Ecological site R016XB001CA
Tidally-Influenced, Salt-Affected

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General information

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.

Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

MLRA notes

Major Land Resource Area (MLRA): 016X–California Delta

16 – California Delta

Most of this area is in the California Trough Section of the Pacific Border Province of the Pacific Mountain System. A small part at the west edge of the area is in the California Coast Ranges Section of the same province and division. This MLRA was originally the conjoined flood plain along the Sacramento and San Joaquin Rivers. As sediment from these rivers built up in San Pablo Bay, a delta formed, creating many streams that divide this nearly level area into “islands.” Strong levees and drainage systems are needed to protect the islands from flooding. Elevation of the islands ranges from below sea level to slightly above sea level. This area is underlain by interbedded marine, estuarine, and fine-grained non-marine sediments transported to the delta by the Sacramento and San Joaquin Rivers as they flowed into San Pablo Bay. As the sediments built up, a delta formed and freshwater mixed with brackish water in marshes and on flood plains. As the marsh vegetation became covered with new sediments, the organic matter content in the soils built up to very high levels. When drained and exposed to the air, these peaty soils oxidize and shrink and then subside.

Classification relationships

Using the December 2010 draft EPA ecoregion level IV: 7j, Delta polygon mostly closely overlaps with MLRA 16.

MLRA 16 mostly aligns with the USFS (1997) ecological subsection 262AI, Great Valley, Delta.

Ecological site concept

This site is a patchwork of salt-affected water-obligate and facultative wet plant communities influenced by the ocean tides. It is found in the lowest positions on the landscape within the LRU, primarily salt marshes and tidal flats. Primary water sources come from the Pacific Ocean, but still mix with the freshwater sources that feed into the ocean from the Sierra Nevadas.

Soils are heavily organic and primarily fine-textured, thermic histosols and entisols. Drainage is very poor to poor and salinity is relatively high and will have significant impacts on vegetation and management response.

Dominated by vegetation that is adaptable to brackish waters, changing water levels and anaerobic soils conditions, primary species consist of salt-tolerant species such as tules (Scirpus spp.) and reeds (Phragmites communis).

Associated sites

R016XB002CA	**Salt-Affected, Stratified, Fluventic** 016XB002 occurs on mineral soils upslope from this site and are best represented by the Valdez soil series and not subject to surface tidal inundation.

Similar sites

R016XA001CA	**Tidally-Influenced, Freshwater** 016XA001 provides a less favorable environment for salt-tolerant wetland species even to the extent that Arundo is more competitive than Phragmites in most of LRU XA.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Scirpus* (2) *Phragmites communis*

Physiographic features

This ecological site occurs in organic and mineral soils from alluvial sources and occurs as many small deltas in the form of an estuary network of islands and channels.

Table 2. Representative physiographic features

Landforms	(1) Estuary (2) Delta
Flooding frequency	Frequent to very frequent
Elevation	0–3 ft
Slope	0–1%
Water table depth	0–2 in
Aspect	Aspect is not a significant factor

Climatic features

Table 3. Representative climatic features

Frost-free period (average)	287 days
Freeze-free period (average)	355 days

Precipitation total (average)	25 in

Climate stations used

- (1) FAIRFIELD [USC00042934], Fairfield, CA

Influencing water features

Soil features

Ecological dynamics

Community Dynamics Section

This ecological site is a complex tidally-influenced riverine complex of marshes, seasonal wetlands and emergent wetland vegetation types of the Suisun Marsh. It is also the most extensive ecological site within the land resource unit making up approximately 87% of identified soils but comprising just 12% of the MLRA. In the most general sense, this historically this site would be a series of islands subject to inundation by runoff and/or tidal waters several times each year.

This ecological site has been subject to some of the most extensive and intensive modification of any lands in the western US. In the late 1800s, agricultural interests initiated the construction of levees along some islands with most of these islands leveed by 1917. Following the leveeing, draining and burning of the hallmark organic soils (histosols) are legendary in the West for food production and having peat surface often exceeding 50’ thickness.

The soils of this ecological site are relatively new arrivals to the landscape with some of the oldest and deepest histosols having been radiocarbon dated to approximately 6,500 years BP (USGS, 2001) and corresponding to increased sea levels at the tail end of the post-Ice Age melt-back. This period of increasing sea level transformed the underlying braided river networks of the current Delta into something more akin to a marine estuary. As a result of river waters meeting marine waters inland, fine sediment loads of the upper watersheds were increasingly deposited over the top of the old riverine system and these histosols developed as sediment and organic matter accumulated.

Under natural hydrology, this ecological site grades upslope into the Salt-Affected, Stratified, Fluventic Sites (R016XB002CA) ecological site which occupies a slightly higher elevation than the flanking organic soils of this site. Unlike the similar Tidally-Influenced, Freshwater Sites (R016XA001), this site is more influenced by salt and less immediately by riverine hydrology. This salt influence is due in large part to the LRU positioned as something of a backwater to the inland watersheds of the Sacramento and San Joaquin rivers but is also by virtue of being closer to the Pacific Ocean on the western front of the constricting narrows between Antioch and Collinsville.

Organic soils support the emergent wetland vegetation (the buildup of organic material occurs through anoxic conditions created by saturated soils). The importance of salt in this context is that decomposition (mineralization) rates of organic materials are increased in the presence of salt water (Weston et. al., 2006), thus likely reducing the rate at which organic soils can build and ultimately limiting the stability of coarse organic materials as found in peaty soils. Unlike with the peaty soils of inland LRU A, the ecological site’s hallmark Joice and Suisun series muck soils display comparatively highly decomposed organic material; these soils may develop recalcitrant cracks upon drying thus complicating both water management and production demands under cultivated conditions.

Soils of this ecological site are subject to subsidence due to oxidation of soil organic matter under the influence of soil aeration. In such cases, unrepaired levee breaches may result in some extents of subsided areas being permanently inundated as in the cases of Franks Tract, Big Break, Mildred Island, and western Sherman Island (Sherman Lake). Complications of salt water influence, water management, economic considerations, and conservation priorities have led much of this ecological site to be managed as waterfowl habitat.

Where constructed levees have been installed across the range of this ecological site, most of the preexisting natural channels and levees have been muted by land levelling but many are still apparent on LIDAR imagery. This

is due in part to differential shrinkage of organic soils relative to the underlying material. Within channels where organic material failed to historically accumulate, oxidation and shrinkage apparently occurs more rapidly than in adjacent areas with deep (>30') peat substrates, thus exposing the underlying topography.

Narrow low elevation natural levees included in this ecological site were historically extensive within this portion of the MLRA. Occurrence of long-lived upland species such as walnut and oak was presumably rare while dominance by single aged stands of cottonwood and willow were more typical where those species could compete with cattail and tule. Such levees were typically a mixture of fine and coarse sediment but unlike the higher elevation levees associated with CA016XA002, these levees were typically subject to regular inundation by tidal waters and consolidation of sediment was largely localized and/or largely unpronounced due to frequent "washing" of the surface sediments and breaching of these levees. As a result of this tidal action, the height of many of these natural levees above the adjacent soils might have been as slight as a few inches or even be apparent only seasonally where tidal action was most influential.

The importance of natural levee height and channel sinuosity relative to vegetative pattern is not fully understood for this ecological site and the range of historic reports mainly focuses on dominant vegetation. However, it is conceivable that a great degree of variability in vegetation across the ecological site could be tied to island and channel hydrology as modified by position and elevation within the watershed. The likely pattern is that the closer to the headwaters an island occurred, the more likely that wider and more stable levees would develop. Considering ar east to west cross section of the MLRA, this would imply a likely decreasing potential for significant oak, sycamore and walnut presence as well as increased turnover of cottonwood in particular as large shallow-rooted trees in such soils eventually topple under their own weight if not by windthrow or force of floating debris.

Vegetation assemblages vary depending on physical drivers. For instance, *Schoenoplectus californicus* was likely more domininant in the western Delta and along channels given its wind and wave reisistent structure, while the taller *S. acutus* grows in more protected areas like those in the north Delta flood basins (Keeler-Wolf pers. comm.). Particularly in the western-central Delta, this habitat type includes woody shrubs such as willow (Salix spp., primarily S. lucida lasiandra) and ferns (Athyrium felix-femina) to make up unique plant community, perhaps related to maritime influences (Atwater 1980, Keeler-Wolf pers. comm.). The wetland species are not precluded by seasonally dry conditions.

Freshwater emergent wetlands can be either tidal or non-tidal. Tidal freshwater emergent wetlands include those areas wetted at mean higher high water during low river stage and comprise what historical records often refer to as tidelands. Non-tidal freshwater emergent wetlands are not directly and predominantly affected by tidal action. However, tides may indirectly affect water table levels in freshwater emergent wetland and hydrological connectivity across landscapes during floods.

State 3 conceivably produces the most vegetative biomass due to agricultural inputs whereas the two preceding states are similar in overall productivity over long periods of time.

State and transition model

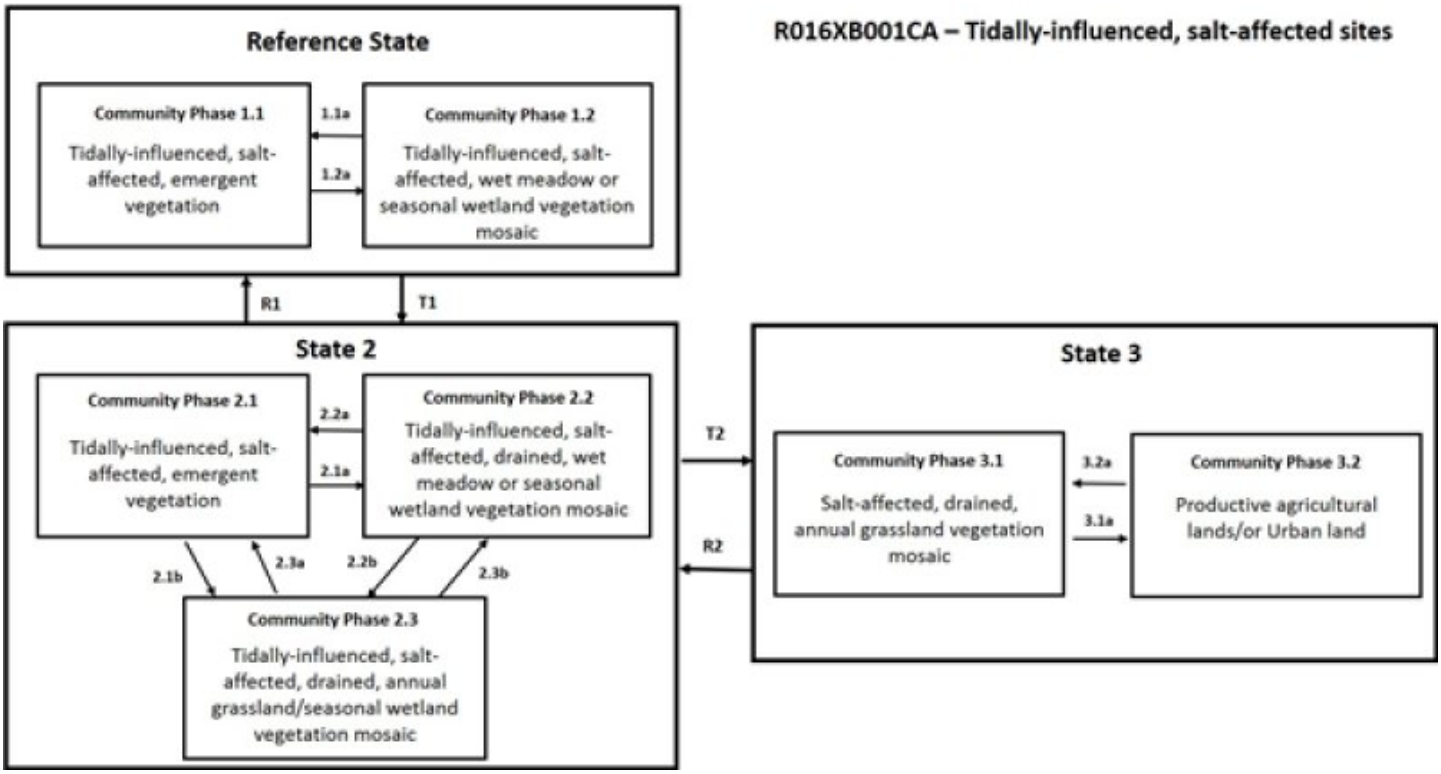

Figure 6. Tidally-Influenced, Salt-Affected Ecological Site

State 1
Reference State

The species composition of the two community phases of the reference state are poorly documented in relation to the site and are better understood at the scale of the land resource unit (LRU) as a diverse mosaic of both marsh and riparian forest vegetation types. Through the influence of both tidal and riverine hydrology, these soils represent both the immediate depositional zone of upstream sediments as well the plant communities most likely to be controlled by high water table influences. This reference state consists two community phases, 1.1 which represents a recently disturbed, inundated and/or deposited soil dominated by pioneering emergent wetland vegetation, and community phase 1.2 representing a less recently disturbed and more diverse mosaic of herbaceous wetland communities. Not surprisingly, this vegetation of community phase 1.2 represents the continuous accumulation of organic material in the soil from onsite vegetation contributions leading to the histosol classification of the representative soils. While most of the LRU has been subjected to significant hydrologic alteration, echoes of these two community phases remain observable in areas which were deemed too economically difficult to reclaim for agricultural purposes or where such efforts to reclaim the land failed and the preexisting hydrology exerted itself.

Community 1.1
Tidally-influenced, emergent vegetation

California bulrush and cattail are clearly dominant species.

Community 1.2
Tidally-influenced, emergent vegetation

Willows species codominant with cattail and bulrush in semi-concentric patterns with willows at the drier extents of perennial wetland areas. Spaces between ponded areas frequently near-monotypic dominance by cattail with occasional extensive stands of willows and/or limited stands of cottonwood trees.

Pathway 1.1A
Community 1.1 to 1.2

Incidental and elevation of soils adjacent to sediment laden surface waters following regular tidal submersion and

sediment contributions from upstream sources.

Pathway 1.2A
Community 1.2 to 1.1

Reorientation of surface hydrology via short-interval flood event.

State 2
Hydrologically Modified Saline Water Complex

The species composition of the two community phases of the reference state are poorly documented in relation to the site and are better understood at the scale of the land resource unit (LRU) as a diverse mosaic of both marsh and riparian forest vegetation types. Through the influence of both tidal and riverine hydrology, these soils represent both the immediate depositional zone of upstream sediments as well the plant communities most likely to be controlled by high water table influences. This reference state consists two community phases, 1.1 which represents a recently disturbed, inundated and/or deposited soil dominated by pioneering emergent wetland vegetation, and community phase 1.2 representing a less recently disturbed and more diverse mosaic of herbaceous wetland communities. Not surprisingly, this vegetation of community phase 1.2 represents the continuous accumulation of organic material in the soil from onsite vegetation contributions leading to the histosol classification of the representative soils. While most of the LRU has been subjected to significant hydrologic alteration, echoes of these two community phases remain observable in areas which were deemed too economically difficult to reclaim for agricultural purposes or where such efforts to reclaim the land failed and the preexisting hydrology exerted itself.

Community 2.1
Tidally-influenced, emergent vegetation

California bulrush and cattail are clearly dominant species while *Phragmites australis* is recognized as a problem in some edges of this ecological site and the LRU primarily along levees.

Community 2.2
Tidally-influenced, marsh seasonal wetland vegetation mosaic

Willows and cottonwood species codominant with cattail and California bulrush in semi-concentric patterns with willows at the drier extents of perennial wetland areas. Spaces between ponded areas frequently near-monotypic dominance by cattail with occasional extensive stands of willows and/or limited stands of cottonwood trees. Alternately, shrub species such as wild rose and blackberry (native and introduced) may occupy areas with historically limited water and may be consistent with slugs of somewhat coarser soils deposited following higher flow events.

Community 2.3
Tidally-influenced, drained, annual grassland/seasonal wetland vegetation mosiac

This is the standout community phase which differentiates this state as distinct from the Reference State. It is characterized by interspersed stands of Mediterranean climate-adapted upland vegetation indicative of dewatering of higher elevation portions of the landscape otherwise punctuated by perennial wetland and to a much lesser degree freshwater marsh vegetation types at the lower elevations. Presence of the upland vegetation portion of the mosaic may pulse over time due to water table fluctuations this community phase with increases during prolonged periods of limited water availability and reduced extents following consecutive years of “surplus” soil water availability. Deep-rooted invasive perennial species such as pepper weed frequently are a problem within the soil moisture transition between pure annual grassland and wetland habitats proper.

Pathway 2.1A
Community 2.1 to 2.2

Incidental and elevation of soils adjacent to sediment laden surface waters following regular tidal submersion and sediment contributions from upstream sources.

Pathway 2.1B
Community 2.1 to 2.3

Draining and pumping of surface waters.

Conservation practices

Dike
Irrigation Water Management

Pathway 2.2A
Community 2.2 to 2.1

Reorientation of surface hydrology via short-interval flood event.

Pathway 2.2B
Community 2.2 to 2.3

Isolation by levee or dike, draining and pumping of subsurface water.

Conservation practices

Dike
Irrigation Water Management

Pathway 2.3A
Community 2.3 to 2.1

Wetland enhancement involving reduced pumping of subsurface waters. Hydrology of adjacent land would likely be effected by this treatment.

Conservation practices

Wetland Enhancement

Pathway 2.3B
Community 2.3 to 2.2

Wetland enhancement involving reduced pumping of subsurface waters. Hydrology of adjacent land would likely be effected by this treatment.

Conservation practices

Wetland Enhancement

State 3
Hydrologically Controlled Agricultural Complex

This state represents a partially controlled hydrology with notably drier soil conditions than historic conditions afforded by the application of levees and in some cases dewatering by pumping or marginally effective gravity drainage. The condition of these areas include some retention of natural topography and native vegetation and is considered here as the representative state. There is potential in any State 2 community phase to restore conditions to the Reference State by removing artificial barriers to hydrology and other more superficial dewatering efforts. Due to the complexity of water flow regulation within the LRU, areas of approximate historic elevation and proximity to natural water flows present the highest opportunity for successful restoration to the Reference State. Restoration of this state in some cases presents unique complications for adjacent land management objectives

which may be influenced by altered hydrology.

Community 3.1
Drained, annual grassland vegetation mosaic

Absence of management following the near total alteration of surface and subsurface hydrology facilitates dominance by Mediterranean climate-adapted annual grassland communities with near exclusive dominance by introduced grass species. Some perennial invasive species such as pepper weed may persist in lowland areas where water collects and soil moisture conditions favor dominance.

Community 3.2
Productive agricultural use/or Urban lands

This community phase is characterized by the highest degree of land use for the ecological site. Vegetation and soils actively managed for agricultural production or has been developed for transportation or structural purposes.

Pathway 3.1A
Community 3.1 to 3.2

Agricultural crop production (or urban development).

Conservation practices

Conservation Crop Rotation
Irrigation Water Management

Pathway 3.2A
Community 3.2 to 3.1

Abandonment of agricultural operations.

Transition T1
State 1 to 2

Partial drainage of the ecological site with modified flood regime leading to longer periods without flooding and more pronounced drying of higher elevations of the ecological site.

Restoration pathway R1
State 2 to 1

Removal of barriers to natural hydrology in areas of the ecological site higher than the mean water table elevation.

Conservation practices

Wetland Restoration
Wetland Enhancement

Transition T2
State 2 to 3

Levee construction and artificial drainage combined with cultivation and/or development.

Restoration pathway R2
State 3 to 2

Removal of barriers to natural hydrology in areas of the ecological site higher than the mean water table elevation

combined with de-levelling of the site.

Conservation practices

Wetland Restoration
Wetland Enhancement

Additional community tables

Other references

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Weston, N. B., R. E. Dixon, and S. B. Joye (2006), Ramifications of increased salinity in tidal freshwater sediments: Geochemistry and microbial pathways of organic matter mineralization, J. Geophys. Res., 111, G01009, doi:10.1029/2005JG000071

Whipple, A, Grossinger, RM, Rankin, D, Stanford, B, Askevold, RA. 2012. Sacramento-San Joaquin Delta Historical Ecology Investigation: Exploring Pattern and Process. San Francisco Estuary Institute, 672: 408 pp.

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Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	
Contact for lead author	
Date	
Approved by	
Approval date	

Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

   _____

2. **Presence of water flow patterns:**

   _____

3. **Number and height of erosional pedestals or terracettes:**

   _____

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):**

   _____

5. **Number of gullies and erosion associated with gullies:**

   _____

6. **Extent of wind scoured, blowouts and/or depositional areas:**

   _____

7. **Amount of litter movement (describe size and distance expected to travel):**

   _____

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

   _____

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

   _____

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

    _____

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**

    _____

12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

    Dominant:

    Sub-dominant:

Other:

Additional:

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):**

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14. **Average percent litter cover (%) and depth (in):**

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):**

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16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:**

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17. **Perennial plant reproductive capability:**
