Ecological site group R004BM200CA
Marshes

Last updated: 03/07/2025
Accessed: 05/10/2025

Key Characteristics

- West of the San Andreas fault line on the Pacific Plate – LRU M
- Hydrologically-influenced, flood-dominated riverine

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

Physiography

This ESG covers the areas within LRU M of MLRA 4B that are tidal estuaries and/or marshlands or were at one time marshlands. They are low elevation, flat areas that extend inland for a varied distance that remain inundated year-round and are strongly impacted by the ocean tides as both source waters and primary disturbance mechanisms.

Climate

The average annual precipitation in this MLRA is 23 to 98 inches (585 to 2,490 millimeters), increasing with elevation inland. Most of the rainfall occurs as low-intensity, Pacific frontal storms. Precipitation is evenly distributed throughout fall, winter, and spring, but summers are dry. Snowfall is rare along the coast, but snow accumulates at the higher elevations directly inland. Fog is a significant variable that defines this MLRA from other similar MLRAs. Summer fog frequency values of greater than 35% are strongly correlated to the extent of coast redwood distribution, which is a primary indicator species in this MLRA. Nightime fog is approximately twice as common as daytime fog and seasonally, it reaches its peak frequency in early August, with the greatest occurrence of fog from June through September (Johnstone and Dawson 2010). The average annual temperature is 49 to 59 degrees F (10 to 15 degrees C). The freeze-free period averages 300 days and ranges from 230 to 365 days, decreasing inland as elevation increases.

Heavy coastal winds are an influential factor in vegetation expression in LRU M that occur primarily in the summer months, explaining the large extent of coastal prairies and coastal scrub species along much of the coastline. Where trees are present along or near the coastline and within the reach of these heavy winds, the tree canopies form unidirectional windswept crowns.

Soil features

The soils are generally fine-textured, have poor drainage and slow decomposition rates, which leads to high rates of organic matter accumulation. There are granitic rocks along with Pliocene and Miocene sandstone and mudstone, and Quaternary sands. Soil temperature regimes are mostly isomesic, with some mesic. Soil moisture regimes are mostly ustic.

Vegetation dynamics

For the purposes of this provisional ESG, all of the areas within LRU M that are marshes or related to marshland dynamics have been grouped into one concept. Further investigation and data collection and information should be gathered to refine these concepts and develop ecological sites from that are more reflective of the finer detailed dynamics of individual ecological sites.

Abiotic Factors

Hydrology is the critical physical factor affecting vegetation in all wetlands, with the predominant hydrological influence in these marshes being tidal fluctuations. Tidal inundation directly affects two important factors for salt marsh plant distributions: soil oxygen status and salinity. At the low ends of the marsh, plants are typically stressed by excessive inundation and anaerobic conditions, whereas the critical factors for plant distributions in the upper marshes are primarily stressed by salinity, competition, or other biotic factors. Both salinity and soil aeration change with elevation and this change is a key factor in determining plant response and distribution. The critical components of tidal hydrology are depth, duration and frequency of flooding. Most often, these components are inferred from tidal elevations when determining vegetation expression, however maximum periods of inundation and exposure to inundation are more crucial than average inundation times.

Freshwater inputs are also a crucial factor dictating vegetation distributions and salt marsh hydrology. This is primarily driven by precipitation inputs and groundwater discharge. The salt marshes covered within this ecological site concept are a combination of both the heavily tidally-influenced marshes where freshwater inputs are rather minimal, and some where they are closer to river headwaters and freshwater groundwater sources that have more limited tidal influence and salinity is much lower. Many of the salt marshes that are further from the coast line and could either be drained or cut off from the coastal waters have become dominated by freshwater sources over time, and tend to more closely resemble the freshwater marsh ecological site concept.

Hydrology drives sediment dynamics, which are what create and sustain these marshlands and dictate the elevations of each marsh community. In most cases the sediments accumulate gradually and are in balance with other processes that affect relative elevation, including sea level rise, subsidence, etc. As a result, these marshes tend to be relatively long-lived and stable. These salt marshes typically have the greatest mineral content in their sediments as well as high organic matter inputs, however many of the salt marshes that are close to the coast line in this ESG are also heavily impacted by the dune sands that blow around and deposit these eolian sands within the marshes as well. Proximity to urban lands, timber harvesting and agriculture from sediment runoff that causes increased sedimentation into these marshes as well and can result in large shifts in vegetation expression due to the changing elevation levels within the marshes.

Soils are another key abiotic factor influencing the plant distributions within this salt marsh ecological site concept. There may be areas of salt marsh near the coast line that will have much coarser-textured soils that drain rather rapidly and have a different chemical composition, due to the eolian sand deposits. These are not typical however, of the bulk of this salt marsh ESG and may need to be recognized in the future as a different ecological site based on these factors. Microbial activity in these salt marsh soils also plays a huge role in the dynamics of this ecological site concept. These marsh soils, soil microbes and hydrology combine to create unique chemical conditions that directly impact vegetation response. As these fine-textured, highly organic soils are flooded, the available oxygen is rapidly depleted. The subsequent microbial demand for an alternative electron receptor other than oxygen during the organic matter decomposition process leads to a series of biogeochemical oxidation-reduction reactions in hydric soils. These low redox conditions lead to the formation of phytotoxic compounds, such as sulfides and denitrification requiring the vegetation that is found in this type of environment to be specially adapted to these types of conditions (Barbour et al, 2007).

Soil salinity is also a critical factor to the soils of this ecological site concept, and is driven primarily through water salinity and evaporation rates. In areas where tidal flushing is frequent, the salinity of soil pore water will be relatively similar to the salinity of the overlying water. However, in the high marsh areas that are not regularly flushed by new waters, the soil salinity is actually much higher than that of the flooding waters that still impact the site, due to evapotranspiration. This process is rather muted in these salt marshes, thanks to the more moderate climates where this ecological site concept is found, however this process will still occur to some degree thanks to the months that are warmer and have limited fog coverage. Spatial and temporal variability of soil salinities are large enough to affect the vegetation patterns of this ecological site concept with relation to elevation and seed germination. There are several species that show significant germination success in high salinity situations, but others that require reductions in salinity during seasons of freshwater influence or recharge in order to get established and withstand the higher saline conditions. Significant reductions in salinity however, can allow the invasion of exotic species that capitalize on the lower salinities and then outcompete for resources once established.

Primary Disturbances

There are few natural disturbances to these salt marshes, outside of the timing, frequency and duration of flooding that regulates the site and keeps the natural dynamics in balance with vegetation adaptability and response. These coastal salt marshes are generally open to the ocean; however this opening will naturally experience events of sedimentation that temporarily close off the marsh from the ocean and create a spit or sandbar between the open ocean and marshes. This will change the dynamics to some degree, but not significantly outside the natural dynamics and stability of the salt marsh. Wrack accumulation (seaweed deposition) and large sedimentation events can also have some impact locally within the areas of the marsh that are in closer proximity to the coastline. Both may bury some plants that are not well adapted to burial, leaving openings for other species that can withstand burial to take those open niche spaces.

Man-made disturbances, such as urban development, levees, timber harvesting and agricultural practices can have significant impacts on the dynamics and vegetative responses leading to state changes that are difficult to reverse without outside inputs in time, labor and money. With many of these outside disturbances large amounts of sediment are added to the system, altering the elevations within the marsh and creating new hydrology-soil-chemical reactions and drainage scenarios that change the ability for certain species that are native to the salt marsh to survive and outcompete other non-native or freshwater native species for niche space. The other significant disturbances that can occur in this system is permanent impoundments that close off the marshes to the tidal influences and salt-water recharge that regulates the system, allowing freshwater from precipitation, fog drip, and groundwater discharge to have a greater influence in the water chemistry. Irrigation from sprinklers in urban environments and from agricultural practices can also change the amounts of freshwater inputs that also change the water chemistry and impact vegetation expression and site dynamics.

Major Land Resource Area

MLRA 004B
Coastal Redwood Belt

Stage

Provisional

Contributors

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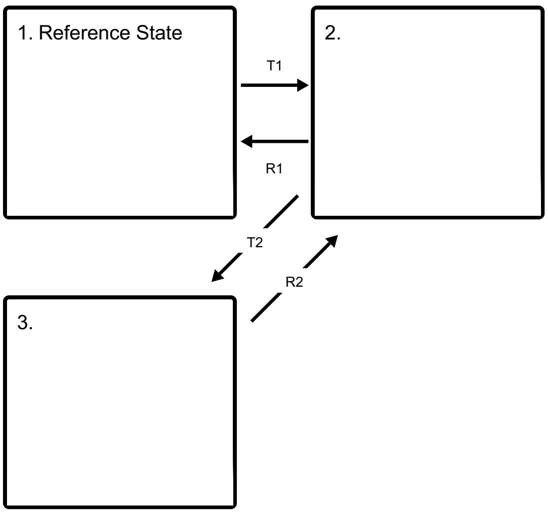
State and transition model

Ecosystem states



State 1 submodel, plant communities

1.1. Reference Community Phase

State 2 submodel, plant communities

2.1.

State 3 submodel, plant communities

3.1. Intensive disturbance

State 1
Reference State

Figure . Tomales Bay (Wikipedia source)

The dynamics described below are general to the level that the site concept has been developed for provisional ecological site concept identification and further investigation purposes only. It is meant to give a general overview of the ecological dynamics of the system and should not be viewed as a model for a specific ecological site level management. It is supported by the current available literature that was reviewed for a general understanding of the system and basic understanding of the abiotic and biotic drivers. Further investigations and soil-site data collection and analysis should be conducted before specific land management can be applied at the ecological site specific scale. This STM only serves to explain the general ecology and dynamics. Reference State (State 1) – the reference state for this ecological site is a complex of vegetation expressions based on proximity to the coast line, salinity levels, and frequency and duration of tidal flooding. The complex interactions between the three factors, plus interspecific and intraspecific competition between plants dictates the cover and distribution of species within this salt marsh concept. This reference state is best represented in the Tomales Bay in LRU M. Due to significant alterations by humans, a very small part of this ecological site is still in the reference state.

Community 1.1

Reference Community Phase

The reference community phase for this ecological site concept is a complex of species divided typically into a low marsh, mid marsh, and high marsh setting, with salt-water emergent natives dominating each elevation of the marsh. Emergent species that have a high tolerance for tidal waves and frequent long durations of tidal flooding are found at the lowest elevations and closest to the coast line and the species with the highest salinity tolerance are found at the high marsh elevations of the salt marshes. As the natural dynamics of flooding, wrack accumulation and sedimentation, fog drip, rain, and groundwater discharge shift throughout each year, these elevations shift and move and the vegetation shift and move with it.

State 2

This state is represented by a less dynamic marsh that no longer experiences the typical flooding events of an open inlet marsh due to permanent closure of the inlet. This shifts the dynamics to either seasonal high water flooding that may be higher in freshwater sources from the upper watersheds in high rain events or man-made water inputs or from daily high tide flooding that overtops the impoundment barrier. This type of dynamic reduces the complexity of species types and distributions and shifts the sedimentation deposition and recharge of salt water. This can create scenarios that are more freshwater dominated as described above due to the inputs from the surrounding watershed or from the precipitation or it can create a scenario where the evapotranspiration rates during the warm, drier parts of the year shift the dominance more towards a more uniform distribution of higher salinity tolerant halophytes.

Community 2.1

This community phase experiences flooding events that will likely be more moderated and less consistent in duration and intensity than those of the reference state community phases that only experience temporary inlet/outlet closures. There will be a more uniform distribution of either emergent species tolerant of more brackish/freshwater conditions or emergent species more tolerant of higher water salinity. There will also likely be more species that are generalists intermixed that can take advantage of the sites new, less complex dynamics. Non-native *Spartina densiflora* (denseflower cordgrass) is a significant species throughout all three elevations of the salt marsh and most dominant in the mid-marsh areas. *Spartina densiflora* does well in this marsh system due to its ability to grow year-round and essentially outcompete most species in these marshes that only grow seasonally. It is more dominant in the mid marsh and higher marsh elevations. *Lepidium latifolium* (perennial pepperweed) is a highly invasive plant that has become dominant in many of the high marsh areas of this ESG as well.

State 3

This state is represented by communities that reflect a more static dynamic of tidal flooding disturbances and results in a shift in primary water source from the salt waters of the ocean to the more freshwater sources from rainwaters and groundwater/surface water discharge and runoff. The changes have occurred due to fragmentation, road networks, dams, urban housing developments, and agricultural practices such as livestock and crops. The alterations are significant enough that the water chemistry and dynamics are more representative of brackish-freshwater marshes that have limited room to shift elevations during tidal events.

Community 3.1
Intensive disturbance

This community phase will be dominated primarily by cattails, pondweeds, and other brackish and freshwater emergent species. It may vary from a rather complex variety of cover and distribution of species much like a marsh might appear, but it also may look more like a pond or wetland depending on how disconnected it has become from the hydrologic functions and dynamics of the ocean tides.

Transition T1
State 1 to 2

This transition occurs through either the natural event of permanent impoundment of the salt marsh through an extremely large sedimentation event that closes off the marsh from the constant flooding events and limits flood impacts to high water events only (creating a backswamp scenario) or through human interventions that result in a similar scenario of cutting the marshes off from their inlet flooding source. This change in hydrology also allows for invasive species to become more dominant when the seed sources are introduced during or after this transition has occurred.

Restoration pathway R1
State 2 to 1

This pathway can occur by reconnecting the marsh with the natural flooding dynamics of the reference state. Especially in the case of naturally occurring sedimentation events that permanently closed off the inlet/outlet of the marsh. Once the sediment has been removed the site should return to its reference conditions fairly quickly. This type of management decision may be costly and may require maintenance if the sedimentation source remains. If there are also invasive species issues, some of the species may not be a problem once the hydrologic function has returned to the system and some may not. A plan to manage and extirpate these invasive species would also be required in the cases where they remain dominant even after the hydrologic functions are returned.

Transition T2
State 2 to 3

This transition occurs mostly from continued man-made impacts that significantly alter the hydrology of this ecological site, through impoundments, increasing freshwater inputs from agriculture or urban developments, and increased sedimentation events.

Restoration pathway R2
State 3 to 2

This pathway may be possible and is entirely determined upon the potential to return some of the original hydrology back to the site. If the freshwater inputs are from man-made sources in the form of irrigation water, surface runoff, etc. finding solutions to limit/reduce these inputs will improve the salinity levels of the site and may shift it more towards State 2 bringing back some of the salt marsh species that are common in higher saline waters. It may be difficult in some cases however, to return the flooding impacts, depending on how the hydrology was disconnected from the site originally.

Citations