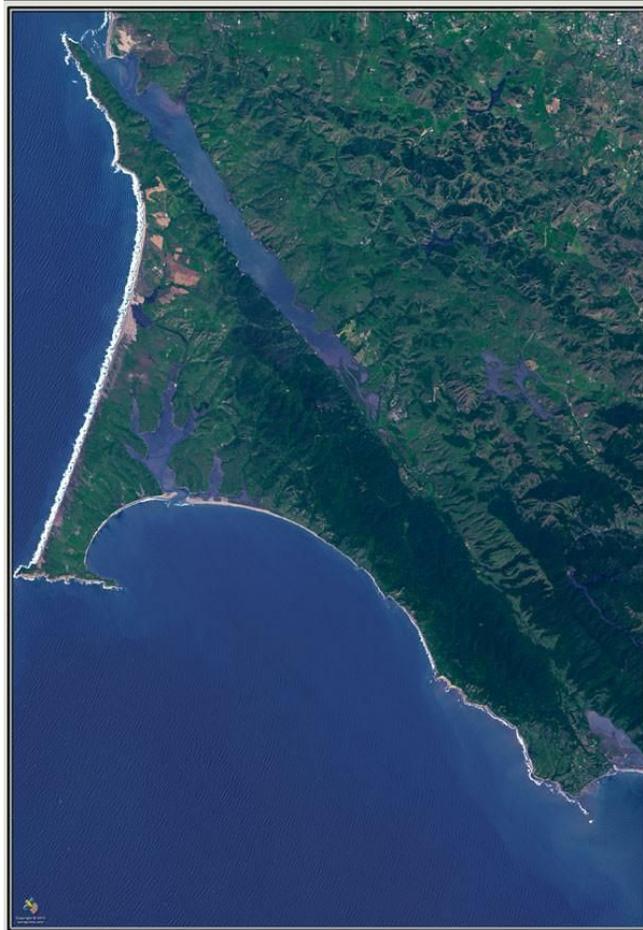




Point Reyes Outdoors



A Guide to Point Reyes National Seashore

Introduction

Thank you for choosing Point Reyes Outdoors. We love nothing more than to share our love for Point Reyes National Seashore and we hope that this guide will enhance your experience. From its thunderous ocean breakers crashing against rocky headlands and expansive sand beaches to its open grasslands, brushy hillsides, and forested ridges, Point Reyes offers visitors over 1500 species of plants and animals to discover. Home to several cultures over thousands of years, the Seashore preserves a tapestry of stories and interactions of people. Point Reyes awaits your exploration.



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Overview

Point Reyes National Seashore is a 71,028-acre (287.44 km²) park preserve located on the Point Reyes Peninsula in Marin County, California. As a national seashore, it is maintained by the US National Park Service as an important nature preserve.

The peninsula includes wild coastal beaches and headlands, estuaries, and uplands. The region is home to 900 species of plants, 490 bird species, and thousands of invertebrate species.

Physical Landscape

The Point Reyes peninsula is geologically separated from the rest of Marin County and almost all of the continental United States by a rift zone of the San Andreas Fault, about half of which is sunk below sea level and forms Tomales Bay. The fact that the peninsula is on a different tectonic plate than the east shore of Tomales Bay produces a difference in soils and therefore to some extent a noticeable difference in vegetation.

San Andreas Fault

All along the California coast, the jagged scars of the San Andreas Fault peek out amongst the landscape it played such a crucial role in forming. Ranging from dramatic rifts and mountains to vast valleys and winding waterways, the San Andreas has dramatically shaped the California coastline and continues to gradually make changes. The San Andreas marks the meeting point between the Pacific and North American plates. True to the nature of transform plate boundaries, the Pacific plate is continually grinding northwest along the North American plate at a rate of approximately two inches per year.

What is today the Point Reyes Peninsula is thought to have once been located as much as 280 miles south of its current location. Tomales Bay, The Olema Valley, and the Bolinas Lagoon are all physical evidence of the San Andreas Fault which connects the three in a straight line, separating the Point Reyes Peninsula from the rest of Marin County. The peninsula lies on the Pacific Plate while most of California is on the North American plate. The San Andreas Fault is a transform plate boundary, which means that one plate is grinding past the other. In the San Andreas, both plates are moving in a general northwest direction, but the Pacific plate is moving at a much more rapid pace, occasionally slipping past the North American and causing earthquakes to occur. Potentially one day Point Reyes will break away from California and become an island destined to eventually collide with continental Alaska.

Geology:

The San Andreas Fault marks a distinct boundary between two very different geologic formations. To the east, hints of green serpentine can be seen poking through the foliage. These rocks are part of the Franciscan formation, originally created underneath the ocean over 150 million years ago before being thrust upward onto the coast by millions of years of geologic activity. The Franciscan formation is quite prevalent up and down the Northern California coast. To the west of the San Andreas, however, the earth is made up of granite over 100 million years old lying underneath a collection of Cenozoic sedimentary rocks formed over 65 million years ago. These rocks are distinctly identical to formations found north of Los Angeles and in the Monterrey region, adding proof to the theory that the Peninsula originated much further south of its current location.

The 1906 Earthquake:

The famous 1906 earthquake that ignited 3 days of raging wildfires in San Francisco also shook the foundation of Point Reyes, knocking over a train, causing fences to jump over 15 feet, and opening up a rather large rift in the Olema valley. In fact, the entire Peninsula of Point Reyes is estimated to have leapt as much as 16 feet northwest in a matter of seconds, giving it a helpful push along its Alaskan-bound journey.

Viewing the Fault:

Evidence of the dramatic San Andreas Fault can be seen looking east from atop Mount Whittenburg or Mount Vision, in the Olema valley, around Bear Valley, or in Tomales Bay. Sitting in a kayak just east of Hog Island, one can look north and south and realize quite obviously that they are floating directly atop the rift that has played such a crucial role in the creation of such a dramatic Californian landscape.

White Gulch

While paddling across Tomales Bay, one's eyes are instantly drawn to the dramatic cliffs of White Gulch where the 100 million year old granitic basement supports outcrops of Laird's Sandstone, dating back only 15 million years. Most commonly, Laird's Sandstone is pale brown, but in White Gulch, the cliffs sport a brilliant white, bleached from many years of sun exposure.

Geology:

Laird's Sandstone always occurs with granite, and usually is formed by the weathering of the granite in association with barnacle fragments, cluing the careful observer into the rock's marine origin. Laird's Sandstone occurs almost exclusively along the western edge of the Inverness Ridge, but also appears in outcrops along Kehoe beach and the steep cliffs of White Gulch.

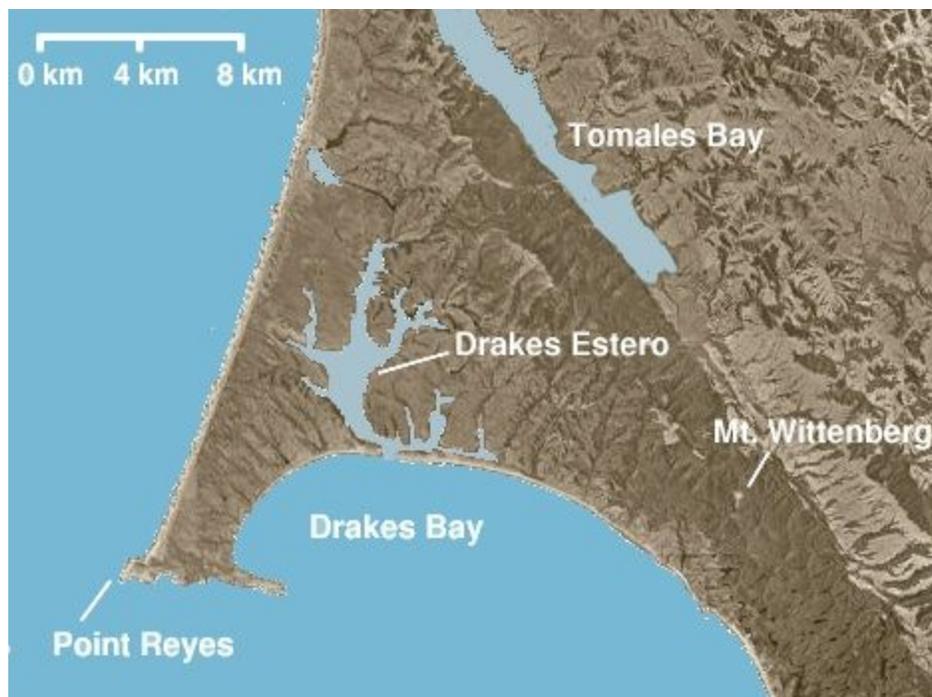
Viewing:

While paddling around White Gulch, kayakers can get an up close view of the dazzling white cliffs as well as some tide pool critters that hang out around the base at low tide, or land on any of the nearby beaches to try and catch a glimpse of a Tule Elk or two hanging out in the hills above the cliffs.

Drakes Estero

Drakes Estero is an expansive estuary that provides the main drainage for the Point Reyes peninsula. Seen from the air, Drakes Estero resembles a human hand, with Barries Bay, Creamery Bay, Schooner Bay, and Home Bay as the "fingers" and Limantour Bay as the thumb. The waters of the Estero flow into Drakes Bay between Drakes Beach and a narrow strip of land called Limantour Spit.

Drakes Estero has been designated as the most probable landing spot of Francis Drake on the coast of North America in 1579 during his circumnavigation of the world and has been established as a National Historic Landmark. A historical marker has been placed on Drakes Beach near the Kenneth C. Patrick Visitor Center and monuments to Drake have been erected at the Drake's Cove landing site.



Climate of Tomales Bay Region

The Point Reyes Peninsula, similar to the rest of California, is characterized by winter rains and summer drought. The temperature varies little between a winter average of 50° F and a summer average of 55° F. The ocean dictates the weather. The eastern arm of the Kuroshio Current starts in warm water near Japan and moves in a clockwise motion up into the Gulf of Alaska and then down the west coast of North America. When it gets here it has a new name, the California Current, 400 miles wide and moving slow, only about 0.5 to 7.5 miles per day. The surface water temperature runs from 48 to 61 degrees with an average of 54 degrees.

The ocean around Point Reyes experiences three distinct phases in its yearly cycles. These phases or seasons are: (1) Upwelling, which generally takes place during spring and summer months, (2) Oceanic period, which occurs in September and October, and (3) Davidson Counter-Current during the winter.

Upwelling lasts the longest and has the greatest effect. The legendary spring winds drive the warmer surface layer offshore. The California Current moves inshore bringing with it cold, nutrient-rich water from down deep. Upwelling can begin as early as February and extend into August reaching its peak in June and July. The combination of long hours of sunlight during the summer and the mixing of the water cause plankton production to increase. Billions upon billions of really tiny creatures called diatoms cause the red-brown color of the water during this time. When the bottom of the food chain is living well, all the rest of the critters above it in the food chain do too. With water temperatures running from 48 to 56 degrees it is the coldest water on the west coast. Lucky us!

About September through October (more or less), the winds cease their almost constant blowing and the southward flow of the California Current slackens and allows a northward inshore flow of warm subtropical water. Plankton counts are at their lowest and the water temperature is at its highest, reaching up to 61 degrees. This is called the Oceanic period and kayakers know it as the best time of the year for paddling.

In November a back eddy off the California Current and Southerly winds from the counter-clockwise movement of low pressure driven winter storms creates the Davidson Countercurrent which moves inshore. Plankton production is low due to the short days and low levels of salinity caused by runoff from the winter rains.

Perhaps the most dramatic feature of the Peninsula's climate is its annual rainfall. The interior Olema Valley receives approximately 40 inches of rain per year, while during the same period, the Point Reyes Headlands may receive only 20 inches. What effect, if any, do you think this extreme difference in rainfall might have in the short 20 miles between Olema Valley and the Headlands?

Enter one of the Peninsula's surrounding canyons or valleys on an average summer day and you will experience its microclimates first hand. The diurnal temperature between the valleys and the western rangeland can vary by as much as fourteen degrees fahrenheit. The Peninsula's unusual biodiversity is greatly affected by these unique microclimates that will be discussed further in the following pages.

Cultural History

Adapted from National Park Service, Point Reyes National Seashore Website

The cultural history of Point Reyes reaches back some 5,000 years to the Coast Miwok Indians who were the first human inhabitants of the Peninsula. Over 120 known village sites exist within the park. According to many experts, Sir Francis Drake landed here in 1579, the first European to do so. In response to the many shipwrecks in the treacherous coastal waters, key lighthouse and lifesaving stations were established by the United States Government in the late 1800s and early 1900s. In the early 1800s, Mexican land grantees established ranchos. They were followed by a wave of American agricultural operations, which continue to this day in the Seashore's pastoral zone.

Coast Miwok at Point Reyes

Before the Europeans came to California, the Coast Miwok people were the inhabitants of what we now call Marin and southern Sonoma Counties. They knew and blended with this bountiful land for thousands of years, developing a rich economy based on gathering, fishing and hunting. Village communities of 75 to several hundred people developed in sheltered places near fresh water and plentiful food. "Kule Loklo" (meaning "Bear Valley") is a recreated village. It stands where no village ever was, but where one might have stood.

Coast Miwok life was intricately woven into the changing seasons. In the late spring, fresh new greens of Indian lettuce, young nettle leaves and clover were gathered. Fire-hardened digging sticks were used by the women to reach deep-set roots and bulbs. The ocean provided kelp in large amounts, some to be eaten fresh, the rest dried and stored for the winter. Tule was gathered in the fall for skirts and tule baskets. The summer sun ripened grasses and flower seeds, gathered by hitting the ripened seed with a beater basket and letting them fall directly into a collecting basket.

Fall was the season for collecting a variety of nuts: acorns (stored in a granary for year-round consumption), buckeye, hazel and bay. Tule was cut and dried for kotcas (houses), boats and mats. Gray willow for baskets and traps was abundant. Winter and early spring were times of shortage when stored acorns, seeds and kelp became important food sources.

The ocean provided food year-round. Crab, clams, mussels, abalone, limpets and oysters were some of the seafood gathered by the women in the tidal zones. Cleaned of meat, the shells were also fully utilized. Abalone shells were made into beautiful ornaments. The Washington clam was one of the most important shells; these were ground into circular, flat disk beads with a hole drilled in the middle. Strings of these beads were the main trade item (money) and were used extensively through Northern California.

The men adopted many different techniques for fishing. Dip nets (bags of netting attached to wooden frames on a handle) were used to scoop up fish, and woven surf nets were used along the open beaches. Cone-shaped traps of woven gray willow were set up in creeks and mouths of rivers. With hook and bait one could successfully catch halibut and rockfish year-round.

Hunting by use of traps and bow and arrow supplied the Coast Miwok with meat, fur and tools. Traps were used to capture such game as quail, acorn woodpeckers and rabbits, which were highly valued for their fur and meat. Deer were usually hunted with bow and arrow, and provided many necessary items. Antler tips were used for shaping arrowheads, sinew (muscle tendon) was used to fasten points to arrow shafts and leg bones were made into awls (needles used in basketmaking) and hair pins. In this way, the Coast Miwok wasted little of the animals they hunted.

The Coast Miwok people lived in the same village for hundreds of years. As we contemplate their existence here, we may learn from them an approach to life and land, which could be sustained for hundreds or thousands of years. As the first caretakers of Point Reyes, the Coast Miwok people continue to teach us much.

Early Exploration of Point Reyes

The ancient home of the Coast Miwok people, the dramatic landscape of the Point Reyes peninsula with its wave battered cliffs, remained undiscovered by European explorers until the late 1500's. Sir Francis Drake probably first sighted and mapped the fog-shrouded headlands in 1579, at which time he is thought to have camped along the beach which today bears his name. Drake's quest for new lands and riches had taken him around South America to the Spanish trade routes of the Pacific Ocean. His ship, the Golden Hinde, was full of gold and luxuries such as porcelain, taken from Spanish galleons traveling from the Philippines to Acapulco.

During the summer of 1579, Drake came ashore somewhere in California to careen his ship to repair the hull. The ship's chaplain complained in his log of "the stinking foggess". The nearly

omnipresent fog at the Point Reyes headlands throughout the summer, along with the chaplain's descriptions of the inhabitants, the landscape and the wildlife, indicate that Drake's Estero may be the location of Drake's camp. Drake claimed the land "Nova Albion" (*New England*) for Queen Elizabeth before setting sail southwest to complete his circumnavigation of the globe before returning to England in 1580.

During the late 1500's, Spanish galleons were making numerous voyages between Mexico and the Philippines. To sail across the north Pacific, ships from Manila would sail north before catching the prevailing easterly winds, arriving along the North American coast north of Point Reyes. It is likely that numerous Spanish crews saw Point Reyes as they sailed south along the California coast toward Acapulco and other Mexican ports where Asian luxury goods such as porcelains and spices were then shipped to Europe. We do know that in 1595, Sebastian Cermeño anchored in the calm waters of what is now called Drake's Bay. As his crew was ashore seeking freshwater, their Manila galleon stuffed with silks and spices, was wrecked in a sudden storm. The crew managed to return home by rowing their long boat to Mexico.

The Spanish had been sending ships along the Pacific Coast and overland explorations throughout North America for many years. In an age of empire building, the Spanish expanded their domain up the California coast from Mexico. Point Reyes officially entered Spanish maps on January 6, 1603 when Sebastian Vizcaino sighted the headlands on the Roman Catholic feast day of the three wise men. Following Spanish tradition, the headlands were named after these religious figures: "la Punta de los Reyes" or the Point of the Kings. Spanish expeditions along the north coast continued. Later, sailors eventually found and entered Tomales Bay, where they would have seen the Miwok village at Segogolue or Toms Point. Amongst the *kotças* (sleeping shelters), the Spanish traded goods made of metal for finely woven Miwok baskets.

Maritime History of Point Reyes

The sea is the soul of Point Reyes. It not only affects the climate and the species found here, but it is the key influence on the human history of the area. The Coast Miwok have depended on this coastline for food and materials for thousands of years; Spanish explorers and merchants, returning with spice and silk from the Asia, navigated by these cliffs and shores; and gold miners, dairy farmers, and lumbermen counted on the ships that sailed these waters for transporting their goods to and from market. Point Reyes' maritime history is a microcosm of California's history.

Today, Point Reyes National Seashore helps preserve the maritime history of California. Among the **dozens of shipwrecks** that were lost in the waters off Point Reyes, lie the remains of the San Agustin. Wrecked in Drakes Bay in 1595, it is the first shipwreck in California history. The San Agustin was only the first of a long line of tragedies. While Point Reyes provided a landmark, it also posed a hazard to generations of sailors who navigated these waters.

In an attempt to reduce the number of wrecks and to provide aid in navigation along these rocky shores, the U.S. Lighthouse Service built the **Point Reyes Light Station** in 1870. For 105 years, it provided mariners with guidance and aid. Despite the efforts of the men and women who worked at the lighthouse, ships continued to wreck on the rocks and beaches. In 1889, the Life Saving Service opened the first of two Life Saving Stations built at Point Reyes. The second station, the **Point Reyes Lifeboat Station** at Drakes Beach, and the last intact marine railway on the West Coast, closed in 1968. The men stationed there attempted the rescue of victims of storm and wreck. The incredible danger of their job can be sensed in their unofficial motto, "You have to go out, but you don't have to come back in."

As technology improved, other means of protecting navigation and communication with ships at sea appeared. Beginning in 1913, Guglielmo Marconi, a pioneer of wireless radio, built radio stations in the area. Ultimately, transmitting and receiving stations in Bolinas, on Tomales Bay, and near the Great Beach reached out across the Pacific to provide communications to ships at sea. Station KPH, the maritime radio station owned by Marconi and later, the Radio Corporation of America (RCA), signed off in 1997 and brought to a close an important chapter in Point Reyes' history.

Whether in climbing down the stairs to the Lighthouse or walking out to the Lifeboat Station, today's visitor can gain a better appreciation for the impact the sea has played on the history of California and in particular, on Point Reyes.

Ranching at Point Reyes

When you cross Inverness Ridge toward the Point Reyes headlands, you leave the pine/fir forest behind and enter the stark beauty of the coastal grasslands, dotted with cattle and scattered ranches.

This open, working landscape is known as the Pastoral Zone. At first glance, open pastures and rolling fence lines are punctuated by windbreaks, stock ponds, and feed lots arrayed around a ranch core. There, the mix of nineteenth century redwood homes and barns with twentieth century aluminum and steel utility buildings becomes evident, suggesting the evolution of the dairy industry. In fact, the National Seashore visitor has happened upon one of the earliest and largest examples of industrial-scale dairying in the state of California.

The Alchemy of Grass Turned to Gold

The 1849 California Gold Rush brought an influx of capitalists, merchants, professional practitioners, laborers, and agriculturists, amongst others seeking alternative wealth along the shores of San Francisco Bay. Some of those who vainly sought mineral gold in the Sierra Nevada foothills came further west, finding gold of another kind at Point Reyes. With their dairying skills honed in their previous homes, they could envision production of golden wheels of cheese and casks of butter to provision the growing population of nearby San Francisco. The treeless coastal plain beckoned with opportunity.

The early American settlers of the 1850s were impressed with the cool, moist climate of Point Reyes, providing near-ideal conditions for raising dairy cows. Abundant grass and forbs, a long growing season, and sufficient fresh water supplies promised productivity well in excess of domestic need. Unknown to the early ranchers, the expansive coastal prairie was most likely the byproduct of burning, weeding, pruning and harvesting for at least two millennia by Coast Miwok and their antecedents.

The Franciscan missionaries set the stage for the explosion of dairy in west Marin with the introduction of feral cattle in 1817. They established the San Rafael Asistencia, near San Francisco Bay, as an annex to Mission Dolores in San Francisco, serving as a recuperative center for ailing Coast Miwok and Ohlone natives. Secularization of the missions following Mexican independence from Spain led to land grant subdivision and the expansion of cattle ranching on the peninsula.

Creation of an Empire

The advancing front of Americano ranchers brought to light poor record keeping, and the behavior of several Mexicano land grantees coveting and utilizing a neighbor's adjacent parcel. As land was sold to the new immigrants, the title to the land usually became ensnared in litigation. During a five-year period ending in 1857, the San Francisco law firm of Shafter, Shafter, Park, and Heydenfeldt obtained title to over 50,000 acres on the peninsula, encompassing the coastal plain and most of Inverness Ridge. Unlike the small dairy operations pre-existing on the peninsula, these Vermont-native lawyer / businessmen saw the opportunity to market large quantities of superior quality butter and some cheese under a Point Reyes brand to San Francisco. The remote location of Point Reyes would be overcome with the expeditious delivery of finished products and livestock to the foot of Market Street by way of small schooners, and eventually by rail and ferry.

Initially, the Shafter's signed new leases with the existing dairy ranches. The singular exception was the sale of Tomales Point to an old friend from Vermont, Solomon Pierce. The Pierce family built a small town to support their isolated twin dairy ranches with the commanding views of the Pacific and Tomales Bay. In time, the Pierce Point Ranches out-competed the Shafter dairy collective in production and quality of finished product.

Oscar Shafter's son-in-law C. W. Howard, and the Shafter brothers proceeded to divide the remainder of their real estate into a tenant dairy enterprise in 1866. The land was subdivided into 33 ranches. Three years later, the business partners partitioned the dairies into six tracts, leaving each to own and manage a collection of coastal plain and ridgeline ranches. Oscar Shafter and Howard utilized the letters of the alphabet to name their individual ranches. "A" Ranch was located closest to the headlands; "Z" Ranch was located at the summit of Mt. Wittenberg, while several letters were left unneeded. James Shafter bequeathed more poetic names like Drakes Head, Muddy Hollow, Oporto and Sunnyside.

The Shafters and Howard employed family members, local residents, or recruited European dairymen as superintendents to construct new dairies, refurbish existing ranches, recruit immigrant ranch hands, and aid selection of the tenant ranchers. The tenant ranches were rented by Irish, Swedish, Italian-speaking Swiss, and Azore Islands-Portuguese families. Surviving Coast Miwok families displaced by the Spanish missions also found work on the dairies situated above their Tomales Bay homes. The Shafters envisioned creating a more civil society for the nineteenth century Bay Area, refining bachelor ranch hands and educating ranch family children. Chinese, Canadian, Filipino, Mexican and German immigrants all found their chance to get started in America through dairying at Point Reyes.

The “Butter Rancho”

The ultimate success of the Shafter / Howard dairy enterprise rested on their ability to market and negotiate contracts with high-end hoteliers and fine food purveyors. The Point Reyes brand of butter conveyed a high level of quality, attested in articles in local contemporary newspapers. "The grass growing in the fields on Monday is butter on the city tables the following Sunday," as the 1880 History of Marin County reported. The brand with letters “PR” inside a star was stamped into cheesecloth-wrapped rolls or casks of butter. This familiar symbol was actually forged by other dairy farmers of the time.

Record yields of butter and cheese came from the dairy farms at Point Reyes throughout the late 19th century. Herds of Devons, Jerseys, Guernseys, and later on Holsteins, numbering from 100 to 250 cows per ranch, catapulted the Point Reyes enterprise as perhaps the largest operation in the early years of the state. In 1867, Marin County produced 932,429 pounds of butter, the largest yield of butter in California. These huge amounts of butter were produced in an era when the finest restaurants served every good steak with a melting slab of butter on top.

The distance to San Francisco and east Marin communities precluded the ability to ship milk for domestic consumption. In the absence of refrigeration, the raw milk was briefly useable by the ranch families and employees. Collected by milkers either outdoors or inside large milking barns, raw milk sat in pans inside dairy houses to allow for cream separation. The surplus skim milk was dumped into a drain leading to an open trench, finding its way to penned, thirsty hogs. It was not unusual to see swine and casks of butter shipped off together on the decks of schooners headed for the city.

The estates of the three Shafter / Howard families declined shortly after the turn of the century. Following the 1906 earthquake, several dairies located on Inverness Ridge shuttered their doors. Although building damage contributed to their demise, these ranches failed due to the absence of Coast Miwok burning and the rapid expansion of native coyote brush and poison oak thickets, leading to dramatic reductions in grazeable pastures for cows. By 1933, all ridgeline dairies were gone.

The demand for Shafter / Howard ranch produce waned, particularly as transportation throughout the Bay Area improved. Other regional dairies were improving their quality, quantity

and distribution of produce, while the cumulative impacts of overgrazing on Point Reyes had caused a significant decline in pasture quality. The accumulation of massive debt, the 1929 stock market crash, and the close of the Depression ultimately brought an end to the three estates, and the “butter rancho”. Land speculators picked up the pieces, and in most instances resold the ranches to the contemporary tenants.

The Transitional Years

During the Depression, ranchers struggled to make ends meet. It was not uncommon for ranchers to augment their incomes with expanded livestock production, such as beef cattle, chickens, and eggs. Several ranches invited Japanese immigrants to raise peas, and Italian immigrants to cultivate artichokes on more remote parcels. These ventures were usually successful. Following the attack on Pearl Harbor in 1941, and the subsequent internment of the Japanese-Americans and relocation of Italian-Americans, the fields went fallow for lack of labor, and mounting soil erosion problems. During Prohibition, whiskey and rum smuggling at Home Ranch on Limantour Estero replaced dairy operations as their sole source of income.

Others changes were coming. The Golden Gate Bridge opened in 1937, expediting movement of produce from the North Bay region into San Francisco. During World War II, the ranches became connected to the regional electric power grid, replacing gas-powered generators to run milking and refrigeration equipment. The cooperative creameries closed, allowing for ranchers to sell raw milk as commodity to regional creameries. After the war, some dairies ceased operation, converting to far less labor-intensive beef cattle operations. Probably most important, fresh war veterans who had transited through San Francisco enroute to the Pacific theatre decided to relocate their families to the Bay Area, swelling the tide of suburbanization into Marin County.

Advent of a New Landlord

Marin County had embraced a favorable growth plan in the 1950s and 60s to benefit real estate developers and speculators, with assistance from the state department of transportation. With the influx of new residents, many of them affluent, property taxes for the county as a whole dramatically increased. At the same time, dairy operators nationally saw prices for the products drop considerably. Dairies regionally had been closing or consolidating for sometime, but the combination of economics, competition, labor costs, taxes, environmental regulation, and land values accelerated the pace. Point Reyes dairies feared the loss of the quality of life as much as declining profitability. If more dairies closed their doors, the fear rose that the supporting dairy industry infrastructure might collapse. Most important, the ranchers valued the pastoral landscape that their parents and grandparents had set roots in, often back to the nineteenth century.

In order to secure their place at Point Reyes, the dairy and cattle ranchers formed an uneasy alliance with the Sierra Club in hopes of preserving their ranches and west Marin open space. The National Park Service had actively sought to establish a literal beachhead on the California

coast, and Point Reyes in particular, as early as 1936. Washington was approached to help solve the pressing needs of many local and national constituencies. The compromise hammered out by Congress and signed by President Kennedy in 1962 explicitly provided for the retention of the ranches in a designated pastoral zone, with ranchers signing 25-30 year reservations of use and occupancy leases, and special use permits for cattle grazing. Over the ensuing ten years, NPS acquired the 17 remaining operating ranches and the property of the abandoned ranches.

In 2002, six historic Shafter / Howard era dairies are operating in the park. An additional nine occupied historic ranches and former ranch sites run beef cattle. The Pierce Point Ranch on Tomales Point ceased operations in 1973. Three years later, Congress authorized creation of the wilderness area incorporating that ranch as habitat for the reintroduction of tule elk. Beginning in 1980, NPS invested in the rehabilitation of the ranch core, citing it as the best example of a nineteenth century west Marin dairy ranch. Pierce Point Ranch was added to the National Register of Historic Places in 1985, and was subsequently opened to the public as an interpretive site.

The former "W" or Bear Valley Ranch was early on designated as the new National Seashore's headquarters. Visitors to the Bear Valley Visitor Center pass through the former ranch core, adaptively reused for park administration and support services. The visitor center itself is a new addition, designed to echo the surrounding agricultural landscape and local history. Plans call for seventeen ranches on Point Reyes to be included on the National Register as a historic landscape district.

Imagine what this windswept, fog-enshrouded landscape may have looked like almost two hundred years ago, before the first cattle made their way here. Imagine Coast Miwok coexisting with tule elk, grizzly bear, mountain lion, whales, dolphins, countless birds and their innumerable prey species. Then imagine the early beginnings of these formerly remote ranches as you drive by enroute to the lighthouse or the tule elk preserve. Perhaps you can imagine in 1916 Pierce Ranch school teacher Helen Smith walking into the creamery to scoop a small cup of cream from the cooling pans to pour over her breakfast pancakes. Her experience is a far cry from our contemporary neatly wrapped packages of butter and milk purchased at the local supermarket. If, on your way home from Point Reyes, you should stop to treat yourself with ice cream, don't be surprised if several days ago it started as grass and a cow you just passed.

For more information, refer to *Ranching on the Point Reyes Peninsula: A History of the Dairy and Beef Ranches within Point Reyes National Seashore, 1834-1992*. By D. S. (Dewey) Livingston, National Park Service, 1993, revised 1994. It is available at reference desks of local libraries, museums and university libraries. An automotive tour of the pastoral landscapes in west Marin on cassette tape, produced by Marin Agricultural Land Trust, is available at National Seashore visitor centers. Tours of selected Point Reyes ranches are offered periodically by Marin Agricultural Land Trust.

Natural History of Point Reyes

Point Reyes National Seashore is well known for its amazing biodiversity.

Flora

Point Reyes lies within the [California interior chaparral and woodlands ecoregion](#). In his book *The Natural History of the Point Reyes Peninsula*, Jules Evens identifies several plant communities. One of the most prominent is the [Coastal Douglas-fir](#) (*Pseudotsuga menziesii*) forest, which includes [Coast live oak](#), [Tanoak](#), and [California bay](#) and reaches across the southern half of Inverness Ridge toward [Bolinás Lagoon](#). Unlogged parts of this Douglas-fir forest contain trees over 300 years old and up to 6 feet (1.8 m) in diameter. But despite these large, old trees, the forest may nevertheless be a result of European settlement. The [Coast Miwok](#) people set frequent fires to clear brush and increase game animal populations, and early explorers' accounts describe the hills as bare and grassy. But as the Native American settlements were replaced by European ones from the seventeenth century onward, the forests expanded as fire frequency decreased, resulting in the forests we see today.

Salt, brackish, and freshwater marshlands are found adjacent to [Drakes Estero](#) and [Abbotts Lagoon](#). The other communities identified by Evens are the coastal strand, dominated by European beach grass (*Ammophila arenaria*), [ice plant](#) (*Carprobrotus edulis*, also called [sea fig](#) or [Hottentot fig](#)), [sea rocket](#) (*Cakile maritima*) and other species that thrive on the immediate coast; [northern coastal prairie](#), found on a narrow strip just inland from the coastal strand that includes some native grasses; coastal rangeland, the area still grazed by the cattle from the peninsula's remaining working ranches; [northern coastal scrub](#), dominated by [coyote bush](#) (*Baccharis pilularis*); and the intertidal and subtidal plant communities. Point Reyes is home to the only known population of the endangered Sonoma spineflower, [Chorizanthe valida](#).

Bishop Pines (*Pinus muricata*)

Background:

The jagged coast of California was once littered with groves of majestic Bishop Pine trees thriving in the rainy winters and foggy summers typical of the coastal weather. Today they exist in scattered coastal communities from Humboldt County south to Santa Barbara. Fossil records, however, show that they once populated a much more expansive area. Bishops grow almost exclusively on granitic soils with rapid permeability and low water capacity. In fact, the granite rocks of Point Reyes which play host to one of the largest Bishop Pine forests in California are incredibly similar to those of the Santa Lucia Mountains near Monterrey; supporting the theory that the Point Reyes Peninsula has migrated hundreds of miles along the coast over millions of years, grinding northwest along the San Andreas Fault inch by inch.

Description:

Depending on the soil, slope, and climate Bishop Pines can adjust their shape and growth pattern. They may grow tall and lanky with very few branches and in close proximity, or, in areas where they have room to spread out from one another, they tend to branch out broadly, twisting and turning with the gusts of wind that howl through the trees. All Bishops have thick dark gray bark with 2-3 inch long asymmetrical cones and needles 4-6 inches long in bundles of two. Bishops can grow 40-80 feet tall with a diameter of two or three feet.

Point Reyes:

Along the north end of the Inverness Ridge in Point Reyes grows one of the most expansive groves of Bishop Pine trees in California. The dense forest covers 7,000 acres across two parks: The Point Reyes National Seashore and Tomales Bay State Park. Many of these trees growing in thick swaths came from seeds released after the 1995 Mt. Vision fire.

The grove is predominantly Bishop Pines mixed with lesser populations of other coast-loving trees including California Buckeyes, Madrones, and the occasional Coast Live Oak casting their shade over dense shrubbery such as Huckleberry, Manzanita, and Bush Lupine.

Eelgrass (*Zostera Marina*)**Description:**

Eelgrass is arguably one of the most critical factors of the Point Reyes marine habitats in Tomales Bay and Drakes Estero. Forests of eelgrass are 10-100 times richer in animal life than adjacent habitats and provide an essential food source for invertebrates and fish as well as foraging grounds for migratory birds. Eelgrass migrated from land to water over 65 million years ago, and remains one of only two true flowering plants to thrive in the harsh marine environment.

Food Source:

Eelgrass supplies the basis for an extremely rich marine food pyramid: microscopic organisms such as diatoms, shelled protozoans, bryozoans, and several types of algae graze on eelgrass blades as their main nutrient source. They in turn are eaten by larger organisms which are consumed by small snails and shrimp which are then gobbled up by even larger organisms and so on. As many as 20 species of commercially viable fish rely on eelgrass in some form or another.

In addition to supporting fish and birds, eelgrass sustains other species that rely on detritus, algae and other food resources available in eelgrass beds. Invertebrate species such as clams, shrimp, snails, nudibranchs, amphipods, worms, and bryozoans consume tiny algae that grow on eelgrass blades, and filter detritus and phytoplankton from the water. In turn, these animals provide food for many other animals that live and/or feed in eelgrass beds. It is estimated that

approximately 20 species of commercially valuable species feed in eelgrass beds at some point in their lives, including Dungeness crabs, rockfish, salmon and Pacific herring

In September, blades of eelgrass break away from their roots and sink to the bottom or break down into detritus, or tiny particles suspended in water. The detritus attracts fungi and bacteria which are then consumed by filter feeders such as clams and scallops.

Habitat:

Eelgrass tends to grow in thick meadows in the calm, gentle waters of bays and estuaries. It is an especially important habitat for several organisms living in Tomales Bay and Drakes Estero. Various species of Sea Hares live exclusively in eelgrass beds. Phyllapsia Sea Hares attach themselves to the blades and camouflage almost perfectly into the background. California Sea Hares make Eelgrass their home as well, but they swim through the blades to blend in rather than attach to them. Bay Pipefish which are related to the Sea Horse look just like a blade of eelgrass, allowing them to safely evade hungry predators.

Environmental Importance:

Eelgrass serves several important environmental functions as well. Because they grow so close together and the blades interweave, eelgrass beds can actually slow the flow of water, allowing suspended sediments to drift to the floor of the bay and feed hungry bottom dwellers. Eelgrass plays an extremely important role in the maintenance of water quality as well. Just one acre of eelgrass can filter enough carbon from the water to equal 3860 miles driven by a single car and absorb nutrients equal to the effluent of 490 people in a one year time period.

In recent years, there has been a 50% decline in North American eelgrass forests due to increased boating, pollution, dredging and development. This is particularly worrisome because the beds are extremely difficult to restore once destroyed. Only about 10% of restoration attempts succeed for longer than one year.

Point Reyes:

In Point Reyes, Eelgrass forests are especially thick in the center of Drakes Estero, and in Tomales Bay they account for over 5% of the total vegetative population. The density of the blades provides an ideal nursery for Herring, as well as directly or indirectly providing a food source for the wide array of migratory birds that choose Tomales Bay as a resting point on their long annual migration.

Fauna

Due to its multiple ecosystems and its location along the Pacific migratory corridor Point Reyes National Seashore has over 490 recorded species of birds, making it one of the best places for

birdwatching in the United States. The northernmost part of the peninsula is maintained as a reserve for [tule elk](#), which are readily seen there. Point Reyes is home to the second largest harbor seal population in California, and sightings of these curious mammals are common. River otters, bat rays, leopard sharks, jellies, sea hares, octopi, and sea stars are common.

Birds

Cormorants

Double-crested Cormorant (*Phalacrocorax auritus*)

Size:

Length: 33 inches

Wingspan: 52 inches

Weight: 3.5 pounds

Description: The Double-crested Cormorant can be found in almost any open body of water ranging from lakes and ponds to the open ocean. They are dark in color with a pale breast, dark belly, long neck and body, and blunt or hooked bill. The distinctive broad head of this bird makes it a true cormorant. Males have black plumes on either side of the head, giving the bird its double-crested name.

Diet:

The diet of the double-crested cormorant is predominately fish, but occasionally it will eat other aquatic animals or insects. To catch its prey, the bird dives down from the surface and chases the fish underwater, scooping it up in its bill and consuming it.

Nesting and Breeding:

Double-crested Cormorants nest in colonies. The nests are generally bulky and built out of sticks. Often, a cormorant nest will incorporate rope, fishnets, or other plastic debris that the bird finds along the beach. The nests are built in trees or on the ground. When on the ground, chicks will leave the nest and congregate together, returning to their own nest at feeding time. The clutches generally contain 1-7 pale blue, unmarked eggs.

History and Point Reyes:

Double-crested Cormorant populations decreased in the late 19th and early 20th centuries due to increasing human activity along the coast. Their populations are now growing, though they are thought to be a threat to fisheries. Cormorants will often eat the fish right out of the farms, and the industry is currently working out how to protect their fish without causing harm to the birds. In Point Reyes, Double-crested Cormorants can be seen in Tomales Bay, Drakes Estero, or along any of the beaches.

Pelagic Cormorant (*Phalacrocorax pelagicus*)

Size:

Length: 28 inches

Wingspan: 39 inches

Weight: 3.9 pounds

Description:

The Pelagic Cormorant is found exclusively down the Pacific coast along rocky ocean shores. They are generally black or grey in color, with occasional green or purple feathers incorporated on its back, wings, and neck. They have a black face with red surrounding the eyes. The Pelagic Cormorant has a long and slender "broomstick" neck, a small head and very thin bill. It is a Pacific Cormorant, meaning it has a narrow head. They generally live solitary or in very small groups amongst the rocky coastline.

Feeding:

Like other cormorants, Pelagic Cormorants feed on fish and other marine invertebrates. They catch a meal by diving down from the surface, chasing after their prey and catching the fish up in their bill rather than stabbing it.

Nesting and Breeding:

Pelagic Cormorants build their nests into shallow bowls made out of grasses and other seaweed, often incorporating other marine debris, even manmade materials. They use their own guano to hold the nest together and to firmly attach it to the cliff. Clutches are often 1-8 greenish white or bluish eggs.

Point Reyes:

Pelagic Cormorants have a stable population, and can be seen along any rocky coastline in Point Reyes such as the headlands, Chimney Rock, or near the lighthouse.

Brandt's Cormorant (*Phalacrocorax penicillatus*)

Size:

Length: 34 inches

Wingspan: 48 inches

Weight: 4.5 pounds

Description:

The Brandt's Cormorant is found in marine environments all along the Pacific coast. It is dark in color, with a thick neck, a dark blunt or hooked bill and a short tail. It has a pale patch at the

base of the bill and a rounded crown. Its narrow head distinguishes the bird as a Pacific Cormorant.

Feeding:

Brandt's Cormorants are found in coastal waters, large bays, and occasionally estuaries. They eat fish and occasionally squid. A Brandt's Cormorant feeds by diving down from the surface after its prey, and snatching it up in its mouth before consuming its meal.

Nesting and Breeding:

The Brandt's Cormorant roosts and nests in large groups on island shores or steep cliffs and forages for food in the open ocean. The nests are large and round; made of seaweed, dry materials collected from around the colony, even items stolen from other nests, and occasionally trash. The clutches contain between 1-6 pale blue or bluish white eggs.

History and Point Reyes:

The Brandt's Cormorant population is steady, having increased from 1900 to 1970 after receiving legal protection from eggging. In Point Reyes they can be seen along the rocky coast and offshore.

Pelican

Brown Pelican (*Pelecanus occidentalis*)

Size:

Length: 4 feet

Wingspan: 6 feet

Weight: 8 pounds

Description:

The Brown Pelican is a large water bird found along both coasts of the United States. They have a grey or brown body with a grey and orange bill and webbed feet. They tend to prefer warm coastal marine environments and are commonly found along ocean shores and bays.

Nesting and Breeding:

The Brown Pelican breeds primarily on islands and often nest in colonies with other water birds such as herons and egrets. They tend to build their nests in short trees, shrubs or directly on the ground out of sticks and grasses. Clutches usually contain 1-4 eggs which are dusty white in color. Unlike most birds that incubate their eggs with their bodies, Brown Pelicans use their webbed feet to heat the eggs, essentially standing on them. In the 1960's when residue from the pesticide DDT was abundant in coastal waters, Pelicans suffered from eggshell thinning, and

eggs often cracked from the weight of their parents, devastating the numbers of successful hatches.

Feeding:

When feeding, Brown Pelicans spot a fish from the air and then perform an impressive twisting plunge into the water, scooping up the fish in a special pouch in their bill. Once the bird settles, it expels the water from the bill and swallows the fish. Other birds often try to get the fish out of the Pelican's mouth while it is draining the pouch, sometimes even sitting on top of the Pelican's head, ready to snatch the fish out of its mouth.

History and Point Reyes:

In the 1970's, the Brown Pelican was considered endangered. During the 1950's and 1960's they were hunted for their feathers to prevent them from devouring fish local fishermen were depending on. Brown Pelicans were also severely hurt by the effects of DDT which stunted reproduction. In the years since both feather hunting and the use of DDT have been banned, the Brown Pelican has made a spectacular recovery. In 2008 populations in the Farallon Islands hit record highs, numbering over 5,000 birds. In Point Reyes, Brown Pelicans can be seen in any body of saltwater.

American White Pelican (*Pelecanus erythorhynchos*)**Size:**

Length: 5 feet

Wingspan: 9 feet

Weight: 16 pounds

Description:

American White Pelicans are larger and more robust than Brown Pelicans, and therefore lack their agility in flight. They are all white with black flight feathers, and an orange bill, legs and webbed feet. During the breeding season, they sport a flattened protuberance on the top of the bill which goes away during the winter. White pelicans spend the cooler months along the pacific and gulf coasts then migrate in a V formation inland during the summer to breed.

Nesting and Breeding:

When breeding, White Pelicans prefer islands near lakes or steep rocky lake shores to offer protection from predators. Once they pick a mate, they remain with the same mate for the entire season. Nests are built on the ground or in low shrubs out of sticks, grasses and reeds. 2-4 chalky white eggs are laid about a week apart from each other. Like the Brown Pelican, the White Pelican incubates the eggs with their webbed feet.

Feeding:

The White Pelican does not perform spectacular dives to fish like its brown relative. Instead, they dip their head underwater to scoop up fish, crustaceans and amphibians into the expendable pouch inside their bills. They often swim in small groups helping each other out. They swim in an increasingly tighter circle to concentrate the fish into a shallow area to make them easier to catch.

History and Point Reyes:

During the 1960's, American White Pelican populations took a steep decline due to destruction of breeding and foraging habitats and exposure to DDT residue. Since then populations have recovered but they are still classified as protected by the US Department of Fish and Game. In Point Reyes they can be seen during the winter on any large body of water.

Marine Mammals

Harbor Seals (*Phoca vitulina*)**Description:**

The Harbor Seal is a member of the Pinniped family, related to Walruses and Sea Lions. They generally have spotted coats ranging in color from white, grey, black or brown. In some areas, including the San Francisco Bay, many seals take on a reddish color. Scientists speculate that this coloration might be caused by high concentrations of iron or selenium in the bay waters. Harbor Seal's coats are made up of short stiff hairs which they molt annually just after breeding season. The coats provide the seal with no warmth; instead they have thick layers of blubber to insulate them. Adult Harbor Seals grow to be 5 or 6 feet in length and as heavy as 300 pounds. They are known as "true seals" which means they have no external ear-flaps and small flippers. Because of their small flippers, to get around on land they have to flop around on their bellies. In the Pacific, Harbor Seal populations are estimated at about 500,000; with approximately 34,000 living on the California coast.

Breeding:

Female harbor seals give birth every year after carrying their young for about 12 months. In California, pups are born between February and April and weigh about 20-24 pounds. Pups are able to swim right from birth, but will often catch a ride on their mother's back to take a break. In Point Reyes, Drakes Estero provides a crucial nursery for new pups. Between March and July, the estero is full of harbor seal pups and mothers.

Habitat:

Harbor Seals live north of the equator in the Pacific and Atlantic oceans. In the Pacific they range from Alaska all the way south to Baja California. They generally live in near-shore coastal

waters where they can often haul out on rocky islands, sandy beaches and in bays and estuaries. Harbor seals feed mainly on bottom dwellers, schools of fish, octopus and squid.

Harbor Seals spend about 50% of their time on land and 50% in water. They can dive up to depths of 1500 feet and remain submerged for up to 30 minutes. When diving, the harbor seals heart rate and metabolism slow which drops the body temperature and allows the seal to tolerate high carbon dioxide levels. Harbor Seals have a greater volume of blood than land mammals and can retain more oxygen when diving. They also have a high content of myoglobin in their muscles which stores oxygen and prevents oxygen deficiency.

Human Impact:

While swimming in the surf, harbor seals will curiously watch humans on the beach, but when hauled out on land, they are very wary of human interaction. If disturbed, they will quickly rush into the water. If they are disturbed often enough, Harbor Seals will abandon their favorite haul-out sites, or even their pups. When observing Harbor Seals, hikers or boaters should keep a distance to avoid disrupting the seals and never approach a seal on the beach.

Point Reyes:

Point Reyes accounts for approximately 20% of California's Harbor Seal Population. They can most often be seen at the mouths of Tomales Bay and Drakes Estero, Double Point, Duxberry Reef and Bolinas Lagoon.

Land Mammals

Tule Elk (*Cervus elaphus nannodes*)

History:

Tule Elk once roamed the central valley of California in numbers of up to 500,000. Beginning with the Gold Rush of 1849, their numbers were severely depleted due to hunting. In 1874, they had thought be extinct for over four years when several very surprised ranch workers discovered a small group of Tule Elk on their property in central California. The landowner Henry Miller protected these Elk until their numbers had reached 140 in 1905 and they began to overrun his property. The elk began to be moved to different locations, including Tomales Point in Point Reyes in 1978.

Description:

Tule Elk are one of the smallest variations of Elk, weighing about 350 to 500 pounds and reaching heights of 4-5 feet at the shoulders. They sport a dusty brown coat with a dark mane surrounding their necks. The males grow antlers made of bone covered in a velvety coating of blood vessels which nourish the bone as it grows. Annually the elk sheds its antlers and begins to grow a new set. Young bulls have very few points on their antlers, and as they grow older they accumulate more and more points each year.

Breeding:

Tule Elk breed in harems. Dominant bulls each control the right to breed with a group of up to 30 cows. Most Tule Elk bulls remain bachelors their entire lives, while only about 10% of the male population does all of the breeding. When a Tule Elk bull is interested in breeding, he must challenge one of the dominant bulls. The elk use their antlers as weapons to fight for the right to breed. Most often, they are intimidated by the older, larger-antlered bull and back off, but occasionally, after a violent stand-off, a new dominant bull arises.

Point Reyes:

In 1978, two bulls and eight cows were brought to Tomales Point. They survived several years of drought before rains brought an increase in plants to feed on and the population suddenly boomed. When the population began to max out the carrying capacity of the point, a section of the herd was moved to the Limantour area above Drakes Beach. Today, the Tomales Point population reaches up to 400 elk, and the Limantour herd numbers about 100. Currently the park is researching ways to slow down the growth of the herd to ensure resources are not drained. The best place to view the Tule Elk is the Tomales Point Trail beginning at Pierce Point Ranch.

Fish

Bat Rays (*Myliobatis californica*)

The warm shallow waters of Tomales Bay are an ideal home for bottom feeding fish such as bat rays. Bat rays get their name from their large wing-like fins, which they flap to unearth hidden prey on the ocean floor. The bat ray is an [eagle ray](#) found in muddy or sandy sloughs, [estuaries](#) and bays, [kelp](#) beds and rocky-bottomed shoreline in the eastern [Pacific Ocean](#), between the [Oregon](#) coast and the [Gulf of California](#). Bat rays are [euryhaline](#), i.e. they are able to live in environments with a wide range of [salinities](#).

Female bat rays, which are larger than the males, sometimes grow to over 5' in diameter, but are more commonly 3-4'. Both genders have a venomous spine that is used for self-defense against sharks and other predators.

Bat rays feed on [mollusks](#), [crustaceans](#) and small fish on the seabed, using their wing-like [pectoral fins](#) to move sand and expose prey animals. They may also dig trenches up to 20 cm deep to expose buried prey, such as clams. Bat ray teeth are flat and pavement-like, forming tightly-packed rows that are used for crushing and grinding prey—the crushed shells are ejected and the flesh consumed. As with all [elasmobranchs](#), these teeth fall out and are replaced continuously.

They are especially active during late spring and early summer, when they mate and have their young. We can often see the tips of their fins coming out of the water as we paddle. Our Morning at White Gulch tours are an ideal time to go scouting for rays.

Shellfish

Oysters

Oysters, clams and mussels, are 'filter feeders' that can filter up to 50 gallons of seawater per day. They feed on the tiny plankton and micronutrients that exist naturally in the marine environment. Their filter feeding helps to keep the bay water clean and clear which allows other marine life to live and thrive. Oysters are considered a keystone species that naturally help to clean, benefit and support the environments where they grow.

The **Pacific oyster**, **Japanese oyster** or **Miyagi oyster** (*Crassostrea gigas*), is an oyster native to the Pacific coast of Asia. It has become an introduced species in North America, Australia, Europe, and New Zealand.

Description:

The shell of *Crassostrea gigas* varies widely with the environment where it is attached. Its large, rounded, radial folds are often extremely rough and sharp. The two valves of the shell are slightly different in size and shape, the right valve being moderately concave. Shell colour is variable, usually pale white or off-white. Mature specimens can vary from 80mm to 400mm long.

Habitat:

Crassostrea gigas is an estuarine species, but can also be found in intertidal and subtidal zones. They prefer to attach to hard or rocky surfaces in shallow or sheltered waters up to 40 m deep, but have been known to attach to muddy or sandy areas when the preferred habitat is scarce. The Pacific oyster can also be found on the shells of other animals. Larvae often settle on the shell of adults, and great masses of oysters can grow together to form oyster reefs. The optimum salinity for Pacific oysters is between 20 and 25 parts per thousand (ppt), and they can tolerate salinities as high as 35 ppt; at this level, however, reproduction is unlikely to occur. The Pacific oyster is also a very temperature tolerant species, as it can withstand a range from -1.8 to 35°C.

Biology:

The Pacific oyster has separate sexes, but hermaphrodites sometimes do exist. Their sex can be determined by examining the gonads, and it can change from year to year, normally during the winter months. In certain environmental conditions, one sex is favoured over the other. Protandry is favoured in areas of high food abundance and protogyny occurs in areas of low food abundance. In habitats with a high food supply, the sex ratio in the adult population tends

to favour females, and areas with low food abundances tend to have a larger proportion of male adults.

Spawning:

Spawning in the Pacific oyster occurs at 20°C. This species is very fecund, with females releasing about 50-200 million eggs in regular intervals (with a rate at 5-10 times a minute) in a single spawning. Once released from the gonads, the eggs move through the suprabranchial chambers (gills), are then pushed through the gill ostia into the mantle chamber, and finally are released in the water, forming a small cloud. In males, the sperm is released at the opposite end of the oyster, along with the normal exhalent stream of water. A rise in water temperature is thought to be the main cue in the initiation of spawning, as the onset of higher water temperatures in the summer results in earlier spawning in the Pacific oyster.

Life cycle:

The larvae of the Pacific oyster are planktotrophic, and are about 70 µm at the prodissoconch 1 stage. The larvae move through the water column via the use of a larval foot to find suitable settlement locations. They can spend several weeks at this phase, which is dependent on water temperature, salinity and food supply. Over these weeks, larvae can disperse great distances by water currents before they metamorphose and settle as small spat. Similar to other oyster species, once a Pacific oyster larvae finds a suitable habitat, it attaches to it permanently using cement secreted from a gland in its foot. After settlement, the larva metamorphoses into a juvenile spat. The growth rate is very rapid in optimum environmental conditions, and market size can be achieved in 18 to 30 months. Unharvested Pacific oysters can live up to 30 years.

Pacific oysters prepared for culinary purposes

Historical background:

Crassostrea gigas was named by a Swedish naturalist, Carl Peter Thunberg in 1795. It originated from Japan, where it has been cultured for hundreds of years. It is now the most widely farmed and commercially important oyster in the world, as it is very easy to grow, environmentally tolerant and is easily spread from one area to another. The most significant introductions were to the Pacific Coast of the United States in the 1920s and to France in 1966. In most places, the Pacific oyster was introduced to replace the native oyster stocks which were seriously dwindling due to overfishing or disease. In addition, this species was introduced to create an industry that was previously not available at all in that area. As well as intentional introductions, the Pacific oyster has spread through accidental introductions either through larvae in ballast water or on the hulls of ships. In some places in the world, though, it is considered by some to be an invasive species, where it is outcompeting native species, such as the Olympia oyster in Puget Sound, Washington, the rock oyster, *Saccostrea commercialis* in the North Island of New Zealand and the blue mussel, *Mytilus edulis*, in the Wadden Sea.

Production techniques:

Numerous methods are used in the production of Pacific oysters. These techniques depend on factors such as the seed supply resources, the environmental conditions in the region and the market product, i.e., whether the oysters are sold in a half shell, or shelled for meat extraction. Production can either be entirely sea-based or rely on hatcheries for seed supply.

Seed supply:

Most of the global Pacific oyster spat supply comes from the wild, but some is now produced by hatchery methods. The seed from the wild can either be collected by the removal of seaweed from beaches or by hanging shell (cultch in suspension from long lines in the open water. The movement towards hatchery-reared spat is important, as wild seed is susceptible to changeable environmental conditions, such as toxic algal blooms, which can halt the supply of seed from that region. In addition, several pests have been noted as considerable dangers to oyster seed. The Japanese oyster drill (*Ocenebra japonica*), flatworm (*Pseudostylochus osterophagus*), and parasitic copepod (*Mytilicola orientalis*) have been introduced accidentally to aquaculture areas, and have had serious impacts on oyster production, particularly in British Columbia and Europe.

Broodstock:

Pacific oyster broodstock in hatcheries are kept in optimum conditions so the production of large amounts of high quality eggs and sperm can be achieved. Pacific oyster females are very fecund, and individuals of 70-100g live weight can produce 50-80 million eggs in a single spawn. Broodstock adults are held in tanks at 20-22°C, supplied with cultured algae and with salinities of 25-32 ppt. These individuals can be induced to spawn by thermal shock treatment. Yet, it is more common for the eggs from a small sample of females (about six) to be stripped from the gonads using Pasteur pipettes and fertilized by sperm from a similar number of males.

Larval and postlarval culture:

Pacific oysters have a pelagic veliger larval stage which lasts from 14–18 days. In the hatcheries, they are kept at temperatures of 25-28°C with an optimum salinity between 20 and 25‰. Early-stage veligers (<120 nm shell length) are fed daily with flagellate algae species (*Isochrysis galbana* or *Pavlova lutherii*) along with diatom species (either *Chaetoceros calcitrans* or *Thalassiosira pseudonana*). The larvae are close to a settlement stage when dark eye spots and a foot develop. During this time, settlement materials (cultch), such as roughed PVC sheets, fluted PVC pipes, or shells, are placed into the tanks to encourage the larvae to attach and settle. It is common, however, particularly on the US West Coast, for the mature larvae to be packed and shipped to oyster farms, where the farmers set the oysters themselves.

Nursery:

Pacific oyster spat can be grown in nurseries by sea-based or land-based upwelling systems. Nursery culture reduces mortality in small spat, thus increasing the farm's efficiency. Sea-based

nursery systems are often located in estuarine areas where the spat are mounted on barges or rafts. Land-based nursery systems have spat mounted on barges in large saltwater tanks, which either have a natural algae supply or are enriched with nutrients from fertilizers.

Tomales Bay Aquaculture

What is Aquaculture?

Aquaculture is the production of seafood in a controlled environment, such as a fishery or oyster beds. Aquaculture is a steadily growing trend; it currently provides almost half of the seafood we consume globally, a statistic that is constantly increasing. By producing our own seafood locally, we reduce the amount that has to be imported, successfully decreasing the amount of emissions put into the environment by transporting goods from overseas.

Background:

For Centuries before European settlers arrived in Point Reyes, the Miwok Indians had harvested and eaten naturally occurring oysters from Tomales Bay. When the first settlers arrived, however, they considered the native oysters to be too small and began farming larger varieties from the east coast in San Francisco Bay.

Development of Tomales Bay:

In 1875, the same year the train came to Point Reyes, two men named Weinward and Terry brought 17 carloads of eastern oysters and bedded them in the Tomales Bay tidelands near Millerton and erected an odd-looking white picket fence around them to keep away the bat rays. The oysters were said to have “fattened as just as well as in San Francisco Bay” but the experiment was not repeated until years later when San Francisco Bay became too polluted to support oysters any longer.

Establishment of an Industry:

In 1907, Eli Gordon from the Pacific Oyster Company planted 450 acres of eastern seed oysters just north of Point Reyes Station. The little settlement later became a flagstop on the railroad called Bivalve. Soon, daily shipments of oysters began to be sent to San Francisco via train and schooner.

In 1923, a group of businessmen from San Francisco planted beds of oyster seeds north of Millerton and established Tomales Bay Oyster company was established and began competing with Pacific Oyster Company on Tomales Bay. They adopted the method of hanging oysters in bags perfected by Charlie Johnson in Drakes Estero in 1958. In 1934, the California Department of Fish and Game issued a 6,000 acre shellfish water bottom lease in Tomales Bay, Drakes Estero, and Limantour Esteros. When the National Seashore was established in the 1960's, the permit for Limantour Estero was eliminated.

Point Reyes Aquaculture Today:

Three commercial oyster farmers continue to operate today in Point Reyes waters. Tomales Bay Oyster Company and Hog Island Oyster company grow their product within the shallows of Tomales Bay, and Drakes Bay Oyster Company uses the pristine estuary of Drakes Estero to produce its crop. The outskirts of all three operations can be explored by kayak amongst the bat rays and leopard sharks looking to feed on the tasty crabs that frequent the oyster beds.

Bioluminescence

Tomales Bay is one of the rare locations where bioluminescent dinoflagellates are visible. These amazing creatures produce bursts of light when disturbed, putting on an incredible light show. They are best viewed on moonless nights in the darkest areas of the bay. Fish swimming, paddle strokes, and the kayaks themselves generate a magical display.

Bioluminescence is light produced by a chemical reaction in living things, similar to the reaction that occurs when you break a light stick. Other animals that are bioluminescent include jellyfish, squid, fish, fireflies, bacteria, and mushrooms! However, the bioluminescence you see in Tomales Bay is produced by dinoflagellates, which are a very small variety of marine plankton.

Why do they light up?

To be honest, we aren't 100% sure why the dinoflagellates light up. The prevailing theory is that the light acts as a sort of 'burglar alarm'. The light may attract higher predators to the plankton's current threat. Other species use bioluminescence to draw prey to themselves, find a mate, or as a warning.