



NORTHWEST CALIFORNIA

A NATURAL HISTORY

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JOHN O. SAWYER

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The Klamath

Land of Mountains and Canyons

The Klamath Mountains are the home of one of the most exceptional temperate coniferous forest regions in the world. The area's rich plant and animal life draws naturalists from all over the world. Outdoor enthusiasts enjoy its rugged mountains, its many lakes, its wildernesses, and its wild rivers. Geologists come here to refine the theory of plate tectonics. Yet, the Klamath Mountains are one of the least-known parts of the state.

The region's complex pattern of mountains and rivers creates a bewildering set of landscapes. Its mountains have a geological history similar to those of the ancient Appalachians in the East. Rocks laid in the distant past tell stories of ancient seas, of landmasses from throughout the world that have been added to North America, and of lofty mountain ranges that have worn down only to rise again. Pleistocene ice and now today's events mold the area's rivers and mountains. No wonder the area is confusing.

The history of the Klamath Mountains begins 450 million years ago with rocks found today in the Trinity Mountains, the highest range in the region. Rock outcrops surrounding Mount Eddy (9,025 ft.) are the oldest and among the largest on the North American continent. These deep-sea basement rocks and associated sedimentary and volcanic rocks occupy the Sacramento and Klamath river watersheds, two of the three master rivers that flow through the Klamath Mountains.

EARLY TIMES IN THE KLAMATH MOUNTAINS

The Klamath Mountains are internationally famous in geological circles. Here geologists began testing the new theory of plate tectonics in the 1960s, which suggests that hot molten rocks well up from the interior of the Earth at midocean spreading centers, where they form rigid tectonic

plates of oceanic crust and upper mantle. As these rocks cool and crystallize, they form a characteristic sequence of rock types (peridotite, gabbro, sheeted dikes, and submarine basalt) on which sediments collect over time. This rock series makes up an *ophiolite suite* (or just *ophiolite*). It becomes part of the rigid plate that moves slowly from the spreading center and interacts with other plates.

When two plates converge, one may descend below the other in a process called *subduction* (Fig. 1). It is a zone of great geological activity, as the lighter continental plate slips over the heavier oceanic plate. A deep ocean trench marks the point where they converge. Here a part of the ocean's crust and its upper mantle may separate and become attached (accreted) to the continental plate, as the rest of the oceanic plate descends back into the mantle. The scraped rock assemblage makes up an *accreted terrane* or *ter-rane* (note the spelling). This process results in mountain building through associated earthquake activity, along with buckling, faulting, and folding of rocks at the plate boundary. Today's earthquakes tell us that the process is still active along the coast of northwest California.

Geologists studying the Klamath Mountains a century ago recognized four belts whose rock units had similar makeup. The belts are younger from east to west, and major faults separate them. Today's geologists interpret the pattern as a set of plates and sutures. They also noticed that the belts were associated with granitic plutons (bodies of crystallized magma) younger than the surrounding rocks. We now know that the belts and fault systems represent a sequence of plate convergence and subduction events, called *accretionary episodes*, which added pieces of land to the western edge of North America during periods of mountain building.

Plate tectonic theory also explains the associated granitic plutons. Granitic rocks—diorite, quartzdiorite, and granodiorite—commonly form the core of many of the world's mountains. As a plate descends, the rocks are heated, and parts become molten magma. Some magma reaches the surface, creating a chain of active volcanoes. Some magma forced (intruded) into the overlying rocks and fractures forms dikes, plutons, and batholiths. *Dikes* are magma that solidified in fractures. *Plutons* are pools of molten rock that never made it through an overburden rock and crystallize in place as the mountain building continues. A *batholith* is a group of plutons of differing age and chemical makeup. Plutons exist throughout the Klamath Mountains (Table 1).

Most of the sedimentary and volcanic rock types seen today in the Klamath Mountains are altered (metamorphosed). Past mountain-building processes heated the area's rocks to high temperatures, put them under intense pressures, compressed them, subjected them to other stresses, and changed them when they met hot fluids. These processes altered the original rock texture and mineral content. Typically, rock minerals rearrange

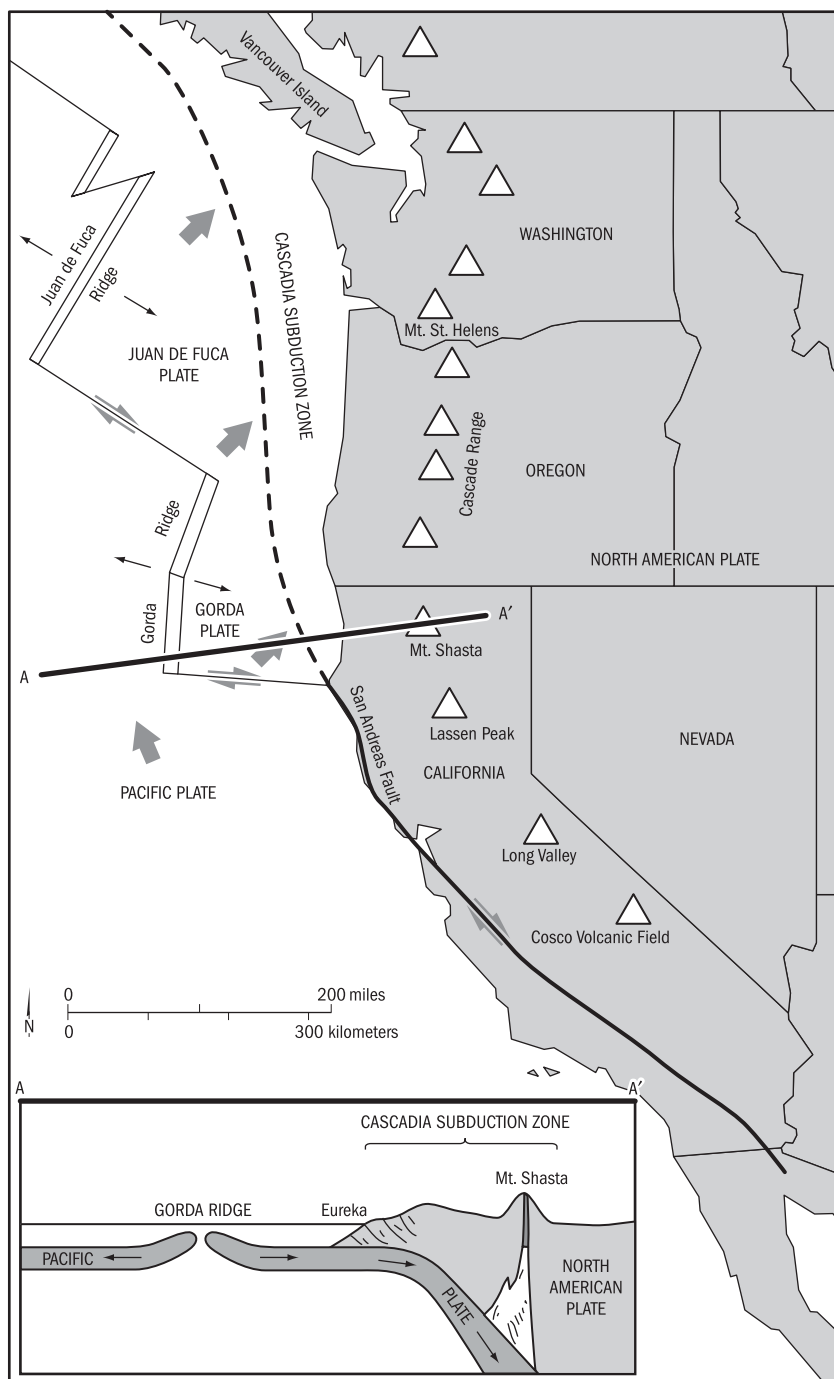


Figure 1. Plate tectonic setting for the West Coast. A—A' indicates the location of the profile of the Gorda Plate being subducted under the North American Plate between Eureka and Mount Shasta. From California Geology (45: 40).

TABLE 1. Plutons listed by mountain ranges and by lithic belts.

<i>Trinity Mountains</i>
EASTERN KLAMATH BELT
Bonanza King gabbro
Castle Crags
Mule Mountain
Porcupine Lake gabbro
Shasta Bally
WESTERN PALEOZOIC AND TRIASSIC BELT
Wildwood
<i>Scott Mountains</i>
EASTERN KLAMATH BELT
Craggy Peak
China Mountain gabbro
<i>Trinity Alps</i>
EASTERN KLAMATH BELT
Granite Peak
Sugar Pine Lake
CENTRAL METAMORPHIC BELT
Canyon Creek
Monument Peak
WESTERN PALEOZOIC AND TRIASSIC BELT
Ironside Mountain
<i>Salmon Mountains</i>
CENTRAL METAMORPHIC BELT
Caribou Mountain
China Creek
Deadman Peak
Russian Peak
<i>Salmon Mountains</i>
WESTERN PALEOZOIC AND TRIASSIC BELT
English Peak
Orleans Mountain
Youngs Peak

TABLE 1. (*continued*)

<i>Marble Mountains</i>
CENTRAL METAMORPHIC BELT
Shelley Lake
WESTERN PALEOZOIC AND TRIASSIC BELT
Heather Lake
Slinkard Ridge
Wooley Creek
<i>Siskiyou Mountains</i>
WESTERN PALEOZOIC AND TRIASSIC BELT
Ashland
Bear Mountain
Grayback
Pony Peak
Slinkard
Summit Valley
Thompson Ridge
Vesa Bluffs
WESTERN KLAMATH BELT
Buckskin Peak
<i>South Fork Mountain</i>
WESTERN KLAMATH BELT
Ammon Ridge
Glenn Creek

SOURCE: Most plutons contain granitic rocks, especially granodiorite. Outcrops of gabbro occur in the Eastern Klamath Belt. A detailed map is available at <http://geopubs.wr.usgs.gov/open-file/of02-490/>.

into parallel planes, causing the rock to shatter into flat pieces. The resulting slates (metamorphosed mudstones) and schists (metamorphosed sandstones) make up *metasedimentary rocks* (or just *metasediments*). Similarly altered volcanic rock types are *metavolcanic rocks* (or *metavolcanics*). For example, greenstone represents basalt altered under low temperature and pressure. There are other altered igneous rocks (Table 2). Crystallization of magma rich in magnesium iron silicates forms peridotite, the basement rock of every terrane. Serpentine, California's official state rock, is a

TABLE 2. Identification of igneous rock types.

Coarse-grained rocks	Granite	Diorite	Gabbro	Peridotite
Fine-grained rocks	Rhyolite	Andesite	Basalt	Dunite
Mineral content	<div>←————— SiO₂</div> <div>CaO, FeO, MgO —————→</div>			
Rock type	Salic (felsic)	Intermediate	Mafic	Ultramafic
Rock color	Light-colored	Medium-gray Medium-green	Dark gray Black	Green to black

NOTE: Extrusive rocks form fine-grained rocks, since magma cools rapidly at the Earth's surface. They are associated with volcanic activity. Intrusive rocks form at considerable depth. They are coarsely grained, with large crystals interlocked in a mosaic pattern (adapted from Plummer, McGeary, and Carlson 1999).

metamorphosed peridotite. Serpentine has a special place in the natural history of northwest California.

WATERSHEDS OF THE KLAMATH MOUNTAINS

The headwaters of the Sacramento River commence on the slopes of Mount Eddy and at Cliff Lake in the Trinity Mountains, and as a set of springs on the lower slopes of Mount Shasta in the adjacent Cascades. Water flows from these sources into Siskiyou Lake and then down the canyon of the Sacramento River to Lake Shasta before entering the Sacramento Valley and finally San Francisco Bay. The headwaters of the Pit River, a major tributary of the Sacramento River, start far away on the shores of Goose Lake and in the Warner Mountains east of the Cascades. Water from these sources flows though the Pit River canyon that has cut through the lava flows of the Cascades, creating a water gap before entering Lake Shasta. The *upper* Sacramento lies east of the Klamath Mountains. The *middle* Sacramento includes the lands of streams that start or flow through the region. Those of the *lower* Sacramento are downstream from Lake Shasta.

The Klamath River also has a long and circuitous route to the Pacific Ocean from its headwaters on the eastern slopes of the Cascades of southern Oregon. The stream flows from Upper Klamath Lake west through a water gap in Cascade lavas, entering the Klamath Mountains just west of Interstate 5 (I 5). The lands east and upstream from the highway make up the *upper* Klamath. The lands west and downstream are those of the *middle* Klamath, including those of the Scott, Salmon, and Trinity rivers. From the highway the stream travels west to Happy Camp, where it turns south until it reaches Weitchpec, where it flows through another water gap in the

Siskiyou Mountains, takes a hard turn to the north, and enters the North Coast region. These western lands are those of the *lower* Klamath.

The lands of the Smith River are quite separate from those of either the Klamath or the Sacramento. The headwaters start high on the western and eastern slopes of the Siskiyou Mountains of Oregon and California. The stream's two major forks meet near the Klamath–North Coast boundary. The land of the last 17 miles to the mouth of the Smith River makes up the ecologically different *lower* Smith River watershed (Map 2).

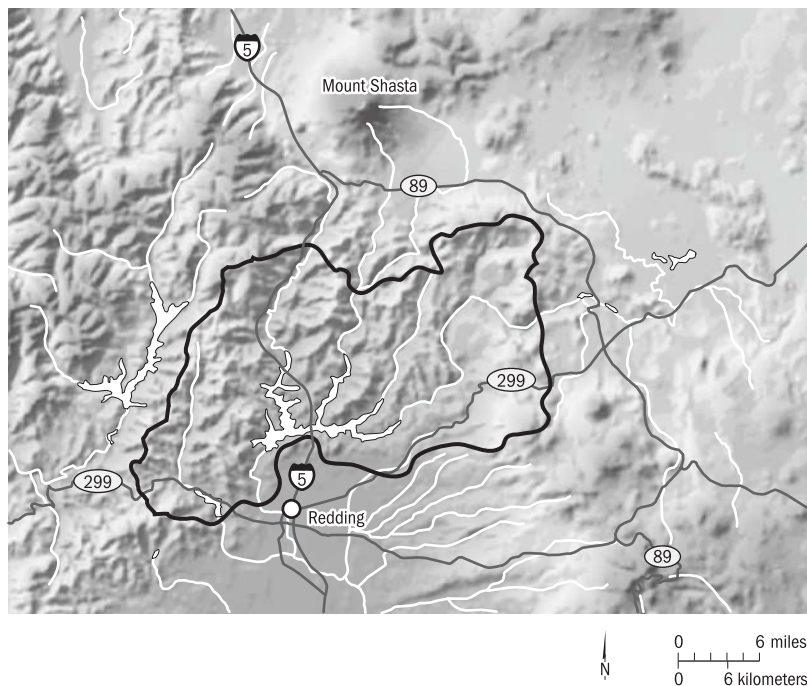
LANDS OF THE MIDDLE SACRAMENTO RIVER

Mount Shasta looms on the horizon when travelers drive north on I 5 toward Redding. The higher ridgeline to the west are the peaks of the Trinity Mountains, the divide between the Sacramento and Trinity rivers. To the southwest are the Yolla Bolly Mountains of the North Coast; to the east are the Cascade volcanoes of Lassen Peak and Burney Mountain. To the north are a set of “hills” that you scarcely notice; these are the lands of the middle Sacramento country (Map 3).

Shasta Lake, more than any other feature, distinguishes this country. Shasta Dam, the hub of the Central Valley Project with its elaborate complex of dams and reservoirs, creates the 29,500-acre Lake Shasta with a shoreline of 365 miles at maximum storage—the largest reservoir in the state. The Sacramento River is only one of its various arms. The McCloud River arm, receiving water from the southern slopes of Mount Shasta, also flows into McCloud Lake, where an aqueduct system transfers about a third of its water to Indian Canyon Reservoir and then to the Pit River arm.

Only two major highways, I 5 and State Route (SR) 299, traverse this 1.35-million acre watershed. The Southern Pacific Railroad and I 5 form an important corridor of interstate commerce, connecting the cities of California with those of Oregon and Washington. Most of the 171,000 people of Shasta County live near the interstate. Almost all reside in Redding (pop. 85,000), the hub of commerce in the northernmost part of the state. The only other towns in this country—Dunsmuir, Lakehead, and Shasta Lake City—are situated along the I 5 freeway. State Route 299 is the major east-west highway connecting Redding with the coastal towns of Arcata and Eureka.

The country's rounded ridges and mountaintops are deeply forested. Steep slopes, half of them exceeding 15 percent, support well-lit woodlands and chaparral. Mining activities devastated much of the original forest cover. Pierson B. Reading discovered gold in 1848 on the banks of Readings Bar on the Trinity River, and prospectors discovered gold the next year in Sacramento's Clear Creek near the community of French Gulch. The Deadwood–French Gulch mining district became one of the richest in the



Map 3. Features of the middle Sacramento River country. The Klamath Region bulges east, and Mount Shasta to the north looks down on Redding at the crossroads of Interstate 5 and State Route 299.

state, but gold was not the only metal found in the Klamath Mountains. Copper mining became important in the late 1800s. They extracted cadmium, lead, limestone, sulfur, and zinc as well gold. Mine symbols dot maps of the Redding area, and with mines came smelters. Decades of emitting poisonous fumes from the region's smelters denuded the local mountain slopes. By the early 1900s, erosion was extreme. Today the waters behind Shasta Dam cover many of these bare slopes. Chaparral blankets the slopes above lake level due to active restoration activities after World War II. A substantial scar of the Iron Mountain Mine comes into view west of Lake Shasta. This mine is a notorious toxic waste site. Its water (which has a pH of -1 , the lowest reported in the world) flows into Lake Shasta.

Lower-elevation streams surge through rugged, rocky canyons above Lake Shasta. Mountain slopes far away from the mining districts remain much as they were in the early 1800s. In the northerly parts of the Trinity Mountains, called the Eddies, we find mountain meadows and 30 sub-alpine lakes. Mount Eddy, the highest peak in northwest California, and

Castle Craggs (4,440 ft.), a granitic batholith of the Mesozoic Age, loom above the forested slopes.

Shasta Bolly (6,209 ft.) and Bully Choop (6,970 ft.), near Whiskeytown Lake (named for the 1849 mining town of Whiskey Creek Diggings), stand well above the crest line in the southernmost extension of the Trinity Mountains. To the north, Grizzly Peak (6,250 ft.) stands well above the other, much lower peaks in the McCloud River, Pit River, and Squaw Creek watersheds. Lower mountain summits in the east are restricted to forested elevations, where logging has left its scars on many of the lower slopes.

The middle Sacramento country experiences hot summers and rainy winters (Fig. 2). These lands do not lie in the rain shadow of the mountains to the west, since many winter storms move up the Sacramento Valley. Areas at higher elevations receive ample precipitation (60–100 in. annually), but the canyon lands receive only half that of the mountain slopes. Winter temperatures at lower elevations are mostly above freezing, and summer temperatures are very high. Only the highest peaks hold snow into the summer.

Biological diversity comes in many forms. Lower-elevation conditions are sufficiently hot that it is best for visitors in the summer to spend their time at “The Lake.” Trips to see the low-elevation limestone areas are preferable in the spring or fall; summer is best focused on higher elevations. The lands are mainly those of the Shasta-Trinity National Forest, and roads are mostly unpaved. Many privately owned sections exist in the watershed. Watch for signs along the roadsides that indicate ownership.

Limestone areas offer something for everyone: high plant diversity, rare animals, interesting fossils, and caves (Pl. 2). Limestone exists in two different belts, each with its own character. McCloud limestone of the Permian Age is replete with corals, brachiopods, and other marine fossils. Hosselkus limestone of the Triassic Age has rich fossil assemblages of ammonites, brachiopods, corals, and ichthyosaurs. These animals lived in warm, shallow seas west of the continent. Outcrops of McCloud limestone are extensive along the McCloud arm of Lake Shasta. Here, Shasta Caverns offers a tour of lighted caves after a boat ride across the lake from I 5. Visitors arrive at the more natural Sawmel Cave after another boat ride. Signs along the trail interpret a Wintu legend concerning a woman slipping and falling into the cave. Arrange to pick up the key from Forest Service personnel before your trip. Impressive Dekkas Rock, an important religious site to the Wintu, is across the lake from the campground that shares its name.

By traveling to the town of McCloud and then south past Lake Britton to Ah-di-na Campground, you can visit The Nature Conservancy’s McCloud River Preserve, the original source of rainbow trout eggs used to introduce rainbow trout to the rest of the world. The preserve allows catch-and-release fishing. The McCloud River was a seasonal home for the Wintu to

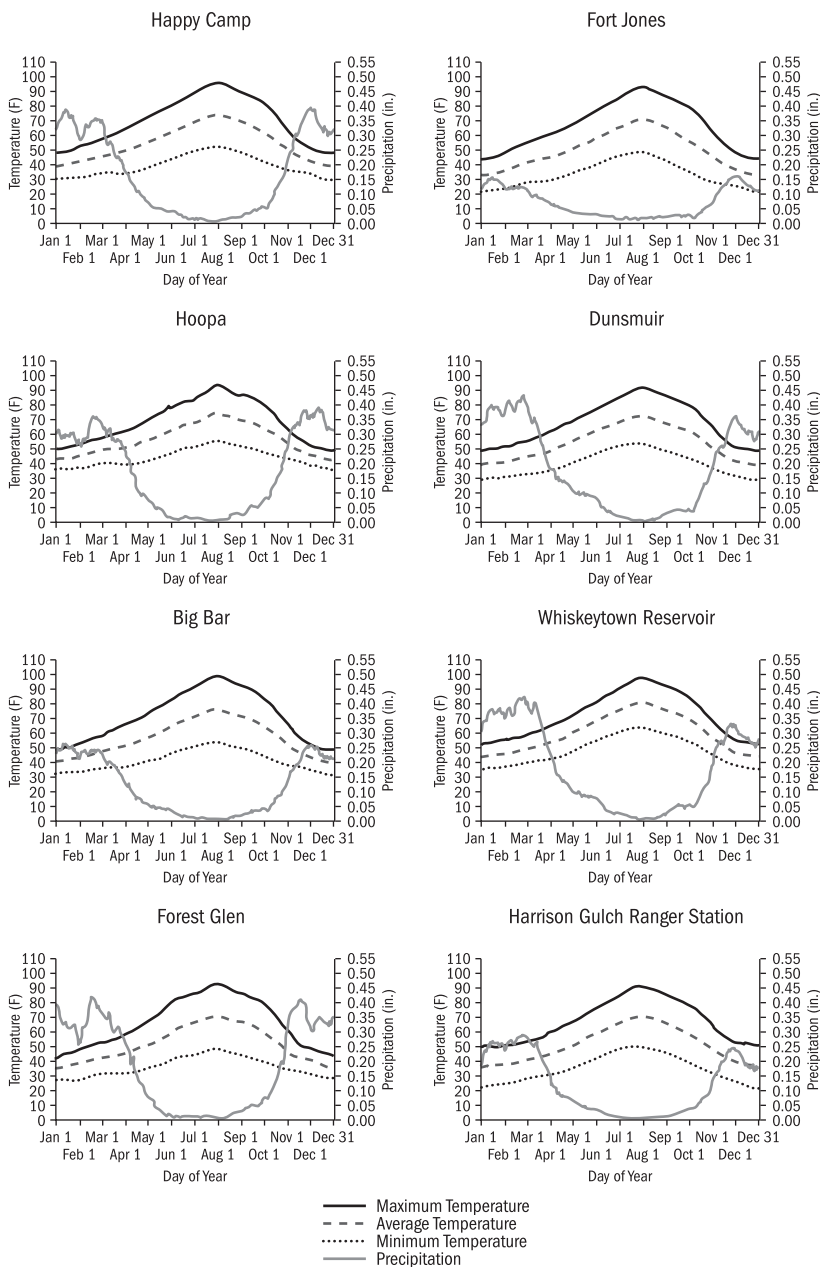


Figure 2. Diagrams of annual temperature and precipitation patterns in the Klamath Mountains. Data from the Western Climate Region of the National Environmental Satellite, Data, and Information Service.

fish and gather acorns and pine nuts. A hike west from the campground will offer a taste of the Girard Ridge roadless area. A road trip on Forest Service (FS) Road 38N23 to Girard Outlook offers great views of Castle Crag and Mount Shasta; it is possible to spend the night in the outlook.

The outrageous shrub diversity described along Low Pass Creek in the vegetation chapter exists in Devil's Rock–Hosselkus Limestone Research Natural Area between the Squaw and Pit arms of Lake Shasta. Hosselkus limestone is famous for many things beyond its Triassic fossils. The most notable living plant is the Shasta snow-wreath, discovered in 1992. It is a member of a genus *Neviusia* that botanists previously considered restricted to the hills of Alabama. The limestone is also home to the Shasta salamander and Pleistocene Age fossils in cave deposits. Use Fenders Ferry Road (FS 27) to access the area, and stop at Potem Falls on the way.

The Castle Crag point out the state park and several nearby areas of biological interest. Visitors know of its excellent rock for climbing and its awe-inspiring views of Mount Shasta. Plant species growing in rock crevices exist nowhere else. The park abuts Castle Crag Wilderness with popular Castle Lake, an area that offers serpentine substrates with their own biological oddities.

The serpentine substrates of the nearby Trinity Mountains also offer many high-elevation gems. South Fork Sacramento Road (FS 26) and Castle Creek Road (FS 27) supply quick access. In 1979, Todd Keeler-Wolf discovered an area around Cliff Lake with 11 conifer species, now designated as Cedar Basin Research Natural Area. Toad Lake, known for its rich serpentine flora, is accessible by the Pacific Crest Trail.

LANDS OF THE MIDDLE KLAMATH RIVER

Interstate 5 north of Mount Shasta first skirts the Greenhorn Mountains, the eastern boundary of the Klamath Mountains, as it cuts through the Shasta Valley, follows the Shasta River to the Klamath River, and then crosses the Siskiyou Mountains into Oregon (Map 4). The Klamath River west of I 5 picks up the waters from three of its major tributaries. The Scott River meets it at Hamburg downstream from the freeway. The Salmon River enters at the mining town of Somes Bar after the big bend south at Happy Camp, originally called Murderers Bar. The Trinity River, the largest of the three, and the Klamath River converge at Weitchpec. The lands of these three watersheds are described separately, but first let's consider the immediate lands in the 1.3-million-acre area of the middle Klamath country (Pl. 3).

While traveling west, the river moves through some 260 million years of geology. Cherts, conglomerates, limestones, sandstones, shales, schists, and serpentine substrates seen along the river represent parts of many different



Map 4. Features of middle Klamath River country. State Route 95 follows the Klamath River from Interstate 5 to Weitchpec and its convergence with the Trinity River.

terranes added to the western edge of North America over millions of years. Mesozoic Age intrusions of granitic rock add further to the lack of geologic order. The rocks get younger to the west, with Galice metasediments of Jurassic Age forming the western boundary of the Klamath Mountains.

Not only did the terranes dock with the continent, but also in the process, they created the massive ancestral Klamath Mountains during Jurassic and Cretaceous times. Volcanoes, associated lava flows, and deep sediments covered plutonic intrusions of granites. Erosion removed hundreds of feet of material from these mountains over the next 100 million years, only for the area to experience another period of mountain building. Today's Klamath Mountains are the result of an even more recent uplift.

Each period of mountain building initiated a cycle of erosion. At first, streams had high gradients creating steep-sided canyons and V-shaped valleys with thin soils. As time passed, stream gradients lessened, slopes became gentler, and soils deepened. Erosion continued until the land had very low relief and was covered with thick, well-weathered soils; geologists call this stage a *penepplain*. If the area has a new period of mountain building, the cycle would begin again. Reaching penepplain stage depends on place and history. Usually areas do not reach the final stage; instead, long periods of erosion create subdued topography.

Today the middle Klamath River gradually passes downward through scenes alternating between gorges, forested slopes (75 percent exceeding 15 percent slope), and small river terraces. Former mining towns such as Gottville, Seiad Valley, Happy Camp, Somes Bar, and Orleans occupy the larger terraces. Ridges and peaks crowd the river, including the even more precipitous walls at China Point and at the mouth of Bluff Creek, made famous by the sighting of Bigfoot in 1958, the local version of the Abominable Snowman, Sasquatch, or Yeti. We now know that Bigfoot was the hoax of Ray Wallace, the then-editor of a Eureka newspaper, the *Times-Standard*.

Several mountain ranges tower above the river. The Siskiyou Mountains to the north include prominent Mount Ashland (7,500 ft.) in the northeast corner, Little Grayback (6,160 ft.) west of Happy Camp, and Berrill Peak (4,350 ft.) near Weitchpec.

South of the Klamath River are the Scott Bar Mountains to the east of the Scott River's confluence with the Klamath and the Marble Mountains to the west. The peaks of the Marble Mountains are highest to the east at Boulder Peak (8,300 ft.), gradually lowering to Marble Mountain (6,780 ft.), the namesake of the range. The mountain is conspicuous not for its height but for its white marble that contrasts strongly with the surrounding dark fir forests. Evidence of glaciation is extensive at higher elevations, and some 100 subalpine lakes dot the range.

The climate is one of sunny summers and rainy winters (Fig. 2). High elevations of the Siskiyou and Marble mountains receive abundant precipitation (45–125 in.) annually, and they maintain deep snowpacks well into the summer. Low-elevation canyons receive only about a third the annual precipitation of the mountain slopes. At lower elevations, winter temperatures are mostly above freezing, with fleeting snow. Summers are hot.

The landscape shows the effects of mining in the 1800s and of the more recent clear-cutting in the late 1900s supervised by the personnel of Klamath and Six Rivers national forests. Today travelers see a mosaic of young tree plantations mixed with the original forest. Several large, recent fires have occurred throughout this watershed.

Biological areas of interest exist near the wilderness areas. Grayback Road (FS 48), from Happy Camp to O'Brien, cuts through the Siskiyou

Mountains between Siskiyou Wilderness to the west and Red Buttes Wilderness to the east. Marble Mountain Wilderness lies south of the river. Following SR 96 west along the scenic Klamath River from I 5 is the fastest way to arrive. National forest roads are numerous and unpaved.

South of the Klamath River and Seiad Valley, FS 46N64 climbs to Lake Mountain Botanical Area, the northern extent of foxtail pine. Also noteworthy are the other peaks of the Marble Mountains to the south near Black Marble Castle (7,445 ft.) and the associated native limestone caves, best left to serious spelunkers. I celebrate the area's awe-inspiring meadowlands in the vegetation chapter.

It requires somewhat less work to see the delights of the western part of Marble Mountain Wilderness. The Wooley Creek batholith, with its erosive granitic soils, has dense fir forests with diverse, understory layers highlighted in Haypress Meadows and Bridge Creek research natural areas.

Within Siskiyou Wilderness, the Forest Service formally recognizes special areas around Preston Peak (7,310 ft.) for their rich forests, meadows, and glacial features. Nearby are botanical geological and research natural areas with exquisite stands of Port Orford–cedar, rhododendron, and herb-rich meadows. I would add Devil's Punch Bowl and Youngs Valley to a list of enticing biological areas. Elk Hole Geological Area has the southernmost stand of Alaska yellow-cedar. Rock Creek Butte Research Natural Area, with its diverse forests with Brewer spruce, is accessed by the infamous GO Road (FS 115N01).

During the 1980s, a dispute arose over the Forest Service building the 55-mile GO Road that would have connected Gasquet on the Smith River and Orleans on the Klamath River. The last miles of road would have crossed lands sacred to the Karuk, Tolowa, and Yurok as the road passed through the Siskiyou Mountains. The Forest Service saw building of the road as significant for the development of timber harvesting, recreation, maintenance, and fire control, but it interfered with the religious practices of native peoples. Years of controversy, including US Supreme Court decisions, international law, passing of the California Wilderness Act in 1984, and the creation of Smith River National Recreation Area in 1990, ended the debate. Today the last six miles are included in Siskiyou Wilderness, and religious practices are preserved.

Interesting areas near Red Buttes Wilderness offer another look at the Siskiyou Mountains via Cook and Green Pass (see above), and the road to Seiad Valley-Cook and Green Pass Road (FS 48N20). House Creek Botanical Area presents a lovely riparian setting before hunting down the rare Baker cypress. The nearby Cook and Green Pass and White Mountain botanical areas, on the mountain crest, are famous for their flowery meadows and rock outcrops. A hike from the pass offers even richer high-elevation experiences.

LANDS OF THE SCOTT RIVER

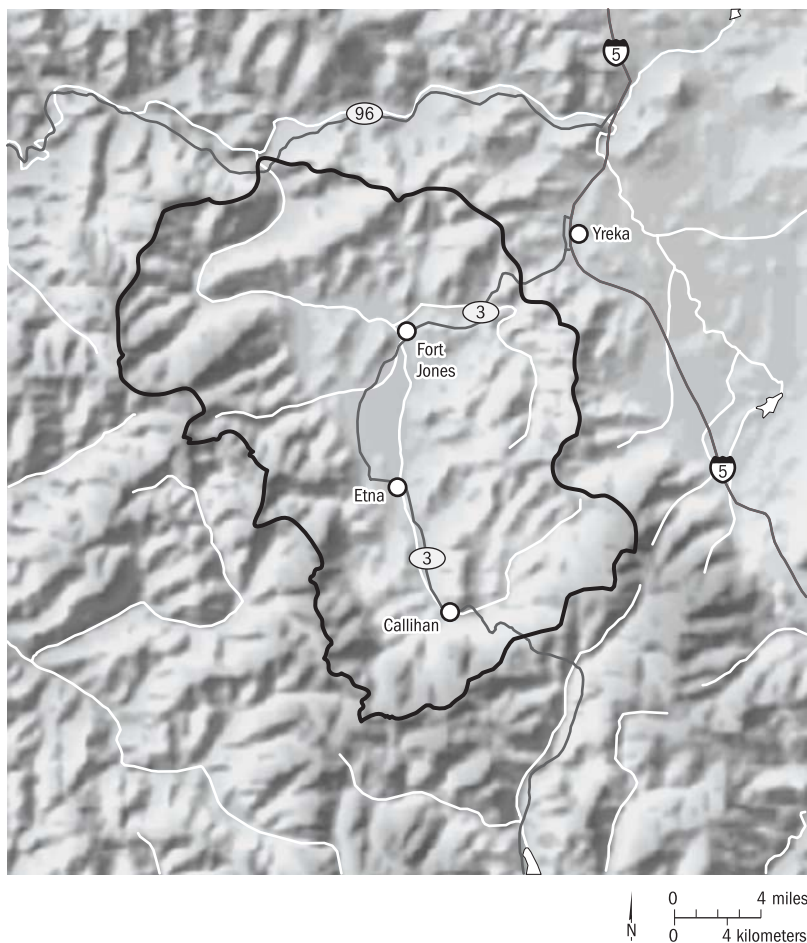
A visit to Scott Valley, the largest in the region, seems like a taste of the Great Basin with its foothill ranchlands of juniper and sagebrush (Map 5). Scott Valley is a fast hop from Yreka and I 5 by way of SR 3 or Grazelle-Callahan Road (Siskiyou Co. 2Ho1) through the modestly tall Greenhorn Mountains clothed in open stands of Jeffrey pine and oak (Pl. 4). A quick look at a map confirms that we are in the rain shadow of several mountain ranges between here and the Pacific Ocean. Indeed, climatic records tell us that this country has the most continental weather in the Klamath Mountains and the driest (overall 18–85 in. annually). While the eastern slopes of the Scott, Salmon, and Marble mountains receive abundant precipitation, Scott Bar Mountains, Scott Valley, and the surrounding foothills receive noticeably less. Winter temperatures are often below freezing with long-lasting snow; summer temperatures are moderate (Fig. 2).

The northerly flowing Scott River in this 521,000-acre watershed begins in the Scott Mountains. Its east fork originates on the slopes of China Mountain (8,540 ft.), just north of Mount Eddy. Its south fork starts at South Fork Lakes near the convergence of the Scott and Salmon mountains and Trinity Alps. This ridge crest is the divide between the Scott and Trinity rivers. State Route 3 enters over Scott Mountain (6,830 ft.) via the route of the old California-Oregon stage. Travelers used this route to reach Oregon before the railroad was completed up the Sacramento River.

The northern slopes are dotted with subalpine lakes and open forests. As with the adjacent Trinity Mountains, they contain serpentine substrates of the Trinity ophiolite. Mountainsides are moderately steep, with about half exceeding a 15 percent slope. China Peak, Kangaroo Lake, Scott Mountain, and Rock Creek botanical areas were established to protect the California pitcher plant and other high-elevation serpentine plants. Subalpine woodlands clothe the crest. These north-facing drainages present many glacial features, including a rock glacier on the north side of Cory Peak (7,700 ft.).

The Salmon and Marble mountains form the western boundary of Scott Valley country. In contrast to the Scott Mountains, the Salmons are mainly granites of the Russian Peak batholith, and beautiful subalpine lakes are concentrated near Russian Peak (8,190 ft.) in the Russian Wilderness, which contains Duck Lakes Botanical Area and the adjacent Sugar Creek Research Natural Area. Wander the trails and old roads of the Duck Lake Creek and Horse Range Creek drainages to enjoy the rich concentration of 17 conifers described in the vegetation chapter.

Only two roads connect the Scott Valley with the Salmon River lands to the west. Sawyers Bar Road (Co. Rd. 1Co1) separates the Salmons and Marbles, although the ranges are continuously high. Marble Mountain Wilderness to the north contains montane and subalpine lakes, and meadows set



Map 5. Features of the Scott River country. The north-tending Scott River leaves the Scott Valley and drops down to the Klamath River. State Route 3 enters from the south at Scott Mountain and leaves over the Greenhorns on the way to Yreka.

off the dense fir forests. The lands around Boulder Peak (8,300 ft.) are another area of serpentine substrates.

The Scott Bar Mountains form the northeastern boundary of the watershed. They are a confusing mixture of Paleozoic and Mesozoic rocks of many kinds, including serpentine substrates. Peaks, such as Deadwood Baldy Peak (6,045 ft.) and Indian Peak Baldy (5,695 ft.), are sufficiently low that these mountains show little effect of glaciation. The still-lower Greenhorn Moun-

tains, with more bewildering Paleozoic and Mesozoic rocks, represent the eastern boundary of the Scott Valley country. Duzel Rock (6,040 ft.), a noticeable capstone of limestone, is prominent on the eastern ridgeline.

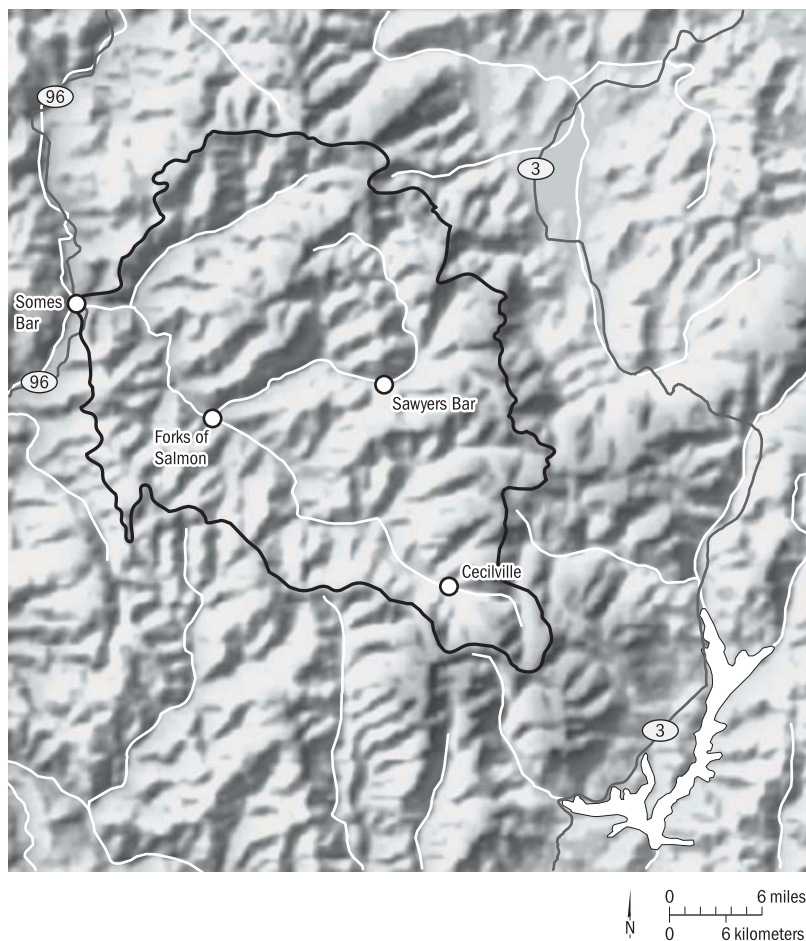
The community of Fort Jones, once a stop of the California-Oregon stage, was called Wheelock, Scottsburg, and Ottitewa before settling on today's name. A local military fort operated from 1852 to 1857. Nearby Etna (originally Etna Mills) began as a gold mining town, but people also found gold in growing grain for the miners' bread. Callahan, another stage stop and mining town, resides at the south end of the valley. Callahan-Cecilville Road (Co. Rd. 1Co2) to the south also allows access to the Salmon River country.

Agriculture greatly reshaped the valley bottom, and today the area is committed to alfalfa. Mountainsides are mostly part of the Klamath National Forest. Scattered parcels managed by the Bureau of Land Management exist among many old, privately owned mining claims in the Scott Bar and Greenhorn mountains. Miners discovered gold on the eastern flanks of these mountains in 1851. Dredging of the Scott River continued into the 1960s, giving it the dubious honor of being the last to be dredged in the state. The river ends at the convergence with the middle Klamath after surging through a scenic canyon north of the valley proper. Scott River Road (Co. Rd. 7Co1) will take you through this canyon.

LANDS OF THE SALMON RIVER

The Salmon River country, the heart of the Klamath Mountains, is the most rugged and isolated of the region's watersheds (Map 6). Some 85 percent of the mountain slopes exceed a 15 percent slope in this 310,000-acre watershed. Getting there to enjoy its beauty takes some doing. Only three Siskiyou County roads traverse the country by closely following its canyons. North Fork Road (Co. Rd. 1Co1) connects Etna in the Scott Valley with Sawyers Bar, and South Fork Road (Co. Rd. 1Co2) to the south connects Callahan with Cecilville. Both streams flow through steep-walled canyons, especially on the South Fork (Pl. 5). Below their convergence, kayakers run the whitewater as cars creep along the one-lane road (Co. Rd. 2Bo1). Chiseled out of the canyon walls well above the rapids, this road connects the hamlet of Forks of Salmon with SR 96.

The ancient bedrock in the country is similar to that of the middle Klamath River, but much of its geology is the result of events of the last two million years. Conditions during the Pleistocene and the Holocene were sufficiently cold that mountain valleys were filled with glaciers that alternated with warmer periods when the valleys were free of ice. The last glacial cycle ended about 150 years ago (Table 3).



Map 6. Features of the Salmon River country. The Salmon River watershed in the Klamath Mountains lacks a state highway. State Route 96 passes to the west at the convergence of the Salmon and Klamath rivers at Somes Bar. The large subbasin in the north is Wooley Creek.

Today hikers climb grand staircases on their way to the glacier-created landscapes of tarns and moraine-created lakes in Marble, Russian, and Trinity Alps wildernesses. Bedrock with polish and scratches and individual boulders left on glaciated surfaces suggest that the ice left only recently, but the southern slopes of many peaks show no evidence of ice.

Peaks rise as much as 8,000 feet above the convergence of the Salmon River with the Klamath River. To the south, Salmon Peak (6,955 ft.) begins a ridge that includes Mary Blaine Mountain (6,750 ft.), Cesar Peak (8,920 ft.),

TABLE 3. Traditional sequence of glacials and interglacials in North America.

	<i>Glacials</i>	<i>Years Ago</i>
Holocene		0–10,000
Little Ice Age		150–600
Neoglacial		3,000–2,500
Late Pleistocene		10,000–130,000
Younger Dryas		12,800–11,600
Wisconsinan Glacial		12,800–80,000
Sangamonian Interglacial		
Middle Pleistocene		130,000–750,000
Illinoian Glacial		
Pre-Illinoian Glacials	5	
Early Pleistocene	6	750,000–1,650,000
Yarmouth Interglacial		
Kansan Glacial		
Aftonian Interglacial		
Nebraskan Glacial		

NOTE: Pre-Illinoian glacial stages occur in both the Middle and Late Pleistocene. Wisconsin = Wisconsinan, Illinoian = Illinoisan in some literature (from Ehlers 1996).

and Caribou Peak (8,170 ft.). Russian Peak to the east and English Peak (7,320 ft.) and Medicine Peak (8,835 ft.) to the west finish the crest around the drainage. The North Fork begins as lakes near English Peak, and the South Fork in the Caribou Lake Basin, with its famous lakes. Wooley Creek, President Herbert Hoover's favorite steelhead stream, starts in the northeast part of the well inside Marble Mountain Wilderness at Man Eaten Lake.

The watershed's climate is one of sunny summers and rainy winters (35–85 in. annually). High elevations receive abundant precipitation and maintain deep snowpacks well into the summer. Low-elevation canyons receive less annual precipitation than the canyons of the middle Klamath River. At lower elevations, winter temperatures are mostly above freezing, with fleeting snow. Summers are hot.

Impacts on the land are similar to those of the middle Klamath River, but the terrain is steeper. The effects of gold mining are especially evident in the Summerville Mining District near Cecilville. Recent fires have changed the country. Fires burned about half of the Salmon River country since the early 1900s and 30 percent since 1975. The 1977 Hog fire burned 50,000 acres, and the 1987 fires burned 90,900 acres in four separate areas.

LANDS OF THE TRINITY RIVER

The Trinity River is the largest drainage in the Klamath Mountains (Map 7). It covers almost two million acres, about a third of the entire Klamath River system. Weaverville, the largest town in the region (pop. 3,554), sits in the center of the watershed. Trinity Lake, another massive reservoir of the Central Valley Project, and the smaller Lewiston Lake dominate the country and its economy. The Lewiston Power Plant diverts water from the Trinity River country through the Trinity Mountains to Clear Creek, where it fills Whiskeytown Lake, only to be transported to the Sacramento River. Trinity

KLAMATH MOUNTAINS DURING THE GREAT ICE AGE

The Quaternary spans the last two million years, including the Pleistocene—the Great Ice Age—and the Holocene—the Anthropogene, the “Age of Man.” The climates during this period were generally colder than were those of the Tertiary. In the mountains of northwest California, this was the time of a series of cold periods with associated glacial advances called *glaciations*, *glacial stages*, or *glacials*. These glacials alternated with warmer periods of glacial retreat called *interglacials*, during which the land was more or less free of permanent ice. The last glacial ended about 150 years ago.

The Pleistocene

Until recently, geologists considered that the Pleistocene in North America involved 4 glacial cycles. Today they distinguish 11 or more before the Illinoian glacial, but they are not important in our discussion. A warm Sangamonian interglacial in the late Pleistocene began about 130,000 years ago and lasted about 55,000 years. The last glacial, the Wisconsin (Wisconsinan), began about 80,000 years ago and lasted until the Holocene.

Glacial ice collected during the Wisconsin in the higher elevations, especially in the Marble Mountains, Trinity Alps, and Trinity Mountains. This ice moved down drainages abrading and quarrying rock, leaving behind the erosional features that distinguish these ranges today. Unlike the Sierra Nevada with its ice caps, glaciers in our mountains formed in the valley bottoms, mainly in north-tending drainages. The ridges and south-tending drainages had less ice or were ice-free. At times, however, ice spilled over ridges and coalesced with adjacent glaciers. Parts of ridges went unglaciated, and they protruded out of the ice as formations called *nunataks*.

The Wisconsin glacial involved a series of ice-free times (interstadials), as well as ones of ice advance (stadials). The last major ice advance, the Late Wisconsin, occurred about 22,000 years ago. Since then, the climate has warmed in spurts with several reversals, during which the ice advanced and then retreated.

During the interstadials, clay, silt, sand, gravel, and boulders (collectively called *till*), eroded from higher elevations, accumulated in mounds and ridges (moraines), as the ice melted. Boulder shape and surface characteristics in the till, and the extent of

Alps Wilderness is the largest and the most visited in the region, but we still know the area as gold rush country.

La Grange Mine, near Weaverville, was the largest hydraulic mine in the world. The California Historical Landmark No. 778 marks the mine site along SR 299. The western slopes of Oregon Mountain are still raw from 90 years of mining that ended in 1941. Today the mine's tailings are a new source of wealth as rock aggregate is now used in construction and road building.

Even though gold existed in all parts of the region, the Trinity River country was, in many ways, the focus of the area's gold rush. Lindsay Applegate

soil development between the boulders, allow geologists to date the different morainal deposits. Newer glacial advances in the Klamath Mountains ended at higher elevations than did the older ones, so typically younger ice flowed over older till.

Holocene

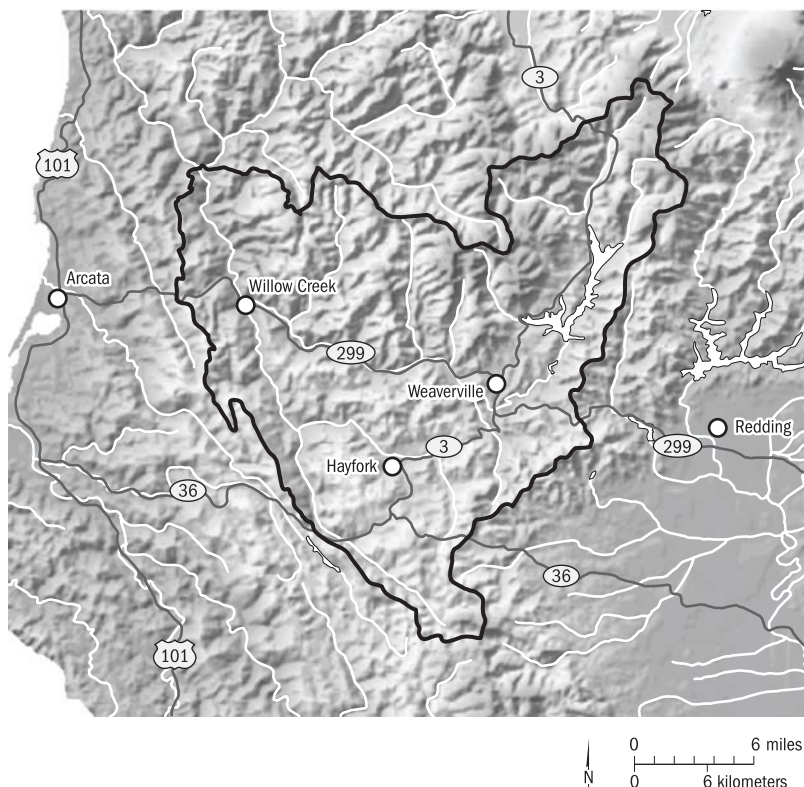
Geologists delimit the Holocene by the time of rapid change from glacial conditions to warm ones in northern Europe that occurred some 10,000 years ago. In North America, including northwest California, the warming began earlier in the Pleistocene. It was stepwise set in character, with reversals to cold, arid conditions. The last cold period was the Younger Dryas, 12,800 to 11,600 years ago. Significant temperature increases followed, melting the last of the Pleistocene ice.

Temperatures in the early Holocene continued to rise, peaking from 7,000 to 5,000 years ago, a time variously called the Altithermal, Hypsithermal, or Xerothermic, when summer temperatures in our mountains were hot and onshore winds brought dense summer fogs to the coast. Moreover, these fogs were more extensive than they are today. Temperatures moderated after the Hypsithermal.

About 4,000 years ago, climates were less seasonal, temperatures cooled, the coast became less foggy, and ice again collected in our mountains. From 3,000 to 2,500 years ago, conditions were sufficiently cold to warrant the name Neoglacial. From 1,300 to 800 years ago, conditions were again warm and arid; this period is the Medieval Warm Period. In California, it was a time of drought; Europe enjoyed a marvelous climate.

About 600 years ago, the climate again cooled, and northwest California entered the Little Ice Age. This glacial lasted until about 150 years ago. The small ice fields on the north slopes of the Salmon Mountains near Thompson Peak date from this time. Since 1850, the climate warmed until the 1940s, only to cool until the 1970s. Now the trend is upward.

I have enjoyed checking out the "glacierets" in the Trinity Alps over the last 40 years. Today these permanent ice sheets exist behind well-defined moraines with very angular boulders, telling of their youth. During the drought of the late 1980s, these sheets were all but lost, only to expand to meet the moraines in 1996. Today the glacierets are again smaller.



Map 7. Features of the Trinity River country. Trinity River country contains the four state routes. State Route 36 to the south passes south of Hayfork at the start of State Route 3, which extends north over South Mountain to Scott Valley. The north-tending State Route 96 starts at Willow Creek.

found it in 1849 at the head of Scott River, a year after Reading discovered gold on the banks of the Trinity River. Other strikes followed in 1850 on the Salmon River and in the eastern foothills of the Greenhorn Mountains near Yreka. Gold mining continues today. When driving along SR 299 between Junction City and Big Bar, look for the small, floating suction dredges that retrieve gold from deep gravels of the riverbed. There are continuing arguments over a proposed open-pit gold mine along Canyon Creek. State Route 3 north of Weaverville takes you to the gold diggings along Coffee Creek and the upper Trinity.

Much of the effect from decades of mining activity is now covered by new forests and not evident when traveling through the country. A visit to historic Weaverville and the Joss House—The Temple of the Forest Beneath the Clouds, the oldest continuously used Chinese temple in

California—will remind you better of the mining past. Most highways are twisty and follow the river canyons. State Routes 3, 299, and 96 encircle the spectacular Trinity Alps. State Route 3 continues north over the Scott Mountains to Scott Valley. State Route 96 follows the downstream reaches of the Trinity from Willow Creek to its convergence with the Klamath River at Weitchpec. Rafting many parts on the Trinity River is an increasingly popular way to savor the area. State Route 36 is the slowest of the region's state highways. Locals drive it freely, but flatlanders (i.e., city slickers) find it narrow, even frightening. It traverses the lands of the Trinity's south fork.

The Scott and Trinity mountains meet just north of Mount Eddy, the headwaters of the Trinity River; the Trinity Alps occur to the west. The eastern ranges, referred to as "the Red Alps," are part of the Trinity ophiolite (Pl. 6). Deadfall Basin Botanical Area and Mount Eddy, Preachers Meadow, and Stuart Fork research natural areas recognize the ecological interest of these serpentine-rich mountain ranges with their rare plants, rich woodlands, and chaparral.

The central Trinity Alps contain several large granitic outcrops offering the hiker a "Sierra Nevada" experience, only at lower elevations (Pl. 7). Canyon Creek and Stuart Fork are among the most popular parts of the wilderness for backpacking. A day hike to Boulder Lake or Bear Lake can give you a taste of "the White Alps." The lower terrain of the New River area takes the hiker into still another aspect of the wilderness, "the Green Alps," the least-known part of the wilderness. Fir forests in North Trinity Mountain Research Natural Area occupy granitic soils in the westernmost part of the wilderness. Down at lower elevations, you can arrange tours of several Hupa village sites, dance grounds, and the remains of Fort Gaston at the Hoopa Tribal Museum in Hoopa. The Vista Point on SR 96 provides views of several restored traditional Hupa houses.

Mountainsides in the Alps are comparable to other watersheds in the region, with two-thirds exceeding a 15 percent slope. They contain the most widespread montane and subalpine terrain in northwest California. Thompson Peak (9,000 ft.) is the tallest peak in the Alps. From here streams radiate like the spokes of a crude wheel. The mountain divides between the streams support myriad peaks. Fifty-five lakes are scattered at the headwaters of the major streams.

The Trinity River has four forks and three other major streams. Coffee Creek, Swift Creek, and Stuart Fork enter Trinity Lake on the west. Canyon Creek and the North Fork enter after the river has made a sweeping bend west. The deep gorge beside Ironside Mountain (5,250 ft.) gets water from the New River and the South Fork. The New River has many tributaries, including the South Fork of the East Fork of New River. After the South Fork enters, the canyon widens to support the elevated terraces and streamside sandbars at Willow Creek and Hoopa Valley before

the river enters another gorge, eventually meeting the Klamath River at Weitchpec.

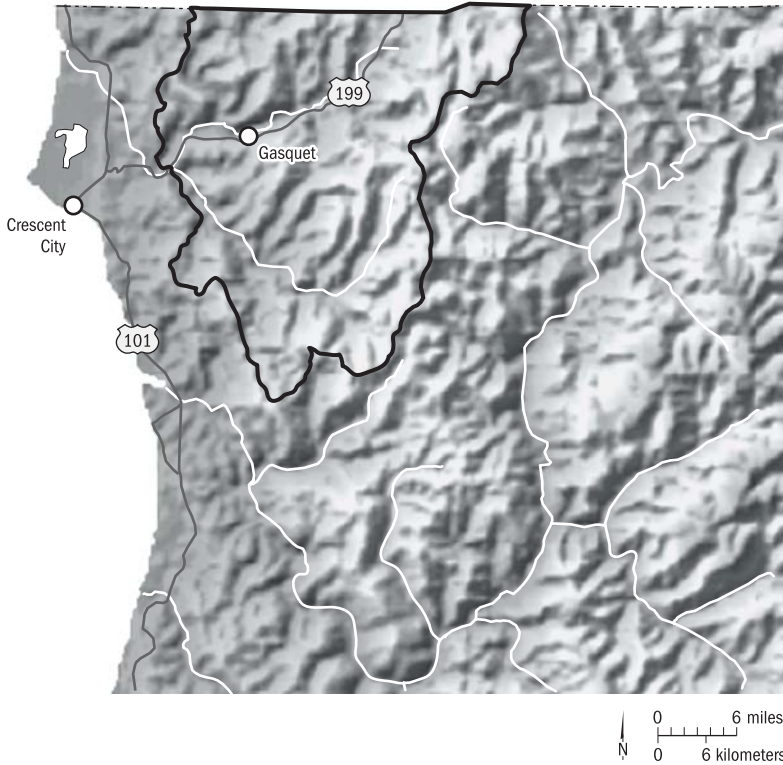
The country of the Trinity River enjoys sunny summers and snowy winters. Its central ranges receive the highest precipitation (60–85 in. annually). The low-elevation canyons, where winter temperatures are mostly above freezing, snow is fleeting, and the summers are hot, receive about 80 percent of the precipitation of the higher terrain. Winter snow accumulates in the mountains and lasts well into summer.

The Trinity Mountains on the east, the North Yolla Bolly Mountains on the south, and South Fork Mountain on the west surround the South Fork country. The South Fork starts on northern slopes of North Yolla Bolly (7,865 ft.), flowing west and north, and picks up water from Hayfork Creek at Hyampom Valley. From there it continues north through still another gorge at Hell's Half-acre Creek before meeting the main stem near Salyer. Members of the Jedediah Smith party called this rugged terrain a "green prison" in 1828.

It appears that Smith still may have picked the best way through these mountains. Mountainsides are generally gentler, with only half of them exceeding a 15 percent slope. This land is a *mélange* of rock types, including gabbro, chert, granitics, limestone, and sandstones called the Rattlesnake Terrane. Outcrops of serpentine substrates are scattered throughout the *mélange*. Western Azalea Botanical Area gives only a taste of the floristic richness of the area. This area has some 30 sensitive plants with intriguing names such as Dubakella Mountain buckwheat. Car trips off SR 36 on Shasta-Trinity National Forest roads to Dubakella Mountain (5,635 ft.) and Tedoc Mountain (5,250 ft.) give the plant lover a more complete look. We find Horse Mountain Botanical Area and Rough Ridge and Smokey Creek research natural areas on South Fork Mountain along the western boundary of the region. The mountain's ridgeline extends from North Yolla Bolly Mountains in the south to Weitchpec.

LANDS OF THE UPPER SMITH RIVER

The upper Smith River and the Smith River Recreation Area are all but the same entity (Map 8). Created in 1990 "to protect the area's special scenic value, natural diversity, cultural and historical attributes, wilderness, wildlife, fisheries, and clean waters," the area involves the largest nondammed river system in the nation. The Smith River's waters return to their famous green soon after the winter storms. This is the quickest-clearing stream of the state's coastal rivers. Fishing on the Smith River is world-class. It provides habitat for Chinook and coho salmon as well as steelhead, rainbow, and cutthroat trout. The bedrock-carved streams flow through steep canyons that are perfect for whitewater rafting and kayaking.



Map 8. Features of the upper Smith River country. The smaller North Fork includes much of the land of the Josephine ophiolite in California.

Congress designated more than 300 miles as wild and scenic. The Smith River is in many ways the crown jewel of the National Wild and Scenic River System.

The winters are among the rainiest in the state (65–125 in. annually). Winter temperatures at lower elevations are mostly above freezing, and snow is fleeting; winter snow accumulates in the mountains and lasts well into summer. Summer temperatures are moderate.

As with the rest of the middle Klamath country, the mountainsides are steep: just over half have a more than 15 percent slope in this relatively small 362,000-acre watershed. Many slopes are unstable because of road building and forest harvesting; landscape scars from natural slides are common. Personnel of the Six Rivers National Forest supervised extensive clear-cutting during the 1970s and 1980s, but much of the rich biological heritage is still intact, even after the huge Biscuit Fire in 2002 that was the size of Rhode Island.

The Smith River's north fork is a country of sparse vegetation, serpentine barrens, and extensive soggy fens (Pl. 8). This is the land of the Josephine ophiolite, which boasts the highest number of endemic vascular plants (70) of any outcrop of serpentine substrates on the continent. Serpentine barrens occupy gentle ridges where sheet erosion removes fine particles and where only scattered plants exist in the lag gravel. The federally listed McDonald's rock cress and other rare plants grow in patches of fescue and scattered, dwarf Jeffrey pine trees.

The fens of this area are famous for the insectivorous California pitcher plant (*Darlingtonia californica*). This species is almost completely restricted to areas with flowing water and serpentine substrates. The base of its leaf forms a vase to pool water, and the top of the leaf forms a "cobra head" replete with a "window" that lures unsuspecting insects inside. Once there, slippery walls and downward-pointing hairs force the insect to the waiting water. The rotting insects contain nitrogenous compounds (chemicals otherwise deficient in this habitat) that the plant uses.

Growing with this remarkable plant is a diverse set of wet-adapted species, many associated with bog and fen conditions in Canada, including the insectivorous butterwort and sundew. Indeed, these areas are often called "*Darlingtonia* bogs," but according to biologists who study bogs and fens in Europe and Canada, *bogs* are areas where rainwater collects as the result of a buildup of decaying plants, such as *Sphagnum*; they are nutrient deficient and acidic. In contrast, fens receive water from streams as well as from rainfall, and they contain fewer nutrients and are less acidic. We should consider these boggy areas as fens, but it is hard to break the habit of talking about them as *Darlingtonia* bogs.

These delights can be enjoyed along US 199 at several spots near the community of Gasquet. Myrtle Creek Botanical Area and the *Darlingtonia* Trail offer a visit to a fen with California pitcher plants. The botanically famous Stoney Creek Trail is an excellent introduction to the serpentine plants of the Josephine ophiolite. Nearby Craig's Creek Research Natural Area shows off woodlands of knobcone pine and western white pine. North Fork Smith River Botanical Area, including L. E. Horton Research Natural Area, is closed to vehicles other than on Weimer Road (Del Norte Co. Rd. 305). Low Divide is the site of Altaville, the center of copper mining between 1863 and 1865 that sported several saloons, hotels, a butcher shop, a blacksmith shop, general stores, mining offices, and housing. None of these buildings survive, and today the area shows little evidence of its mining period.

Broad, flat ridges, such as Gasquet Mountain (2,425 ft.) and High Plateau (3,500 ft.), stand above rugged canyons. These mountains are peneplain surfaces from earlier periods of mountain building. They are areas of low relief and have very deep soils, with little faulting or tilting of

the old landmass. Mining companies seriously considered strip-mining the deep soils for chrome, cobalt, chromium, and nickel on Gasquet Mountain in the 1980s. Plans involved processing the soil in a coal-burning smelter with water from newly created reservoirs. The mines would destroy the mountaintops and dam, and contaminate the streams. Acid rain created by the local smelters would fall on the Siskiyou Mountains and other mountains to the east. Debate raged throughout the 1980s and ended with creation of Smith River National Recreation Area in 1990. Today the emphasis is on taking delight in the wild rivers and wild mountains.

The high mountains offer still another look at rich conifer forests, montane meadows, and subalpine lakes in Siskiyou Wilderness. Bear Basin Butte Botanical Area just west of the Siskiyou crest is famous for having 16 conifer species. We find other enriched mixtures at lower elevations at nearby Broken Rib Mountain Botanical Area and at Rock Creek Butte Research Natural Area east of the Siskiyou crest. The views from Bear Basin Butte offer grand views of Preston Peak and the ocean. Look for the isolated piece of redwood forest along French Hill Road (FS 411) on the way to see the nearby lodgepole pine stands at Upper Coon Mountain. Glaciers occurred at the higher elevations of the Siskiyou Mountains, but much of the terrain remained free of ice.