analytical framework for incorporating climate change impacts into the regional and watershed planning process for consideration of climate change. This handbook provides guidance for assessing the vulnerabilities of California's watersheds and hydrologic regions to climate change impacts, and prioritizing these vulnerabilities.

The State of California has developed additional online tools and resources to assist water managers, land use planners, and local agencies in adapting to climate change. These tools and resources include the following:

- *Safeguarding California: Reducing Climate Risk* (http://resources.ca.gov/climate_adaptation/docs/Safeguarding_California_Public_Draft_Dec-10.pdf), which identifies a variety of strategies across multiple sectors (other resources can be found at http://www.climatechange.ca.gov/adaptation/strategy/index.html).
- *California Adaptation Planning Guide* (http://resources.ca.gov/climate_adaptation/local_government/adaptation_planning_guide.html) developed into four complementary documents by the California Emergency Management Agency and the California Natural Resources Agency to assist local agencies in climate change adaptation planning.
- Cal-Adapt (http://cal-adapt.org/), an online tool designed to provide access to data and information produced by California's scientific and research community.
- Urban Forest Management Plan Toolkit (http://www.ufmptoolkit.com/), sponsored by the California Department of Forestry and Fire Management to help local communities manage urban forests to deliver multiple benefits, such as cleaner water, energy conservation, and reduced heat-island effects.
- California Climate Change portal (http://www.climatechange.ca.gov/).
- DWR Climate Change Web site, "Local and Regional Resources" (http://www.water.ca.gov/climatechange/resources.cfm).
- The Governor's Office of Planning and Research Web site, "Climate Change" (http://www.opr.ca.gov/m_climatechange.php).

The primary water supply in the region is the Klamath, Eel and Russian River systems. With diminished spring snowpack storage and very few significant aquifers, the potential for water supply shortages increase. Agricultural water use efficiency and urban water use efficiency are resource management strategies outlined in Volume 3 that can assist in adapting to water scarcity. These strategies would benefit the region that has already developed most of its potential surface and groundwater supplies. Urban water use efficiency focuses on conservation to lower municipal demand, and agriculture water use efficiency helps the grower use water in a way that is most effective to the crop, while minimizing yield losses.

Several of the resource management strategies in Volume 3 can be singled out as providing benefits for adapting to climate change in addition to meeting water management objectives in the North Coast region. These include:

1. Agricultural Water Use Efficiency
2. Urban Water Use Efficiency
3. Regional and local Conveyance
4. Conjunctive Management and Groundwater storage
5. Precipitation Enhancement
6. Regional and Local Surface Storage
7. Pollution Prevention
8. Agricultural Land Stewardship

9. Ecosystem Restoration
10. Forest Management
11. Land Use Planning and Management
12. Recharge Area Protection
13. Watershed Management
14. Integrated Flood Management

The myriad of resources and choices available to managers can seem overwhelming, and the need to take action given uncertain future conditions is daunting. However, there are many actions that water managers can take to prepare for climate change, regardless of the magnitude of future warming. These actions often provide economic and public health co-benefits. Water and energy conservation are examples of strategies that make sense with or without the additional pressures of climate change. Conjunctive management projects that manage surface water and groundwater in a coordinated fashion could provide a buffer against variable annual water supplies. Forecast-coordinated operations would provide flexibility for water managers to respond to weather conditions as they unfold.

Water managers will need to consider both the natural and built environments as they plan for the future. Stewardship of natural areas and protection of biodiversity are critical for maintaining ecosystem services important for human society such as carbon sequestration, pollution remediation, and habitat for pollinators. Increased cross-sector collaboration between water managers, land use planners, and ecosystem managers provides opportunities for identifying common goals and actions needed to achieve resilience to climate change and other stressors.

Mitigation

California's water sector consumes about 12 percent of total statewide energy (19 percent of statewide electricity, and about 32 percent of statewide natural gas, and negligible amounts of crude oil). As shown in Volume 1, Figure 3-28, "Energy Use Related to Water," water conveyance and extraction accounts for about 2 percent of energy consumption in the state, with 10 percent of total statewide energy use attributable to end-users of water (California Energy Commission 2005, 2013; California Public Utilities Commission 2010). Energy is used in the water sector to extract, convey, treat, distribute, use, condition, and dispose of water and wastewater. Figure 3-29, "Water and Energy Connection," of Volume 1 shows all of the connections between water and energy in the water sector; both water use for energy generation and energy use for water supply activities. The regional reports in *California Water Plan Update 2013* are the first to provide detailed information on the water-energy connection, including energy intensity (EI) information at the regional level. EI information is designed to help inform the public and water utility managers about the relative energy requirements of the major water supplies used to meet demand. Because energy usage is closely related to GHG emissions, this information can support measures to reduce GHG, as mandated by the State.

Figure NC-23 shows the amount of energy associated with the extraction and conveyance of one acre-foot of water for each of the major water sources in this region. The quantity of each water source used in the region is also included, as a percentage. For reference, only extraction and

Figure NC-23 Energy Intensity per Acre-Foot of Water

Type of Water	Energy Intensity (= 1-250 kWh/AF = 251-500 kWh/AF)	Percent of Regional Water Supply*
Colorado (Project)	*This type of water not available*	0%
Federal (Project)	<250 kWh/AF	21%
State (Project)	*This type of water not available*	0%
Local (Project)	<250 kWh/AF	27%
Local Imports	<250 kWh/AF	1%
Groundwater	<250 kWh/AF	28%

Energy intensity (EI) in this figure is the estimated energy required for the extraction and conveyance of one acre-foot (af) of water. This figure reflects only the amount of energy needed to move from a supply source to a centralized delivery location, not all the way to the point of use. Small light bulbs are for EI greater than zero, and less than 250 kilowatt hours per af (kWh/af). Large light bulbs represent 251-500 kWh/af of water (e.g., four light bulbs indicate that the water source has EI between 1,501-2,000 kWh/af).

*The percent of regional water supply may not add up to 100% because not all water types are shown in this figure. EI values of desalinated and recycled water are covered in Volume 3, *Resource Management Strategies*. For detailed descriptions of the methodology used to calculate EI in this figure, see Volume 5, *Technical Guide*.

conveyance of raw water in Figure 3-29, "Water and Energy Connection," of Volume 1 are illustrated in Figure NC-23. Energy required for water treatment, distribution, and end uses of the water are not included. Not all water types are available in this region. Some water types flow mostly by gravity to the delivery location and may require little or no energy to extract and convey. As a default assumption, a minimum EI of less than 250 kilowatt hours per af (kWh/af) was assumed for all water types).

Recycled water and water from desalination used within the region are not shown in Figure NC-23 because their EI differs in important ways from those water sources. The EI of both recycled and desalinated water depend not on regional factors but rather on much more localized-, site-, and application-specific factors. Additionally, the water produced from recycling and desalination is typically of much higher quality than the raw (untreated) water supplies evaluated in Figure NC-23 For these reasons, discussion of EI of recycled and desalinated water are found separately in Volume 3, Resource Management Strategies. EI is discussed in Box NC-5.

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Box NC-5 Energy Intensity

Energy Intensity (EI) is the amount of energy needed to extract and convey an acre-foot (af) of water from its source to a delivery location. Extraction refers to the process of moving water from its source to the ground surface. Many water sources are already at ground surface and require little or no energy for extraction, while others (groundwater or sea water for desalination) require energy to move the water to the surface. Conveyance refers to the process of moving water from a location at the ground surface to a different location. Conveyance can include pumping water up and over mountains or can occur by gravity. EI should not be confused with total energy (i.e., the amount of energy [kilowatt hours] required to deliver all of the water from a source to regional customers). EI does not focus on the total amount of energy to deliver water to customers, but instead on the portion of energy required to extract and convey a single unit of water [in kilowatt hours per af (kWh/af)]. EI gives a normalized metric used to compare alternative water sources. (For detailed descriptions of the EI methodology and the delivery locations assumed for the water types, see Volume 5, *Technical Guide*).

In most cases, this information will not be sufficiently detailed for actual project-level analysis. However, these generalized, region-specific metrics provide a range in which energy requirements fall. The information can also be employed in more detailed evaluations by using such tools as WeSim, which allows modeling of water systems to simulate outcomes for energy, emissions, and other aspects of water supply selection.

Although not identical, EI is closely related to greenhouse gas (GHG) emissions (for more information, see the “Climate Change and the Water-Energy Nexus” section in Volume 1, Chapter 3, “California Water Today”). On average, generation of one megawatt-hour (MWh) of electricity results in about one-third of a metric ton of GHG (eGrid 2012). This estimate takes into account all types of energy generation through the state and for imported electricity.

Reducing GHG emissions is a State mandate. Water managers can support this by using EI in their decision-making process. It’s important to note that water supply planning must consider different factors in addition to energy impacts, such as public safety, water quality, firefighting, ecosystems, reliability, energy generation, recreation, and costs.

Accounting for Hydroelectric Energy

Hydroelectricity generation is integral to many of the state’s large water projects. The State Water Project (SWP), Central Valley Project (CVP), Los Angeles Aqueduct, Mokelumne Aqueduct, and Hetch Hetchy Aqueduct all generate large amounts of hydroelectricity at multi-purpose reservoirs at the heads of each system. In addition to hydroelectricity generation at head reservoirs, several of these systems also generate hydroelectricty by capturing the power of water falling through pipelines at in-conduit generating facilities, which are hydroelectric turbines placed along pipelines to capture energy as water runs downhill in a conduit. Hydroelectricity is also generated at hundreds of smaller reservoirs and run-of-the-river turbine facilities.

Because of the many ways hydroelectric generation is integrated into water systems, accounting for hydroelectric generation in EI calculations is complex. In some systems, such as the SWP and CVP, water generates electricity and then flows back into the natural river channel after passing through the turbines. In other systems, such as the Mokelumne Aqueduct, water can leave the reservoir by two distinct outflows, one that generates electricity and flows back into the natural river channel, and one that does not generate electricity and flows into a pipeline leading to water users. In both these situations, experts have argued that hydroelectricity should be excluded from EI calculations because the energy generation system and the water delivery system are, in essence, separate (Wilkinson 2000).

DWR has adopted this convention for its EI calculations. All hydroelectric generation at head reservoirs has been excluded. Consistent with Wilkinson (2000) and others, DWR has included in-conduit and other hydroelectric generation that occurs as a consequence of water deliveries, such as the Los Angeles Aqueduct’s hydroelectric generation at plants on the system downstream of the Owen’s River diversion gates. DWR has made one modification to this methodology to simplify the display of results: energy intensity has been calculated at each main delivery point in the systems. If the hydroelectric generation in the conveyance system exceeds the energy needed for extraction and conveyance, the EI is reported as zero. That means no water system is reported as a net producer of electricity, even though several systems (e.g., Los Angeles Aqueduct, Hetch Hetchy Aqueduct) produce more electricity in the conveyance system than is used. This methodology does not account for several unique benefits that hydroelectric generating facilities at reservoirs provide, including grid stabilization, backup for intermittent renewable energy sources, and large amounts of GHG-free energy.

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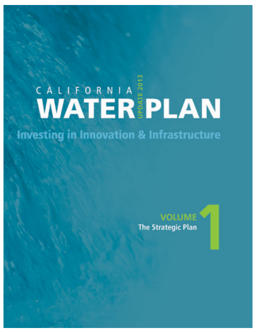
Personal Communications

Ford G, Staff Environmental Scientist, Water Branch, California Department of Fish and Game, Email on Jul 16, 2012, Internal memo to B-160 Regional Report authors on priority areas and needs specific to the North Coast Hydrologic Region, from a Department of Fish and Game perspective for California, in relation to California water supply, Communicated thru Lew Moeller.

Navigating Water Plan Update 2013

Update 2013 includes a wide range of information, from a detailed description of California's current and potential future conditions to a "Roadmap For Action" intended to achieve desired benefits and outcomes. The plan is organized in five volumes — the three volumes outlined below; Volume 4, *Reference Guide*; and Volume 5, *Technical Guide*.



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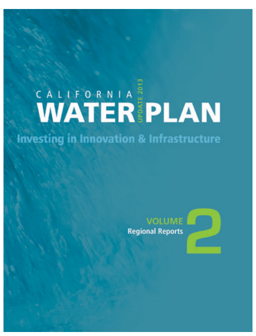
- Call to action, new features for Update 2013, progress toward implementation.
- Update 2013 themes.
- Comprehensive picture of current water, flood, and environmental conditions.
- Strengthening government alignment and water governance.
- Planning (data, analysis, and public outreach) in the face of uncertainty.
- Framework for financing the California Water Plan.
- Roadmap for Action — Vision, mission, goals, principles, objectives, and actions.



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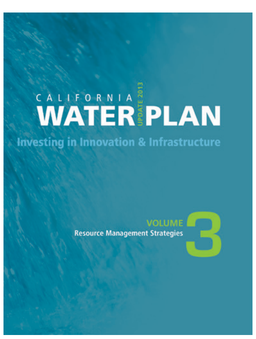

Integrated Water Management Toolbox,
30+ management strategies to:

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Integrated water management *is a comprehensive and collaborative approach for managing water to concurrently achieve social, environmental, and economic objectives. In the California Water Plan, these objectives are focused toward improving public safety, fostering environmental stewardship, and supporting economic stability. This integrated approach delivers higher value for investments by considering all interests, providing multiple benefits, and working across jurisdictional boundaries at the appropriate geographic scale. Examples of multiple benefits include improved water quality, better flood management, restored and enhanced ecosystems, and more reliable water supplies.*

Edmund G. Brown Jr.
Governor
State of California

John Laird
Secretary for Natural Resources
Natural Resources Agency

Mark Cowin
Director
Department of Water Resources

October 2014