

# Web of Life: Interdependence

- What is a food web?
- What does an ecosystem consist of?
- What are the biotic and abiotic players within an ecosystem?
- What is interdependence?

## Objective

Students will solidify their concept of food webs. Students will understand that ecosystems rely on abiotic factors as well as wild life. Students will be able to describe how all things on Earth are connected.

## Preparation

You will need a print out or have PDF of *Plant and Animal List* ready. At least 1 for each small group of students. Review what a **food chain** is. Give a clear example, maybe have it written for students to reference.

## Delivery

**Part 1: Connection Stories**—Ask students whether or not they agree with this statement, “Everything on Earth is connected.” Call on students who agree and disagree to elaborate. Then ask a non-believer to pick two things they think are **not** connected. Now it’s up to you to tell a story about how these two things are connected—either directly or indirectly (define these for students). Now, students can challenge each other, or themselves, to come up with a connection story for two seemingly disconnected things.

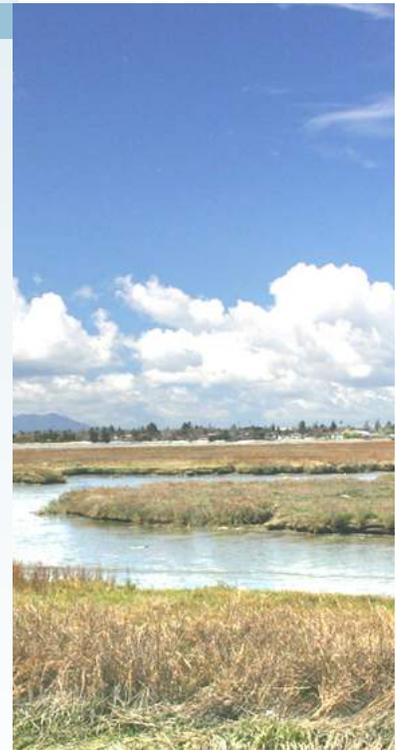
**Part 2: Web of Life**—Now students will work solo or in small groups to make a web of connection between at least 10 species from the *Plant and Animal List*. They will write all ten species of their choice in a large circle around the outside of their sheet. Once they are done they can share with one another and they’ll see how many different webs are all happening at the same time. Now challenge students to include 3 abiotic factors into their Web of Connection. Now challenge students to include humans into their web.

**Discuss** Ask students what would happen if one of the species in their web was taken out due to pollution or loss of habitat? What is it connected to and how will that be affected?

**Part 3: School Yard/Home**—Now that students are experts in the interdependence of all things, alive and inanimate. Their final challenge is to make a Web of Connection in their school yard, at the park, or at home. They will need a yard of string (or longer) and some paper clips, if available (not necessary). They’ll need to find a Web of Connection using direct and indirect effects on the biotic and abiotic factors they find.

## Debrief

- Are all things on Earth connected? Has your opinion changed?
- How do humans fit into these natural webs of connection that we see all over? Do they have a negative or positive affect? Why?
- What are some examples of things that humans do that negatively impact webs of connection? What are some positive examples? How can you positively affect these webs?



### Theme

Ecology: Biodiversity & Food Webs

### Age

4-8th

### Duration

45-60 mins

### Materials

Plant and Animal List, paper, writing utensil, string/cord,

### Standards

NGSS: LS2.A-C; LS4.D  
EP&C’s: P.2-C.A,C ; P.3-C.C ; P.4-C.B,C

### Vocab

**Food Chain:** A ranked group of species where each higher species relies on the one below.

**Food Web:** A system of interlocking food chains.

**Ecosystem:** A community made of all living and non-living things within a given area.

**Abiotic/Biotic:** Non-living/living. Examples would be Soil/Worm.

**Direct/Indirect Relationship:** Hawk eats mouse—direct. Mouse eats grass seed—direct. Grass seed and hawk—indirect.

**Interdependence:** all living and non-living things are dependent on each other.

# Animals of San Francisco Bay

## Mammals

### **Black-tailed Jackrabbit (*Lepus californicus*)**

Found throughout the San Francisco Bay area in salt marshes, open fields, and mountains. Diet consists of grasses, nuts, and seeds. Eaten by owls, hawks, and foxes. Its long ears help to cool it in hot weather.



### **California Ground Squirrel (*Spermophilus beecheyi*)**

Lives in upland burrows that it digs itself, found in dry grasses in the marsh or on levees. Feeds on nuts, seeds, fruit, grasses, some insects, and carrion. Eaten by owls, hawks, and foxes.

### **California Sea Lion (*Zalophus Californianus*)**

California sea lions inhabit rocky and sandy beaches of coastal islands and mainland shorelines. They eat fish, squid, and octopi. Sea lions are adapted for movement on land as well as in the water. Their loud roars explain why they are named after lions that live on land.



### **Harbor Seal (*Phoca vitulina*)**

Graceful swimmer but clumsy on land. Spends part of each day on land, coming ashore at places called haul-outs. Eats one large meal a day, consisting of fish, shellfish, and squid. Eaten by large sharks and killer whales. Habitat includes mudflats, shallow water, bay waters, and sandy beaches.

### **Muskrat (*Ondatra zibethica*)**

Semiaquatic rodent found in North America. Its body, about 30 cm (about 12 in) long, is covered with brown to blackish outer hairs and a dense underfur. The tail, almost as long as the body and nearly hairless, is scaly and flattened laterally; it is used as a rudder in swimming. Its diet is mostly water plants, but it also eats freshwater mussels, other invertebrates, and fish.





**Salt Marsh Harvest Mouse**  
*(Reithrodontomys raviventris)*

Endangered species found only in the salt marshes of the Bay. Feeds exclusively on pickleweed. Brown with a rusty belly. A tiny mouse, it is only 2 1/2 to 3 1/2 inches long. Eaten by birds of prey such as owls, northern harriers, and red-tailed hawks, as well as herons, egrets, and clapper rails.

**Birds**

**American Avocet (*Recurvirostra americana*)**

Head and neck rusty in breeding plumage, gray in winter, black and white wings with white stripe, gray body. Long legs and upturned bill, which is swept side to side through shallow water when feeding on invertebrates. Commonly found in open wetlands, most common in shallow waters. Nests on levees and islands in and around the salt ponds.



**American Coot (*Fulica americana*)**

Dark grey and black duck-like bird with a white bill. Feeds on the shore and on the surface of the water or under it, diving with an upward jump before submerging. Found in freshwater ponds and in sloughs. Large flocks occur on the mudflats. Often called mud hen.



**American White Pelican (*Pelecanus erythrorhynchos*)**

Large bird with black lining of the wings. Breeding adult has pale yellow crest, bill is brighter orange. Does not dive for food, but dips its bill into the water while swimming. Breeding birds may fly 150 miles from the nest to feed. Alternates flapping and gliding while flying.



**Anna's Hummingbird (*Calypte anna*)**

Male's head and throat are a deep rose red. Female's throat has reddish flecks. Both have grayish underparts, washed with green. Feeds on nectar, water, spiders, and tree sap, and is found in open woodland, chaparral, and gardens.



**Barn Swallow (*Hirundo rustica*)**

Iridescent blue back, with a cinnamon colored belly and throat. Most distinctive is a long, deeply forked tail. Nests under bridges, inside culverts or on building walls. Open cup-shaped nest. If it cannot find any mud to create the nest, the barn swallow makes its own by walking in water and then soil. Eats insects while flying.





**Barn Owl (*Tyto alba*)**

Pale face with dark eyes in a heart-shaped outline on the face. Upper parts are rusty brown and underparts vary from white to cinnamon. Nests and roosts in dark cavities in city and farm buildings, cliffs, and trees.



**Black-necked Stilt (*Himantopus mexicanus*)**

The black-necked stilt's glossy black back, bill and back of neck contrast sharply with white underparts (the "tuxedo bird"). Long red or pink legs. Found in the salt ponds, the black-necked stilt is mostly a summer resident throughout California but winters in the San Francisco Bay as well.



**White-tailed Kite (*Elanus leucurus*)**

Long, pointed grey wings, straight, long, mostly white tail and belly, grey back. Black shoulders show in flight. Often hovers (like a kite), flapping wings rapidly while hunting, then dive-bombs its prey. Eats mainly rodents and insects. Seen above marshes and resting on dead trees. Formerly called White-tailed Kite.



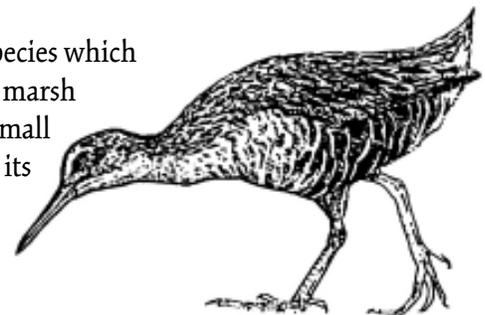
**Brown Pelican (*Pelicanus occidentalis*)**

This large, greyish bird is often seen flying above the ocean or bay. The brown pelican has an 8 foot wing span and catches fish by diving bill first into the water. An endangered species, the Brown Pelican's population declined due to DDT and DDE, pesticides whose use is now banned in the United States.



**California Clapper Rail (*Rallus longirostris obsoletus*)**

Gray-brown marsh bird with cinnamon underside. An endangered species which lives only around the San Francisco Bay. Lives in dense patches of salt marsh cordgrass and pickleweed. Feeds on crustaceans, insects, spiders, mice, small fish, and cordgrass. Clapper rails are eaten by birds of prey and foxes; its eggs are eaten by rats.



**California Gull (*Larus californicus*)**

Adult has dark grey wings and back, white head, dark eye, and a yellow bill with black and red spots. Greenish yellow legs. These gulls, seen often around the salt ponds, mature in four years and acquire different plumage in each of the first four winters.

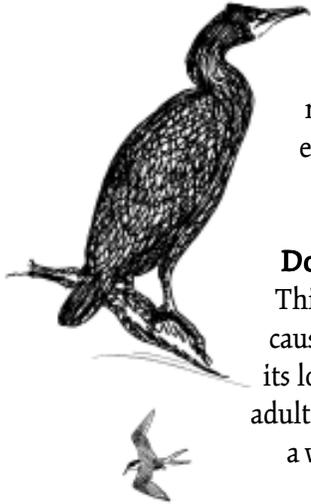
**Canvasback (*Aythya valisineria*)**

Diving duck, with legs set far back on body for ease in diving; makes walking difficult. Male has chestnut red head and neck, white back and sides, dark breast. Female has pale brown head and neck and pale grey back and sides. The canvasback can be found on the open bay, especially in San Pablo Bay.



**Double-crested Cormorant (*Phalacrocorax auritus*)**

Large, rounded throat pouch is orange year-round. Double crests are seldom visible. Kinked neck is distinctive in flight, flies with rapid wing beat. A resident along coast, lakes and estuaries. Body is black throughout.



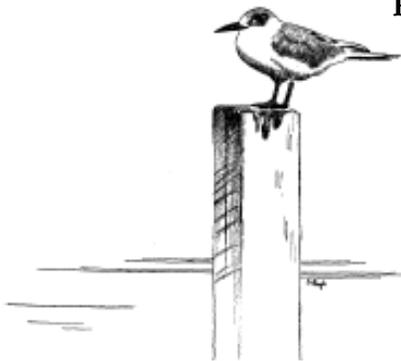
**Dowitcher (*Limnodromus scolopaceus*)**

This shorebird's nickname is the sewing machine bird because of its feeding technique, probing in the mudflats with its long, straight bill. Winter plumage, grayish; breeding adult is entirely reddish below, spotted brown above, with a whitish rump patch. Found in sloughs and mudflats.



**Forster's Tern (*Sterna forsteri*)**

Pale grey above, black crown and nape (back of neck) in summer, red bill with black tip in spring. Orange legs and feet, slow wing beat. Long, deeply forked grey tail has white outer edges. A widespread migrant on seashore bays, inland lakes and marshes. Tends to be quarrelsome with birds of other species, sometimes attacking them viciously to protect its nest. Can be seen hovering and diving for fish in the salt ponds and sloughs.



**Great Blue Heron (*Ardea herodias*)**

One of the largest wading birds in California, standing to 4 feet tall. Slate blue with white head, black stripe extends above eye, white fore neck streaked with black. Graceful and majestic, the great blue heron eats frogs, mice, and fish (spears fish and flips them upwards, catching them in midair). Resident of fresh and salt water marshes and tidal areas.



**Great Egret (*Ardea alba*)**

Large white heron with yellow bill, blackish legs and feet. Stalks prey slowly and methodically. Population was greatly reduced by feather plume hunters (for hats) at the turn of the century. Now population is recovering. Common in marshes and mudflats. Formerly called Common Egret and American Egret.



**American Kestrel (*Falco sparverius*)**

Bird of prey about the size of a robin. Rust colored feathers, bright yellow talons, and a hooked beak. Kestrels have binocular vision, which means their sight range is similar to humans. They live in prairies, meadows, and fields. Kestrels are carnivores. Their main diet is insects, but they also eat small animals such as rats, mice, and lizards.



**Killdeer (*Charadrius vociferus*)**

Two distinctive black or brown breast-bands, bright orange tail and eye ring, black bill. Loud, shrill call that sounds like "kill-dee". Lives in grasslands and estuaries. Can live close to people and has been known to nest on the flat roofs of houses.

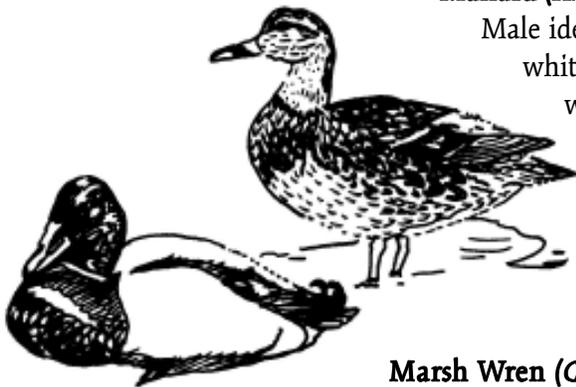


**Long-billed Curlew (*Numenius americanus*)**

Large shorebird (23 inches long) with a cinnamon brown back and lighter breast. The bill is very long and downcurved. Feeds in mudflats with bill, feeding on small mud

**Mallard (*Anas platyrhynchos*)**

Male identified by metallic green head and neck, yellow bill, narrow white collar and chestnut breast. Black tail feathers curl up. Female with molted plumage. Chiefly winters in salt marshes. A "puddle duck" that feeds with its tail in the air and head underwater.



**Marsh Wren (*Cistothorus palustris*)**

Brown crown, bold white eye line, black triangle on upper back, streaked with white, underparts mostly white. Call sounds like a lawn sprinkler (whish, whish). Found in reedy marshes, either fresh or brackish water.



**Northern Harrier (*Circus cyaneus*)**

Distinct white area between the lower back and tail. Wings are long and narrow, with a 4 foot span. Flies close to the ground searching for mice, rats, frogs, rabbits, small birds and other small prey. Commonly found in wetlands and open fields. Formerly called the Marsh Hawk.



**Northern Pintail (*Anas acuta*)**

When feeding, this dabbling duck “tips over” for its meal (plant matter) showing off its long tail feathers. The male has a chocolate brown head and white neck with a dark stripe down the back. Black central tail feathers extend to form a “pintail”. Female is mottled brown, paler on head and neck. Found around sloughs and salt marshes.



**Northern Shoveler (*Anas clypeata*)**

Large, spatula-like bill, longer than head. Male has a green head, white breast and brown sides. Female’s grayish bill is tinged with orange. A dabbling duck found in marshes.

**Peregrine Falcon (*Falco peregrinus*)**

A powerful raptor with a black “helmet” and long, pointed wings. The fastest bird in the world, the peregrine can reach speeds of up to 200 miles per hour, diving from above to kill its prey, usually small to medium-sized birds. The peregrine falcon was recently delisted as an endangered species. Its population has recovered due to federal protection and a national ban on the use of DDT, a pesticide that accumulates in the food chain and weakens eggshells.



**Pied-billed Grebe (*Podilymbus podiceps*)**

Small, stocky brown bird with a black ring around its stout whitish bill, black chin and throat, pale belly. Nests around marshy ponds and sloughs; tends to hide from intruders by sinking like a submarine. Grebes spit up pellets of undigested materials, such as bones, like owls do.



**Red-tailed Hawk (*Buteo jamaicensis*)**

A skilled glider, the red-tailed hawk has broad and fairly rounded wings; plumage extremely variable. All adult red-tailed hawks have a dark bar on the leading edge of the underwing, contrasting with paler wing linings. Reddish upper tail, paler red undertail. Preys on rodents.



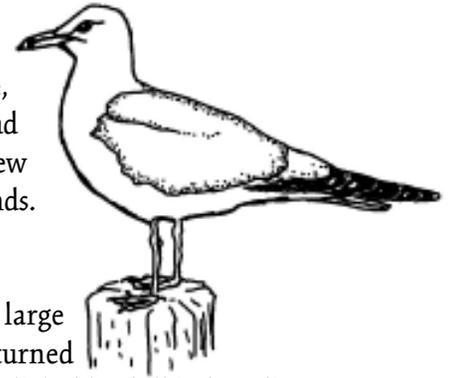
**Red-winged Blackbird (*Agelaius phoeniceus*)**

Glossy black male has red shoulder patches. In perched birds, yellowish border shows. Female is dark brown above, with a streaked belly. May be found singly or in large flocks, usually nesting in thick vegetation of freshwater marshes, sloughs and fields.



**Ring-billed Gull (*Larus delawarensis*)**

Adult has black ring around yellow bill. Greenish-yellow legs, pale-grey mantle, white head and underparts, black primary feathers tipped with white spots. Head streaked with brown in winter. These gulls mature in three years and acquire new and different plumage in each of the first three winters. Found around salt ponds.



**Ruddy Duck (*Oxyura jamaicensis*)**

A chunky, thick-necked duck with large white cheek areas and a stiff upturned tail. Male has rusty sides and a light blue bill in breeding season (April to August). Female is mottled brown. Nests in dense vegetation of freshwater marshes, lakes and ponds. Can be found on salt ponds during winter.



**Snowy Egret (*Egretta thula*)**

White feathers, black bill, black legs with bright yellow feet (these “golden slippers” are used as lures to attract fish). In the breeding season, fluffy plumes curve upward from the back of the head and neck.



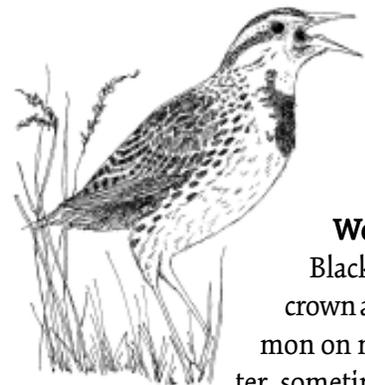
**Turkey Vulture (*Cathartes aura*)**

Seen from below, two-tones wings (flight feathers dark silver-grey, linings black). In flight, wings are often held in an upward, shallow “V” seldom flapping, usually rocking from side to side. Turkey Vultures feed on carrion (dead animals) and refuse. Common in dry open country.



**Western Meadowlark (*Sturnella neglecta*)**

Black V-shaped band on bright yellow breast. Wing upper parts are dark, with lighter edges. Song is a variable series of bubbling, flutelike notes, accelerating toward the end (beautiful)! Common in open country and grasslands, often heard before it is seen.



**Western Sandpiper (*Calidris mauri*)**

Black legs, drooped bill at tip. In summer, back and crown are rusty, in fall the plumage is gray above. Common on mudflats, where it probes at the edge of the water, sometimes submerging its head.



**Western Snowy Plover (*Charadrius alexandrinus nivosus*)**

A threatened shorebird. Pale above and white below, with a thin dark bill, dark legs, and a dark breast band and ear patch. Nests on sandy beaches, dried salt ponds, and salt pond levees. Recognizable by behavior: these small, compact birds dart a short distance, quickly stop, and then run again. Eggs and chicks blend in with sand or levee material, making it difficult for predators to see them.





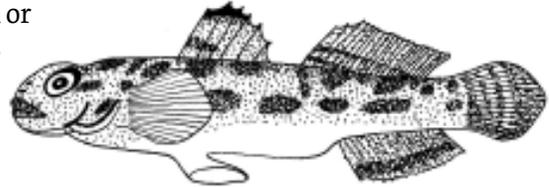
**Willet (*Catoptrophorus semipalmatus*)**

Large and plump when standing, grayish above, belly white. In flight, striking black and white wing stripes are visible. Nests in wetlands, winters in salt marshes and on coastal beaches. Often seen in small flocks.

**Fish**

**Bay Goby (*Lepidogobius lepidus*)**

A bottom-dwelling fish with a "suction cup" under its chin. Tan or pale olive, grows to 4 inches long. Feeds on plankton and detritus, eaten by birds, such as egrets, herons, and terns.



**Chinook**

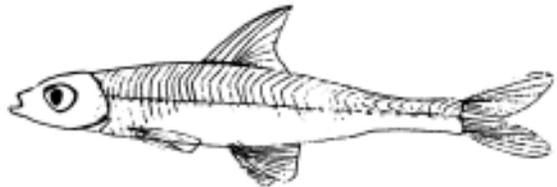


**Salmon (*Oncorhynchus tshawytscha*)**

The largest of the salmon, the chinook can be almost 6 feet long and weigh up to 135 pounds. Chinook have black spots on their back and dorsal fin. Salmon are "anadromous", which means they are born in fresh water rivers or streams, they swim to estuaries or the ocean to grow up, and then return to fresh water to spawn.

**Delta Smelt (*Hypomesus transpacificus*)**

Silvery fish with a faint, speckled side stripe and a small mouth. Grows to about four and a half inches long. Habitat is brackish and fresh water.

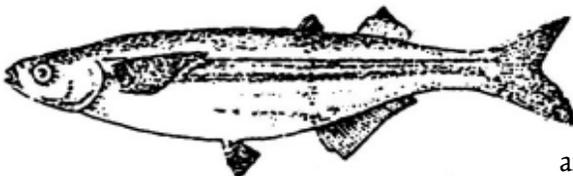
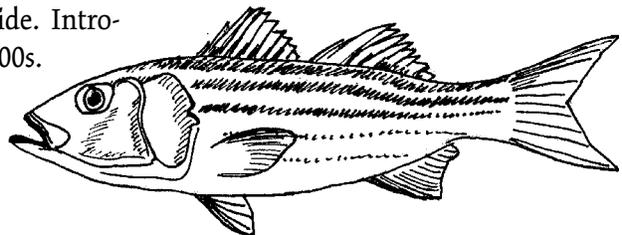


**Leopard Shark (*Triakis semifasciata*)**

This shark is gray above with black spots and crossbars on back and sides, white below. The leopard shark grows to 7 feet and eats a variety of fishes and invertebrates. It is not considered dangerous to humans.

**Striped Bass (*Morone saxatilis*)**

Greenish above, silvery below, with black stripes on the side. Introduced to the Pacific Coast of North America in the late 1800s. A migratory fish which moves along the coast and into rivers in the spring to spawn.

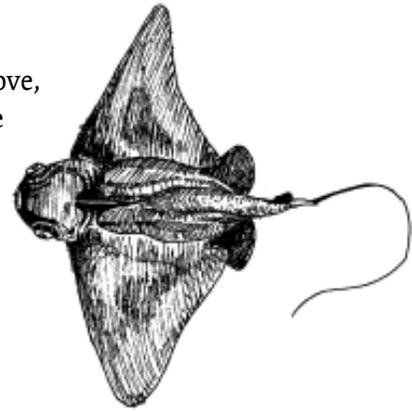


**Topsmelt (*Atherinops affinis*)**

Green fish with a bright silver side stripe; silvery below. Can be up to fourteen inches long. Habitat is bay waters, rocky areas, and kelp beds.

**Bat Ray (*Myliobatis californica*)**

Square head is elevated above wings; color is dark brown to olive or black above, white below; tail is long and whiplike. Grows up to four feet long. Can be seen swimming in sloughs.



**Invertebrates**

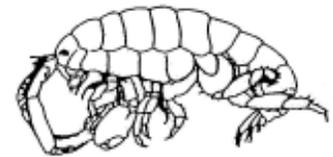


**Western Pygmy Blue Butterfly (*Brevithidium exilis*)**

The smallest butterfly in North America, the pygmy blue has brown wings with a white fringe and blue near its body. Often seen around Australian salt bush. Butterflies peak in late summer and fall.

**Amphipods (*Amphipoda*)**

A crustacean about the size of a pinhead, it is flattened from side to side and has long legs at both ends. Scavenger who feeds on detritus (decomposed plants and animals).



**Isopods (*Isopoda*)**

A tiny crustacean flattened from top to bottom, it has 2 pairs of antennae and four sets of jaws. There are over 10,000 species of isopods living on land, in fresh water, and in salt water. The isopods found in San Francisco Bay are related to the sowbugs and pill bugs you might find in your garden.

**Crabs (*Brachyura*)**

Has claws and four other pairs of legs. Sheds its shell as it grows (molts). Burrows in the mud and feeds upon detritus and plankton. Can move quickly.

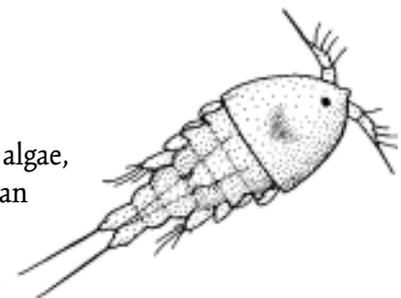


**Clams (*Lamellibranchia*)**

A bivalve of varying size. Uses its muscular foot to burrow in mud. Has two openings in its shell to filter water in order to obtain food.

**Copepod (*Copepoda*)**

Crustacean (like the crab and lobster) which is about 2 mm. long. Feeds on algae, bacteria, and detritus (decomposed plants and animals). Eaten by small fish. Can be found in shallow waters and mudflats of sloughs.





### **Mussels (*Filibranchia*)**

A bivalve that lives on shores attached to rocks by strong threads excreted by a special gland. Lacks head and tentacles. Eats detritus and plankton. Eaten by humans and shore-birds.

### **Polychaetes (*Polychaeta*)**

One of the numerous species of worms living in the mud along the sides of sloughs and on the muddy bay bottom. Some species crawl on the mud or swim, but most build tubes for their home. Eats mud and sand, digesting the organic material and passing the mineral sediments in long, coiled earthworm-like castings.



### **Snails (*Gastropod*)**

Crawls slowly in shallow water, feeding on diatoms scraped off the mud by its tongue. Also eats algae, plant material and clams. Has a single coiled shell and a distinct head and tentacles. Habitat is mudflat in the slough.

### **Ghost Shrimp (*Callinassa stimpsoni*)**

Small creature which burrows in the mudflats. A crustacean, but covered with a flexible cuticle rather than a hard shell. To feed, it sifts through sand to find bacteria, diatoms, and detritus.



## **Wetland Plants of the San Francisco Bay Area**

### **Alkali-heath (*Frankenia salina*)**

This low, sprawling shrub is commonly found in the drier parts of salt marshes, along levees, and other areas with very alkaline soil. The small green leaves are opposite each other and the small pink flowers grow in the leaf axil (the area where the upper side of the leaf meets the stem).

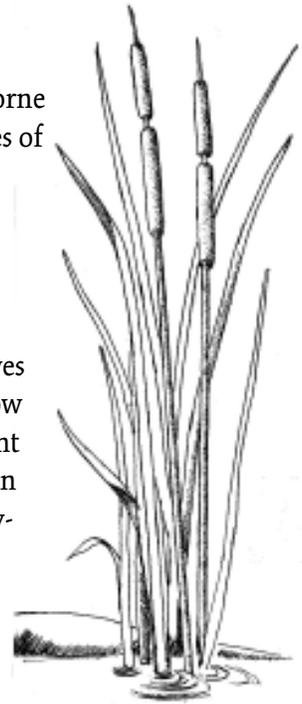


### **Australian Saltbush (*Atriplex semibaccata*)**

The stem of this greenish-gray plant lies along the ground in dense mounds. The flowers are small and inconspicuous and the red, fleshy fruits are edible. This is an important food for the larvae of the Pygmy Blue Butterfly.

### **Cattail (*Typha spp.*)**

Tall upright plants with a 6 to 12 inch cigar-shaped seed head that scatters downy airborne seeds in the fall. Cattails grow in freshwater marshes and provide important sources of food and cover for wildlife.

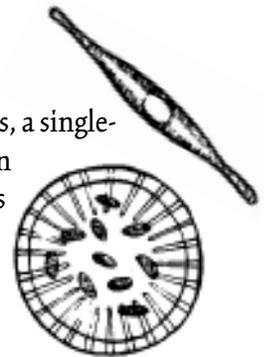


### **Cordgrass (*Spartina foliosa*)**

This plant looks somewhat like a corn plant and lives between the mudflat and pickleweed zones. It can grow up to 4 feet tall and 1 acre produces more usable plant material (biomass) than 1 acre of wheat. Since it can be submerged for up to 22 hours, cordgrass moves oxygen from its leaves to its roots to survive.

### **Diatoms**

A microscopic type of phytoplankton with “pillbox” shaped cases made of silicon. Diatoms, a single-celled algae, account for most of the amazing productivity of salt marshes. The thick golden sheen sometimes seen on the surface of the mud flat is actually a mat of millions and millions of diatoms.



### **Dodder (*Cuscuta salina*)**

This orange, stringy, parasitic plant is found on pickleweed. Small white flowers bloom from June through August. Its leaves are reduced to minute scales. Its common name is Devil’s Sewing Thread.

### **Fat hen (*Atriplex patula*)**

The arrow-shaped leaves of this plant have white crystals on them. Wet your finger, rub one of the leaves and then taste your finger. Can you taste the salt from the leaves? The leaves can be used as a substitute for spinach. Ground squirrels and mice eat the leaves and ducks are very fond of the tasty seeds.



### **Gum Plant (*Grindelia stricta*)**

This low-growing plant is a member of the sunflower family. If you look closely at what appears to be the center of the 1-2 inch yellow gum flower, you will find that it is really many tiny flowers. The plant takes its name from the sticky substance it secretes, especially around the flower heads.

**Ice Plant (*Mesembryanthemum nodiflorum*)**

This low-growing plant is covered with tiny glistening beads that are swollen with water. In the fall, the seeds turn red and sparkle like rubies. This small succulent plant was introduced from Africa in the late 1800s



**Pickleweed (*Salicornia virginica*)**

The compressed leaves of this low-growing marsh plant look like a series of gray-green pickles attached end to end. Pickleweed takes salt water up through the roots and stores the excess salt in the top “pickles”. In the fall, this part turns red and falls off, ridding the plant of the extra salt. Taste a tiny bit of this edible plant, but be sure to leave lots for the salt marsh harvest mouse to eat!



**Salt Grass (*Distichlis spicata*)**

This grass grows in the upper salt marsh. It has stiff, wiry leaves and often grows low along the ground. Look for salt crystals that have been “sweated” out onto the leaves.



**Sea Lavender (*Limonium californicum*)**

Also known as Western Marsh Rosemary, this native marsh plant has wide, oval leaves at the base of tall stems. Small, lavender flowers in bunches at the tops of the stems. Cultivated plants are used in flower displays. Salt can often be found on the leaves.



**Tule (*Scirpus acutus*)**

Long, slender, reed-like plants that are found in brackish and freshwater marshes. Tule are found in dense stands at the edges of sloughs, ponds, and ditches.

