

# Tidal Salt Marshes

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## Tidal Salt Marshes

Chemistry- chemically what determines what happens to the vegetation.

Salinity- - -

Nitrogen- - - - -

Phosphorus- - - -

Iron- - - - -

Sulfur- - -

-salt marshes influenced by these factors because they are continually flushed with seawater and have anaerobic soils

Why do plants grow really well or not at all? (Puerto Penasco example in class)

-The Water Table-

Underneath the marsh is an aquifer. Water rises to the surface via capillary action. When water gets evaporated, salts stay behind. The highest salinity is around the pams. The lowest salinity levels are around the low intertidal zone where it is continually flushed by seawater. Rain collects under the dunes and becomes a perched brackish aquifer. However, it is hard for plant roots to get down to this water level ( 40 ft. or more).

-Right above the high intertidal zone is an area called the supralittoral zone. This zone contains lush growth, all salt-tolerant plants, but not necessarily halophytes.

Influences and Adaptations to Salinity:

There is not a precise measurement for salinity because seawater has a mixture of salts. 85% of seawater is NaCl. Seawater is also composed of MgSO<sub>4</sub> (Epsom salt), CaSO<sub>4</sub> (plaster of Paris), bicarbonate, and KCl.

The units for salinity measurement are:

1. ppt - g/L total salts. There are 32-35ppt in the ocean, and 40ppt in desert seas.
2. moles/L - The molecular weight of NaCl is 58, seawater has 500-600 mM.
3. pressure units - the osmotic pressure effect. Distilled water has 0MPa, seawater has - 2-3Mpa. (1 Pa = 1 newton/m<sup>2</sup> .) Pressure can also be expressed in bars, seawater is measured to be 20-30 bars.
4. Electrical Conductivity (EC) - a measurement of how well electricity conducts through water. Seawater has 60 dsm.

### Mechanism of Salt Tolerance:

The problem with seawater is that Na is toxic to cells, and salty water has low water potential. In normal cells the water and solutes inside give the cell turgor and water continues to move into the cell because there is a lower water potential inside. In seawater, the lower water potential is on the outside and water leaves the cell. This creates small, shriveled up cells.

Halophilic bacteria can take seawater into their cells because they have developed enzymes that can tolerate salt.

Algae cells make organic compounds to lower their water potential, which keeps the salts out. Algal enzymes are not at all tolerant of salts.

Higher halophytic plants have developed a vacuole inside of their cells, which will keep NaCl contained, while the cytoplasm has only organic solutes and a low NaCl concentration.

Emergent plants face a special problem due to the large amount of water flowing through them and high transpiration rates. The amount of water that a plant needs to process for growth is 200-500g per g of dry matter. (200 g for C4 plants, 500 g for C3.) It seems that any amount of salt in the water would load the plant with salts. It does not happen this way, plants have developed a very efficient system for filtering out salts at the root system. 99% of the salt is excluded from the plant, and what does get in is put in vacuoles.

### Characteristics of Halophytes:

1. Exclude most NaCl efficiently from roots.
2. Many are C4 (requiring less water).
3. Can store NaCl in cell vacuoles, especially in the leaves.
4. Can excrete salts into the leaves through salt glands or bladders.
5. Can become succulent to dilute or concentrate NaCl as needed.

Can you discuss the different factors that effect salinity?

### Influences of Nitrogen:

Salt marsh vegetation almost always limited by nitrogen. The plants need a lot of it to make proteins, amino acids, etc. Salt marsh vegetation, however, does not get much nitrogen. 99% N -organic (not available to plants because they can not take complex compounds from the soil, slow decomposition without O<sub>2</sub>), 1% N - ammonia (can only use this type of nitrogen), and a little nitrate.

Influences of Phosphorus:

Phosphorus is usually available in high levels. It is not a limiting factor.

Influences of Iron and Other Metals:

These metals tend to be very abundant and can even reach toxic levels (seawater has them, so the metals build up in the soil from continual flushing).

Influences of Sulfur:

Sulfur is an abundant ingredient in seawater ( $\text{MgSO}_4$ -Epsom Salts). When it reaches marsh soils, the sulfur gets reduced by sulfur reducing bacteria. These bacteria, in turn, produce hydrogen sulfide ( $\text{H}_2\text{S}$ -toxic at even low levels, makes that rotten egg smell). It also makes iron pyrites and iron sulfide. When you plow this land, and then try to reclaim it, it gets oxidized, which in turn, makes sulfuric acid ( $\text{H}_2\text{SO}_4$ ) - acidic soils = no growth.

Natural Sulfur Cycle:

Sulfate reducing bacteria=organic matter= $\text{H}_2\text{S}$ =Sulfur oxidizing bacteria=back to beginning

-decomposition of organic matter takes place in this cycle (70 % of decomposition)

-consequences of this includes: 1) lack of  $\text{O}_2$

2) seawater has so much sulfur

Ecosystem Structures and Energy Diagrams: Vegetation and Production in Ecosystem Structure

-how cycles interact in self contained systems ( even though these are not self contained because it interacts with seawater)

Vegetation and Distribution:

Tidal Salt Marshes: *Spartina* (cordgrass) dominates the east and west coasts of North America, making up the main marsh system of the coastal US. *S. foliosa* is found on the west coast, while *S. alterniflora* (smooth cordgrass) and *S. patens* (short cordgrass) are found on the east coast. The reason these species are of so much interest is their high productivity. *Spartina* supports a detrital food chain.

Eugene Odum has done a lot of work with *Spartina* and has developed the concept of tidal energy subsidy. Odum measured the productivity of *Spartina* and found 750 g/m<sup>2</sup> in the high intertidal zone, 2300 g/m<sup>2</sup> in the intermediate zone, and 4000 g/m<sup>2</sup> in the low intertidal zone. This productivity is as high as any agricultural crop, even though *Spartina* faces low levels of nutrients, high salinity, and anaerobic soil. The tidal energy subsidy theory explains that tidal action brings oxygen and nutrients to the plant as well as flushes salts deposited on its leaves.

2 interesting cases of *S. alterniflora*:

1) In the 1970's, this species was brought to the south San Francisco Bay area. It quickly spread all of the way up to Puget Sound, replacing all of the low growing halophytes. Now the coast is dominated by *Spartina* marshes.

2) In the late 1890's, *Spartina* was brought to a marsh in Poole, England. It spread and then crossed with a local species *S. maritima* to make a male sterile hybrid *S. townsendii*. The new species spread vegetatively and doubled its chromosomes to produce another species *S. anglica* that is fertile. All of these species have taken over England's marshes.

Associated species in salt marshes are species that grow in fronts or pockets of the dominant species (usually *Spartina*).

Positive estuaries have a river at the back and get less saline going away from the sea. The true halophytes are found at the front, less salt tolerant wetland plants are found at the back.

In a positive estuary *Juncus*, *Scirpus*, and *Phragmites* colonize the back zone. *Spartina* or mangroves, with patches of halophytes like *Batis* and *Salicornia*, dominate the middle zone. Annual *Salicornia* colonizes the front before *Spartina* can get going; this is because *Salicornia* can easily colonize mud flats.

Negative estuaries are like the Colorado River delta with no current river flow. These areas are saltiest near their backs.

In a negative estuary, the back zone is covered in *Allenrolfia*, *Atriplex*, and *Distichlis*. The front zone has algae and seaweed as well as *Salicornia*.

A salt marsh will typically only have about a dozen species living in it.

In the Gulf of Mexico, the species that are found are *Distichlis palmeria* (Nypa grass or Palmer's grass), and *Salicornia bigelouii* (a succulent annual) in the low zone. The bushes *Salicornia subterminalis* and *Salicornia virginica* occupy the middle zone. There are also the ground covers *Patis maritima*, *Cressa truxillensis*, *Suaeda esteroa*, *Atriplex barclayonia*, *Frankenia grandifolia*, and *Monathochloe littoralis*. In the high zone larger bushes are found such as *Atriplex canescens*, *Allenrolfia occidentalis* and *Suaeda torreyana*.