Salt Marsh Vegetation

Examples from the Tijuana Estuary

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Introduction

The salt marsh at Tijuana Estuary is similar to many marshes in southern California. Because so much of the region's wetlands have been destroyed, the remnants are now being protected and public access to many marsh areas is restricted.

Using the Tijuana Estuary in southern California as an example, this booklet describes salt marsh vegetation and explains how marsh plants are able to tolerate the stresses of their variable environment. The booklet is intended to stimulate your interest in California's coastal marshes, and it should be a useful observational tool for visitors to not only the Tijuana Estuary, but also to the Bolsa Chica Ecological Reserve (in Huntington Beach), Upper Newport Bay Ecological Reserve (in Newport Bay), San Elijo Lagoon (in Cardiff), and Los Penasquitos Lagoon (in Del Mar).

We are pleased to make available to the public, information resulting from our coastal resources research.

James J. Sullivan
Program Manager
California Sea Grant College Program

The Tijuana Estuary

What is an estuary?

You may have heard the Tijuana Estuary referred to as a slough, a lagoon, a coastal wetland, or just a salt marsh. Historical place names do not always conform to modern habitat classifications. However, since Tijuana Estuary is a partially enclosed body of water which receives both fresh water (from rainfall and runoff) and sea water (from tidal flushing), it qualifies as an estuary.

What is a salt marsh?

Surrounding the channels and tidal creeks of Tijuana Estuary is an intertidal, vegetated zone known as a salt marsh. This area of wet, salty soils supports several characteristic plant and animal communities. Salt marsh species must survive the challenges of a constantly changing environment that ranges from dry to wet and from fresh to saline.

What is the salt marsh vegetation like?

A good way to find out is to walk through it from the high tide line down to a tidal creek bank. You'll find that the species change as you walk down slope – even though the total change in elevation may only be about a foot! Salt marsh plants are *very* sensitive to the differences in tidal activity and soil salinity that occur with slight differences in elevation.

4 The lowest elevation of the salt marsh is around mean sea level, while the upper extent is about at extreme high water, a range of about five feet. Conditions at the lower elevation are moist and salty because of frequent wetting by the tides. This is in stark contrast with the highest marsh habitats, which are often very dry and low in salts (where drainage is good).

During your walk through the marsh, you will see two basic kinds of plants – large, conspicuous flowering plants and small, easily missed algal mats.

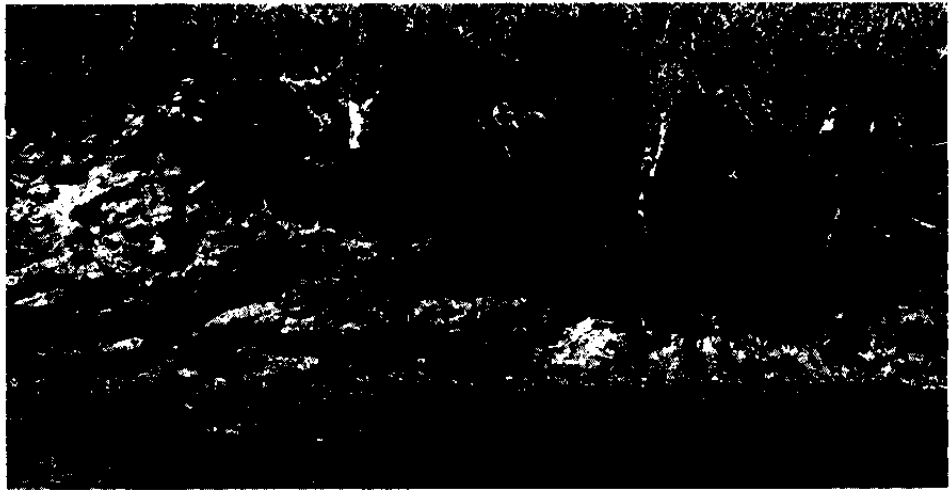
The highest intertidal areas form a transition with the coastal upland vegetation. These areas are the most accessible and hence the most disturbed marsh habitats. The mat-forming lovegrass *(Monanthochloe littoralis)* and the small, shrubby succulent, *Salicornia subterminalis*, are often abundant.

An endangered plant, salt marsh bird's beak *(Cordylanthus maritimus)* grows in this habitat.

6 Intermediate elevations (above mean high water) support a wide variety of species, sometimes as many as a dozen in a quarter square meter. Common are perennial pickleweed *(Salicornia virginica)*, sea blite *(Suaeda californica)*, sea lavender *(Limonium californicum)* and *Jaumea carnosa*. The endangered Belding's Savannah sparrow often builds its nests in the pickleweed.

Low elevations (below mean high water) are dominated by the native cordgrass, *Spartina foliosa*. It grows to a meter or more in height and provides dense cover and nesting material for the endangered light-footed clapper rail.

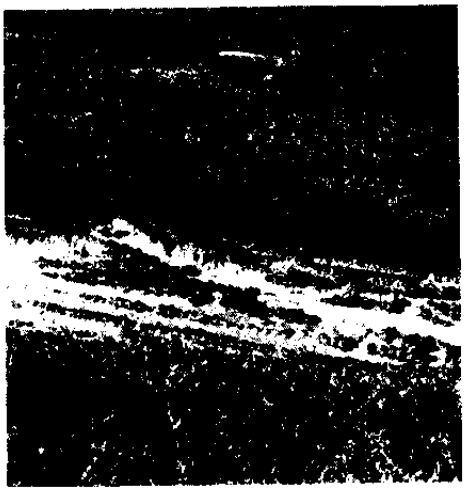
8 Banks of tidal creeks (at about mean sea level) are too wet or have too rapid currents for the establishment of flowering plants. Algal films dominated by diatoms are common here. The mobile diatoms can move into the sediments to avoid being washed away by the tides.



Mudflats support more than just diatoms. The soft sediment houses millions of worms, snails, crabs, and other small animals which are food for shorebirds.

10 **What are the stresses of the salt marsh environment?**

From a plant's point of view, tides and salt are both stressful. In addition, many human activities damage the salt marsh vegetation. Even small disturbances can change the composition of a salt marsh. A single vehicle track or trail of footprints can destroy marsh plants, create a ditch of standing water, or allow invasion of different plant species. Hence, it is important to take great care in walking across marshes to help preserve their features for others to enjoy. Keep vehicles off the vegetation; stay on paths; minimize the area trampled. Unfortunately, the disturbances of offroad vehicles, garbage dumping and landfilling are all too visible in the Tijuana Estuary.



How are tides stressful to salt marsh plants?

Depending on the type of plant considered, tides either provide too much or too little water! Like the problems that beach residents have when high tides and storm waves inundate their homes, the flowering plants of the salt marsh are uncomfortable when submerged by the tide. Being wet isn't the problem, however, since moisture alone is not stressful. Instead, problems develop in the roots of plants. When the soils are saturated with water, it is hard for oxygen to move into the soil. Oxygen moves much more freely in air and in soils with lots of air spaces. So, when water stands for long periods, all the oxygen in the soil becomes used up by roots and animals. In essence, roots undergo the same kinds of stress that we do when deprived of oxygen – they begin to suffocate.

12 While roots do not cough and gag, they DO show reduced growth and, hence, flowering plants do not thrive in soggy soils or in areas frequently submerged by the tides.

Salt marsh algae have just the opposite reaction to tidal submergence. The mats of algae grow very well in moist conditions (they don't have any roots) but are stressed by the dry conditions when the tides recede. Most visitors to salt marshes overlook these important plants, because

they are small and shaded by the flowering plants and because their dark color matches the soil where they grow. But if you hold back the tall plants, you will probably discover a felt-like layer of algae on the soil and on the lower parts of the stems of the marsh vegetation. It takes a microscope to appreciate the beauty of the dozens of algal species found in these mats, but only a careful look to see that the marsh is made up of more than flowering plants.

The algal mats are eaten by the California horn snail, fiddler crabs and shore crabs. Look around the crab holes, and you will see bare soils where crab activities have removed the algae.

14 **How are salty soils stressful to marsh plants?**

Just as the sun crystallizes salt on the skin of ocean swimmers, it concentrates salts in the soils of the salt marsh after the tides recede. Rainfall washes the salts out again, but during our long dry season, the salts keep concentrating until some areas become twice as salty as the sea! Although the winter rains provide temporary relief, the daily tides quickly return the marsh to its usual, saline condition.

The salty soils affect plants in two ways. First, they have a wilting effect by making it difficult for plants to take up water. Second, the salts enter the plant roots along with water and, once inside the cells, they interfere with growth. Sea water is primarily sodium chloride (ordinary table salt), and sodium is toxic to delicate enzyme systems within plant cells.

How do flowering plants tolerate high tides or long periods of submergence?

Since standing water stresses the roots of salt marsh plants by reducing the supply of oxygen, the plants have to find alternative supplies of oxygen in order to survive long periods of submergence. Species which have lots of air spaces within the stems and roots are most successful in meeting the challenge of tidal submergence. Oxygen which is present in the air or which is produced by the green plant parts moves into these air spaces and eventually reaches the roots. Sometimes, when you break apart a clod of marsh soil, you can see how oxygen has moved from the roots into the soil. Usually the soils are black, but around the roots, the oxygen rusts the iron in the soil and you see a halo of orange around the root fiber.

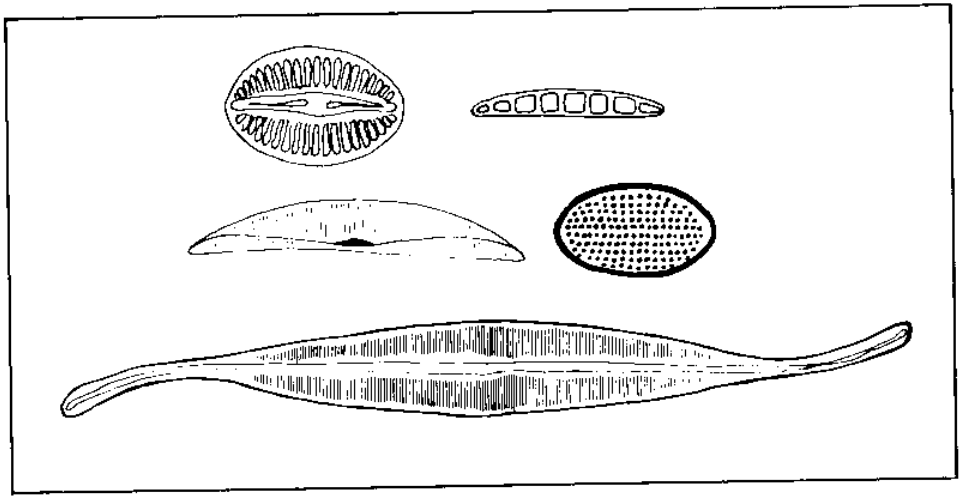
16 **How can algae stand to dry out during long periods of exposure?**

Our bodies don't dry out rapidly because we have a protective layer of skin on the outside. Most algae are too simple in their design for this type of protection – the whole plant may be only one cell or one layer of cells. But these simple cells are capable of producing jelly-like material which acts like a protective skin. If you touch the

blackish algal mats that live on the soil surface, they will feel slimy because of their jelly-like secretions. Rather than to repel your touch, its purpose is to slow the drying process!

Many of the green algae that live in the salt marsh develop only in pools or float on the channel surface. Most of them die when rafted at high water mark.

18 A third type of algae, the one-celled diatoms are able to move through the soil surface. When it's moist, they come to the surface; when it's not, they move into the soil for protection. If you don't believe it, lay a piece of thin tissue over the wet mud of a tidal creek. Come back after a few hours of daylight, and it should be laden with golden-brown diatoms that have crawled through it to reach the light.

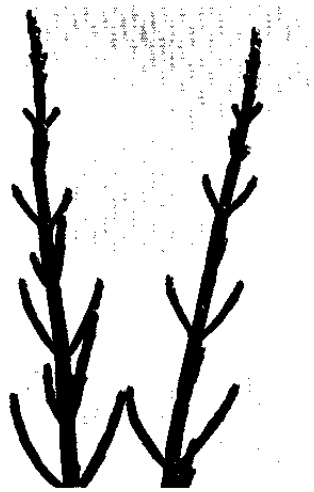


Being simple in structure allows algae to experience lots of water loss without drying. This is especially true of the bluegreen algae, some of which can feel as dry as paper and still be alive. Once returned to a moist environment, they soak up water and resume growth. Our more complex bodies would require days to recover – at best!

How do salt marsh plants tolerate salty soils?

If most plants could stand to grow in salty soils, California would have a lot fewer agricultural problems. But the salts that accumulate in irrigated soils are too stressful for most crops, and yet they aren't as concentrated as in salt marsh soils. The few types of plants that can grow in saline soils are called halophytes, and they use a variety of techniques to deal with the problems of salty soils.

Some halophytes have the ability to pump salts back into the soil, effectively excluding the toxic sodium from reaching damaging concentrations in the plant's growing tissues. The rest take up the salts and deal with them internally. You can easily tell which plants have high concentrations of salt inside – they taste like pickles. In fact, one of the most common salt marsh plants is called pickleweed and was used as a salad plant by Native Americans.



Many halophytes dilute their internal salts by becoming succulent. But this is only a temporary solution to the problem of salt accumulation. Eventually, all plants that take up salt must excrete it or transfer it to inactive tissues.

Salt crystals on the undersides of sea lavender, cordgrass and lovegrass leaves are excreted there by specialized salt glands. One might think of it as perspiration, only with a much higher salt content than we excrete. See if you can identify these salt deposits on the salt marsh plants.

22 Still other halophytes have disposal sites for salts – places where high concentrations of salt will not damage growing tissues. The bulb-like hairs on the native ice plant are good examples. Puncture a "bulb" and taste the liquid.

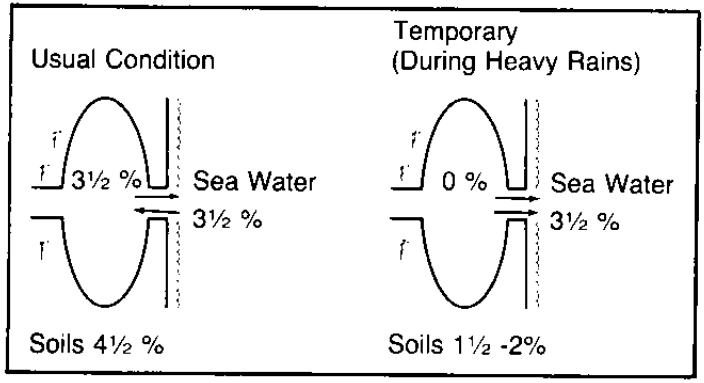
The saltwort drops its older, salt-laden leaves which then float away with the tides.

Do halophytes need salty soils in order to thrive?
No, most do not. Although halophytes grow in soils that are too salty for most plants, they often do much better if watered from the tap. Hence, it is clear that the salt marsh habitat is stressful, and it is understandable why our very saline marsh habitats have low-growing vegetation. But, while the flowering plants are limited by the salty soils, their poorer growth allows considerable light to reach the soils below, and that in turn provides a suitable habitat for algal mats.

24 **How can human activities change our estuaries and salt marshes?**

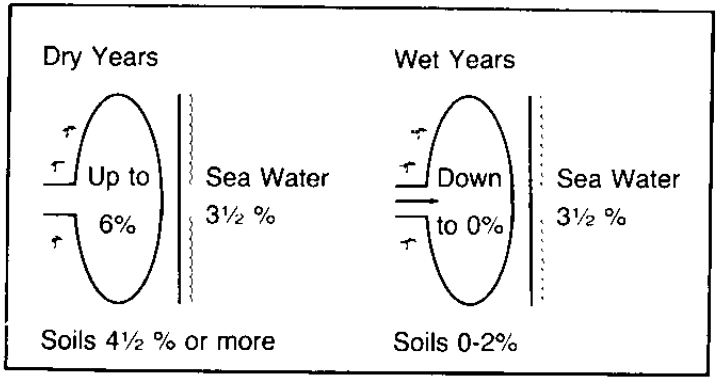
Salt marshes are part of the total estuarine ecosystem, and they owe their existence to the tides. If the tides could not flush the estuary, there would be no intertidal habitat for salt marshes to develop. Instead, the accumulation of rainfall and runoff would lead to freshwater marshes. Because of the importance of tidal activity, any alteration in tidal flow into estuaries can ultimately affect the salt marsh vegetation. Furthermore, the flow of water into and out of estuaries is necessary to maintain an open connection with the sea.

In southern California, road building, dredging, filling, and construction of upstream dams all influence the movement of fresh and salt water into and out of our estuaries. Filling activities reduce the amount of water that can move into the estuary. With less water coming in with the tides, sand builds up at the ocean entrance, and the estuary becomes a nontidal lagoon. If the storms and high tides do not breach the sand bar from the ocean side, or if floods do not wash it out from the landward side, the lagoon will stay closed. Dramatic changes will occur in the salt marsh, but exactly how the marsh changes will depend on how long the sand bar remains and how much rainfall occurs while the lagoon is closed.



TIDAL ESTUARY

During the rainy season, saline channels shift to freshwater; saline soils become brackish.
Conditions reverse after rainy season.



NONTIDAL ESTUARY OR CLOSED LAGOON

Closed lagoons and their marsh soils become hypersaline in dry years, fresh to brackish in wet years. Lagoon waters become stagnant without tidal circulation.

26 If a long drought period follows lagoon closure, the water behind the sand bar will become very warm, salty, and low in oxygen. Fish and shellfish will die; birds will be deprived of their food; floating algal mats will develop – then die and decay. The result will be a very smelly, stagnant water body. In the surrounding salt marsh areas, which were previously intertidal habitats, the soils will become very dry and salty. The soil algal mats will dry out, and flowering

plants will be under both moisture and salt stress.

If rainfall is fairly heavy after lagoon closure, the trapped sea water will become diluted (called brackish). And, if brackish or freshwater accumulates behind the sand bar, the salt marsh soils may also become brackish. This increases the growth of the flowering plants, but may decrease algal growth, both through shading and drying later in the year.

So, there will be changes in the salt marsh if tidal flow is altered, but it is not always easy to predict what direction those changes will take. A short period without tides will have less effect than a long period. A dry spell will affect a closed lagoon differently than a period of heavy rains will.

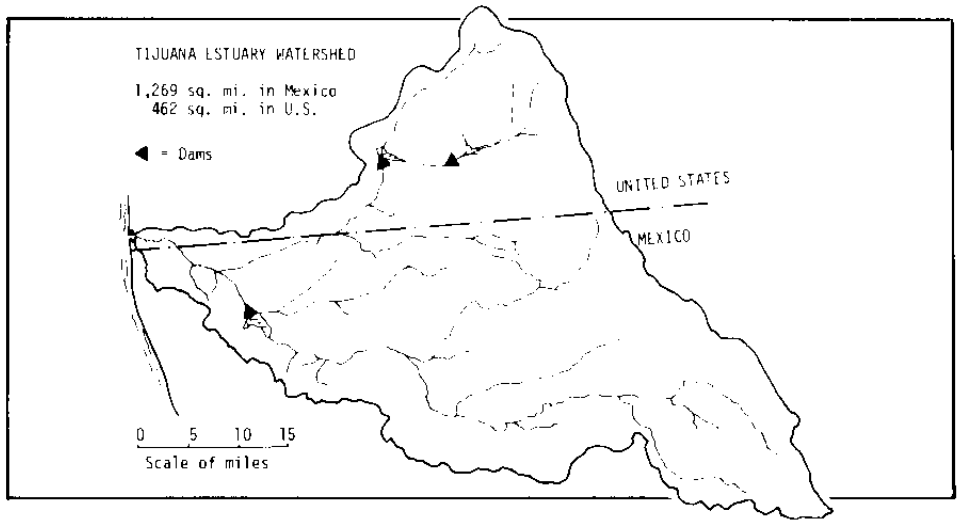
Events in 1980 at the San Diego River flood control channel showed that tidal influence can also be reduced by releasing water from upstream dams. For a long time after the January and February floods, fresh water was allowed to flow downstream, where it pushed back the tides and flooded the salt marsh that grows west of Highway 5. The freshwater flow continued long enough to wash nearly all the salts from the soil. Seeds of freshwater marsh plants also came downstream, and cattails began to grow and flourish throughout the former salt marsh habitat! In a five-month period, the salt marsh

was almost completely replaced by freshwater marsh species. This rapid change in marsh composition demonstrates how sensitive the vegetation is to changes in tidal influence.

These tall cattails grew through the dying pickleweed vegetation at the San Diego River marsh when the soils changed from saline to fresh. Although pickleweed can usually stand freshwater conditions, the long period underwater during the 1980 floods killed large patches, opening the way for invasion by cattails.

Has the Tijuana Estuary changed as a result of man's activities?

Tijuana Estuary is one of the few southern California wetlands that does NOT have a major highway or railroad running through the marsh habitat. There are, however, three upstream dams in its watershed: Morena, Barrett, and Rodriguez. These dams reduce the Tijuana River's



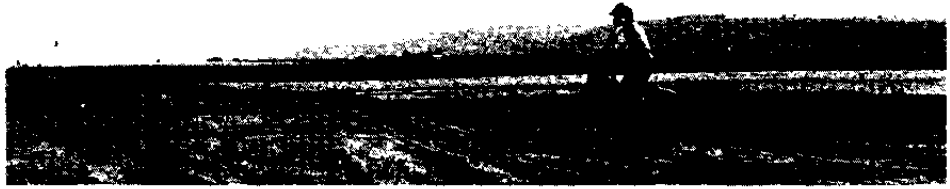
flow, but the ocean connection is usually not blocked by sand. The effects of these dams are hard to determine, because we have no comparable estuary without upstream dams. We suspect that Tijuana Estuary's salt marsh is much closer to its natural condition than other southern California wetlands where tidal flow has been interrupted or reduced.

However, the Tijuana Estuary does have scars which can be traced to human activities. In the

30 upper intertidal marsh areas, especially just south of Coronado Avenue, several types of disturbances are clearly seen. You can see that the area has been used as a casual dumping ground for unwanted concrete, wood, plant trimmings, and junk. Vehicle traffic has removed vegetation from a large area, including space where an endangered plant called salt marsh bird's beak could grow. This lovely plant has flowers that look like an owl's beak.

Elimination of its habitat by disturbances such as dirt bike activity has severely reduced the plant's distribution.

Two large, shallow lagoons on the northeastern part of Tijuana Estuary were once used for sewage treatment. They are connected to the tidal channels by a man-made channel, which is recognizable by its straight course. Natural channels develop curves and meander through the salt marsh.



Can these scars be healed?
Yes. There are several salt marsh restoration projects in California which are demonstrating how to enhance coastal wetlands. The first step is stopping the disturbance. Much of the landscape will then heal itself, given enough time. Or, managers can intervene to speed up the recovery process by resculpturing the topography, planting native species, or encouraging the return of animal populations through habitat manipulation.

However, it is often impossible to return a wetland to its pristine condition. Because most areas have been used or abused by man for hundreds of years, we simply can't determine what they used to be like. Enhancement of wetlands must therefore be based on modern-day ideas about what is natural (ecologists help in this area), what people don't like (mosquitos and stinking lagoons rank high here), and what people want (birds, fish and shellfish are popular).

How salt marshes like those surrounding the Tijuana Estuary are managed, then, depends in part on your understanding of this unique vegetation. This booklet should help you appreciate it as a system of specially adapted plants whose distributions and abundance are keyed to the environmental conditions within a narrow intertidal range, and which interact with one another to form a distinct ecological community.

Marsh vegetation can be artificially established in disturbed areas. Cordgrass (in the author's hand) is being planted along the dike in San Diego Bay. Cages are used to protect plants from grazers.

About the Author

Dr. Joy Zedler is a professor of biology at San Diego State University. Over the past five years, her research in southern California coastal wetlands, and the work of several graduate students, has been supported by the California Sea Grant College Program, the U.S. Department of Interior Fish and Wildlife Service, the U.S. Navy, and the San Diego Unified Port District. Dr. Zedler currently serves as coordinator of the California Sea Grant coastal resources program.

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