



# California's Coastal Prairies

A PROJECT OF THE SONOMA-MARIN COASTAL PRAIRIE WORKING GROUP

## Ecology

*Coastal prairies are low-growing – usually less than a meter in height - in areas with summer drought, fog, and frequent and often dramatic disturbances, such as fire, grazing, and burrowing.*

This simple description of the coastal prairie environment identifies a suite of challenges for living in coastal prairie: lack of shelter, drought, grazing, soil disturbance, and fire. Some species may avoid unfavorable conditions, while others tolerate, or even depend on these processes for persistence. To appreciate coastal prairie, it is helpful to understand a few general concepts and specific examples of how organisms tolerate or thrive with disturbance.

### CONCEPTS SUMMARY

- ▶ Grasslands are increasingly regarded as disturbance-dependent habitats, ones that require disturbances, such as drought, fire, grazing, and burrowing, to persist. In many (but not all) grasslands, disturbance prevents shrubs and trees from invading from surrounding areas and converting grasslands to shrubland, woodland, or forest.
- ▶ Species dependent on grasslands often have traits and strategies that allow them to deal with or take advantage of recurring disturbances.
- ▶ Understanding the three basic plant life-history strategies is helpful for appreciating how these species can persist in disturbance prone environments.
  - **Annual** plants usually germinate, flower, set seed, and die within a year. They are quick, aggressive growers and produce small, abundant seeds. Seeds persist in the soil and germinate over many years, spreading risk from drought, fire, grazing and other disturbances across multiple years.
  - **Biennial** plants often complete their life cycle in two years, surviving drought and avoiding grazing during the first year as an inconspicuous basal rosette. “Biennial” plants can wait longer than two years while waiting for weather conditions that enhance reproduction. Many biennials in coastal prairies are introduced.
  - **Perennial** plants may live from several years to many decades. In disturbance prone environments, persistence can be quite a trick since the adult must be able to survive fire, grazing, drought, and soil disturbance. Although many specialized strategies exist, general

disturbance-related approaches include extensive or specialized root systems to store water and nutrients during drought, seed production late in the year as grazing levels decline, and location of growth tissues near the soil to allow resprouting after fire.

## DROUGHT SUMMARY

- ▶ California grasslands (including coastal prairie) grow in a different climate than other temperate grasslands. Most temperate grasslands have a wet summer growing season and a cold winter dormant period. California is one of five regions in the world with a “Mediterranean” climate that is exactly the opposite: dry summer dormant period and wet winter growing season.
- ▶ California coastal prairies enjoy the mildest climate of the California grasslands: high and low temperatures are less severe near the ocean, and summer temperatures are further ameliorated by clouds and fog.
- ▶ Despite a mild climate and extended growing season, coastal prairie plants and animals must survive up to five months with no significant rainfall. Species use a variety of strategies to enhance survival during drought:
  - **Fog Harvesting** – Some perennial grasses in coastal prairie harvest 28-66% of their water from fog.
  - **Deep Water Harvesting** – Perennial grasses generally have abundant roots over a meter (3 ft) in depth. Purple needlegrass (*Nassella pulchra*) can have roots 7 m (20 feet) deep!
  - **Water Conservation** – Most perennial grasses exhibit summer dormancy, when they temporarily suspend visible growth. An example is California melic (*Melica californica*). Other traits that conserve water are long narrow leaves and stems, hairs on leaves, or light grey-green coloring.
  - **Water Storage** – Some perennial forbs store food and water as bulbs, tubers, corms or large taproots.
  - **Avoidance** – Many forbs and grasses are “winter annuals” that germinate in the winter, flower in the spring, and survive as seeds in the soil over the hot, dry summer. Animals, such as elk, move into other more productive habitats.

## FIRE SUMMARY

- ▶ Coastal prairies are sustained by disturbances, such as fire, that prevent invasion by shrubs and trees.
- ▶ When humans arrived in California about 11,000 years ago, they increased the occurrence of fire in coastal areas. Although coastal prairie grasslands may have been more difficult to burn because they remain green for much of the year, there is evidence that Indians regularly burned these moist grasslands.

- ▶ Fire clears thatch, recycles nutrients, creates openings for seedlings, kills colonizing shrubs and trees, and destroys bacterial and fungal pathogens.
- ▶ Some of the strategies that allow coastal prairie species to persist in areas with frequent fire:
  - Buried seeds, such as those of tufted hairgrass (*Deschampsia cespitosa*), survive fires because the soils insulating properties keep the embryo safe from high temperatures reached at or above the soil surface.
  - Growing buds and storage organs (e.g. rhizomes, tap roots, tubers, bulbs, corms) of perennial plants can be insulated from killing heat beneath the soil surface. Tufted hairgrass survives fire by re-sprouting from basal buds located in the root crown.
  - Contractile roots pull bulbs down under the soil as they enlarge protecting them from the heat of surface fires.
  - Burrowing animals often survive fires. Badgers are rarely threatened by fire deep underground in their burrows. Small mammals usually survive fire as well but leave burned areas for areas with intact vegetation.
  - Many animals flee. It is uncommon for mule deer and elk to be trapped and killed by fires. Smaller vertebrates, such as snakes and lizards can survive by seeking refuge under rocks, in rodent burrows, or by fleeing to unburned areas.
- ▶ Species that can survive fire may thrive in post-fire landscapes:
  - Forage (grasses, sedge, rushes, forbs, and browse from shrubs) on burned areas is often more palatable and nutritious for grazing and browsing animals than the forage on unburned areas.
  - Many rare grassland plants depend on fire to stimulate seed germination. These species, usually forbs, are called “fire followers” or “fire annuals” because they thrive in post-fire landscapes and are seldom seen in unburned areas.
  - “Pyrogenic flowering resprouters” flower profusely the first spring after a fire and disperse seeds that germinate the following winter. Examples include the geophytes, such as soaproot (*Chlorogalum pomeridianum*), *Calochortus* spp., *Brodiaea* spp., and Fremont’s death camas (*Zigadenous fremontii*).
- ▶ California’s coastal prairies are distributed from southern California to Oregon, usually within 100 km of the coast and under 350 m in elevation.
- ▶ The main types of landforms associated with California coastal prairie are coastal marine terraces, coastal bluffs, hillside slopes, uplifted grassy bald hills and lowland grasslands.

- ▶ Coastal prairies, like other types of grasslands, are sustained by disturbances that prevent invasion by shrubs and trees (e.g., fire, trampling, digging, wallowing and grazing)
- ▶ California tribes regularly burned coastal grasslands to increase the quality and quantity of grassland resources for their use. Through their burning practices, the extent of coastal prairies and other grasslands increased relative to scrub and forest habitats throughout California.

## GRAZING SUMMARY

- ▶ Coastal prairies are sustained by frequent disturbances, such as grazing, that prevent invasion by shrubs and trees.
- ▶ Coastal prairies evolved with intense levels of grazing and browsing by large and small animals.
  - **Pleistocene Grazers** – In prehistoric times, coastal prairies were alive with large migratory and resident herbivores including mammoths, horses, camels, llamas, and bison that became extinct in the late Pleistocene.
  - **Recent Pre-Historic Grazers**– In the last 10,000 years, more familiar herbivores, such as elk, deer, gophers, and rabbits, were abundant. The effect of small grazers in coastal prairies is often underestimated. Pocket gophers can consume from 18-49% of above ground vegetation and more than 30% of below ground primary production (e.g. roots, bulbs, rhizomes) in some areas.
  - **New Arrivals**– With the arrival of the first Spanish colonists in the 1700s, new grazers entered California grasslands: domestic cattle, horses and sheep, and other grazers, such as elk, declined.
- ▶ Grassland plants show a number of strategies to evade or persist in spite of grazing:
  - **Avoidance**– Flowering culms (stems) lean obliquely or horizontally from the plant to avoid grazers overhead.
  - **Concealment of Reproductive or Growth Tissues** –Many perennial plants store food and water underground as rhizomes, tap roots, tubers, bulbs, corms. (Although this is an ineffective strategy against diggers). Grasses restrict growth tissues (basal meristems) to the base of the plant. When the tops are eaten, the plant continues to grow from the bottom. California oatgrass (*Danthonia californica*) and sun cups (*Camissonia ovata*) hide some or all of their seeds at the base of plant to avoid herbivory.
  - **Compensation and Resistance**– Many grasses respond to grazing with additional growth (tillers, rhizomes or stolons). Rangeland specialists refer to the new lateral growth as “stooling.” Tufted hairgrass (*Deschampsia caespitosa*) can show dramatic stooling in response to heavy grazing. Some grasses form a mat-like sod that is difficult to break up when heavily grazed. Grasses, such California oatgrass

(*Danthonia californica*), have stems with nodes that freely breaking away from the plant leaving the other stems and roots intact.

- **Chemical or Structural Defenses**– Plants also possess a suite of features that make them less palatable to grazers including awns (a spikey projection on grass flowers), spines (e.g., thistles), hairs (e.g., clovers), toxins, or silica. Grasses may have evolved to incorporate silica in their tissues over 65 million years ago as a response to dinosaur herbivory.

## SHELTER SUMMARY

Coastal prairies are low-growing – usually less than a meter in height. Without shrubs and trees, coastal prairies do not have readily available cover or shelter for many species to avoid predators or raise their young. Strategies for finding shelter are variable:

- ▶ **Find What You Can** - Many species use what little cover there is by staying close to large perennial bunchgrasses, forbs, or sedges (e.g., nesting of Northern Harriers). Thatch can also be important cover for many insects and mollusks. Raptors and other birds of prey that hunt in grasslands utilize nearby trees for nesting and cover.
- ▶ **Tunneling** – Burrowing animals, such as badgers and gophers, excavate burrows and tunnels both for shelter and for finding prey. Other organisms, such as crickets, spiders and salamanders, use abandoned burrows.
- ▶ **Surface Tunneling and Canopies** – California Meadow Voles (*Microtus californicus*) create grass tunnels or runways at the surface that provide cover between burrow openings. Grasshopper and Savannah Sparrows cover their nests with a canopy of bent grass.
- ▶ **Camouflage** - Herbivorous insects, such as stick insects, grasshoppers, moths, butterflies and their caterpillars exhibit plant-based cryptic colors to protect them from predator detection.

## SOIL DISTURBANCE SUMMARY

- ▶ Coastal prairies are sustained by disturbances, such as burrowing, that prevent invasion by shrubs and trees.
- ▶ Coastal prairies evolved with intense levels of soil disturbance from burrowing and rooting animals, many of which are now extinct in coastal prairie habitat:
  - **Pleistocene Diggers** – In prehistoric times, huge areas in grasslands may have been dug up by short-faced bears (*Arctodus simus*) and other large herbivore megafauna that went extinct in the late Pleistocene
  - **Recent Pre-Historic Diggers** – In the last 10,000 years, grizzly bears (extinct since 1922) dug up large areas as they foraged for bulbs. California Indians also commonly harvested the bulbs and corms of forbs in grassland areas, a practice now largely discontinued.

- **New Arrivals** –The arrival of Europeans heralded the introduction of wild boar (introduced in the 1500s) and domestic pig (introduced in 1925) which have since hybridized and become the rototilling machines we know today.
- ▶ Animals burrowing for food, such as tubers and roots, may cause the most extensive disturbance due the repetitive and widespread nature of the activity. Burrowing animals of coastal prairie include badger, gopher, mice, voles, skunk, weasel, bear and pigs.
- ▶ Pocket gophers may create some of the most extensive soil disturbance in coastal prairie. Up to 30% of the area in California annual grasslands is covered by freshly excavated soil from pocket gopher activity.
- ▶ Gopher activity can be beneficial to some plants.
  - Gophers create open areas of mineral soil (differing in texture, water-holding characteristics, and nutrient levels from surrounding areas) that enhances seed germination, plant growth, and seed production.
  - Gopher activity can break apart crowded bulbs, creating smaller bulblets and corms that grow into new and separate plants.
  - Gophers move and inadvertently plant large seeds cached in their burrows.
- ▶ Both native and non-native plant species can take advantage of gopher disturbance. Gopher activity has been shown to increase species diversity by creating spaces for plants to grow, and to favor wildflowers over grasses, annual over perennial plants, and introduced annual plants over native perennial and annual plants.