Critical Tidal Marsh Ecosystem Habitats at the Bay's Margin

A description (December 2013)

by D. Thomson (SFBBO)

with input from: H. Shellhammer (SFSU Emeritus), C. Overton (USGS), C. Sloop (SFBJV), L. Valoppi (USGS-SBSPRP), B. Traut (CCSF), K. Moffett (Stanford), M. Goman (Sonoma State)

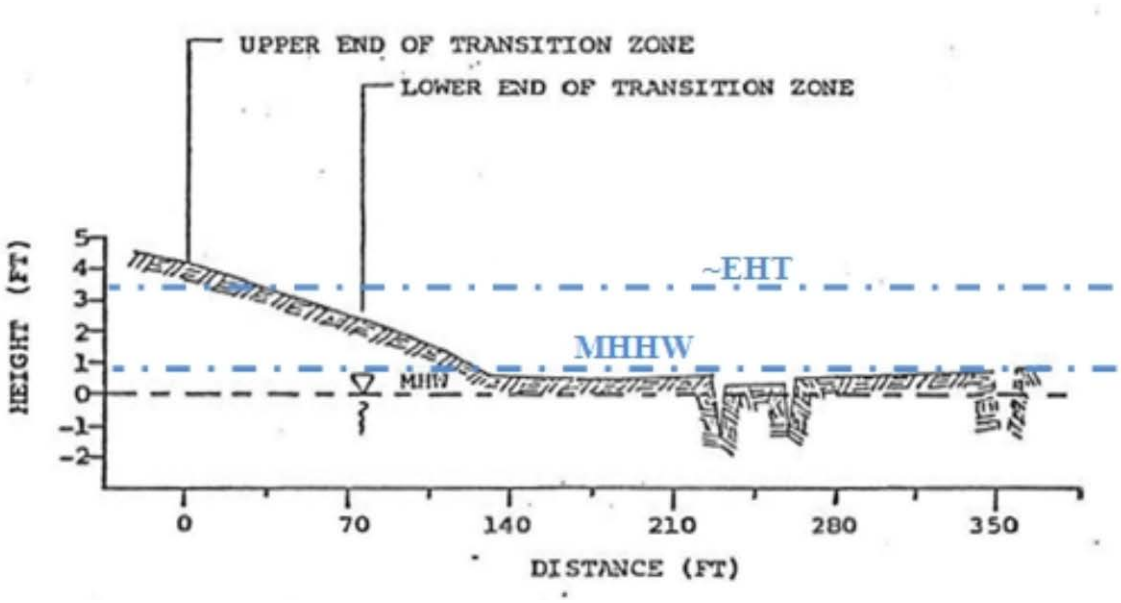

Fig. 1 - Elevations of the transition zone above MHW at Pinole Point, California from Harvey et al. 1978

Author's Note: MHHW & HAT relative elevations are from Redwood City, CA; data was unavailable for Point Pinole, CA.

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Summary

In order to improve management of the Tidal Marsh Ecosystems in San Francisco Bay, a detailed description and characterization of habitats found along the boundary between estuarine and terrestrial systems must be developed. Description and characterization will help clarify which management actions could support the ecological functions needed by the ecosystem. They will guide delineation and assessment of habitats along the Bay's margin, which will be used to develop GIS-based models that further our understanding of their extent and status. And the models will help guide the prioritization of sites for management actions. A goal of this project is promoting ecosystem persistence, in part through maximizing the quantity of transitions given climate change and estuarine response projections, but primarily through maximizing the quality of what can be achieved with limited resources.

Introduction

Recovery of San Francisco Bay's tidal marsh ecosystem is a regional focus for a wide array of agencies and groups. After habitat losses exceeding 75%, the Estuary was estimated to require 100,000 acres of tidal marsh restoration to stabilize the ecosystem (Bay Goals 2000). Work is ongoing, and cost projections exceed one billion dollars over the next 50 years to complete land acquisitions, planning, and implementation of restoration projects (Save the Bay 2007), making it one of the three largest natural resources project areas in the US.

However, these cost estimates do not include consideration of needed habitats above the high marshes. Habitats adjacent to high marsh include transitional habitats between estuarine and terrestrial habitats, also known as tidal marsh-upland "ecotones" (see Appendices), and some portion of the terrestrial habitats beyond the transitions. To be inclusive we refer to all habitats needed by the tidal marsh ecosystem above the zone of strong tidal influence as "the Bay's Margin". These habitats are thought to provide critical supplementary functions for tidal marsh ecosystem fauna (summarized in Josselyn, 1983). They are also, in their own right, habitat for many rare, threatened, and endangered plant species (Baye, 2000). And broad, gently sloping lands may allow the tidal marsh ecosystem to better adapt to climate change. Although estimates of the loss of habitats at the bay's margin are rare (one estimate exceeds 90% - Shellhammer, 1982), it has been disturbed enough to significantly degrade the functions provided to the tidal marsh ecosystem (Baye 2004).

Management guidance (Bay Goals 2000) and the USFWS Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California (Bloom et al 2013) note that these habitats are crucial components of the ecosystem, and require as much attention as tidal marsh. However neither document was scoped with describing their character or assessing their status. While there is at least one contemporary study on them (Traut, 2005), and an analysis of their historic character (Grossinger and Baye 2004), none have provided enough detail to guide their delineation and management. The only example of "design recommendations" is in PWA & Faber (2004), but they only address some topographic characteristics and do not explain their rationale. A complete characterization is required for appropriate delineation, as well as ranking sites for management. A definition of Transition Zones in this context may also help guide management, such as this one proposed by Thomson to the Bay Goals Technical Update (currently in process):

Estuarine-Terrestrial Transition Zone Definition

Estuarine-terrestrial transition zones occupy the boundary between land and sea,
from the zone of regular flooding to the effective limit of tidal influence.
They harbor a unique plant community, provide critical wildlife support to adjacent ecosystems,
and play an important role in linking marine and terrestrial processes.

Developing a Habitat Description (backstory)

We use the term "bay margin" because the description adopted should not conform to the standard definition of Transitions between plant communities. A concept from the science of plant biogeography (from where the Transition concept originates - see Appendix A) is not be suitable for guiding recovery actions within the tidal marsh ecosystem. As the zone of mixing between both adjacent habitats, transitions between estuarine and terrestrial habitats may contain features that are only important to the terrestrial ecosystem, or (as is the case) a portion of the terrestrial habitat could also play a crucial role. Whatever the case, the description needs to develop from functions critical to the tidal marsh ecosystem.

It is also important to point out that it appears the local concept of "ecotone", "transitional zone", or "upper limit of marshes" and their importance to the tidal marsh ecosystem developed from the bottom-up, meaning from organismal biologists rather than top-down from ecosystem ecologists. That has implications for this definition because their importance noted in the management guidance cited above is based on the perceptions of those organismal biologists embodied in the functions compiled below, not on any thorough or widely accepted definition of such habitats. It is reasonable to point out this does not mean a broader, more thorough view is unimportant. Certainly the perceptions of the organismal biologists as published may not be thorough enough to characterize all the functions needed by the tidal marsh ecosystem. But it is also reasonable to point out that the current landscape is too modified for recovery of many functions that have been noted by historical ecologists (ex. the vast alluvial floodplains that once dominated the South Bay). Therefore, the definition and characterization below focuses on organismal biologist's perceptions, but utilizes a broader understanding to inform those views. In Appendix B we present excerpts from publications found during our exploration into regional perceptions.

What specifically are the functions that have been described? Most cite high tide refugia, but it is likely the high marsh found along the slope up from flooded marsh areas beneath the actual transition zone, in addition to any high marsh within the marsh plain, which provides that function (Overton, pers. com.). The only local peer-reviewed study of tidal marsh-upland transitions found high marsh to be (at least part of) the transitional habitat between the tidal marsh and higher elevations (Traut 2005). And some cite the bay's margin as providing refugia from extreme high tide events that flood high marsh vegetation (Albertson, pers. com.). Nevertheless, most tidal marshes in the estuary are too young to have developed high marsh habitat within the marsh plain, and fauna must rely on the slope towards higher elevations for refuge from high tides throughout the year.

The bay's margin is also important because sea levels may rise too quickly for the estuary's marshes to keep pace (Callaway et al 2007). If models and other analyses are correct, marshes appear to be at risk of losing important habitats (such as high marsh) and eventual permanent submergence unless they have room to migrate upslope (i.e. shift their spatial distribution landward as the Bay rises and expands). Therefore, broad expanses of gently sloping open space connected to the tidal zone should be conserved to prepare for this possibility. There would have to be great efforts made to reconnect the Bay with its historic transitions, as they are currently cut off from the tides by salt ponds and other levees. There would also have to be quick action to ensure current planning projects (ex. the USACE Shoreline Study) and other development does not create new barriers to conservation of the tidal marsh ecosystem.

Below is a narrative summary of the description, informed by many specialists and their publications (see citations), and followed by a working list of detailed habitat characteristics. The primary question asked was this: <u>What do you mean when you refer to the tidal marsh ecotone?</u> And what does it mean in the context of your specialty? For example, what does a salt marsh harvest mouse want from a transition? Does it differ for individuals in different parts of the marsh, far from the terrestrial transition? What characteristics would be ideal, such as plant community composition and structure (particularly seasonality), but also landforms, as well as adjacent habitats and their land uses?

Narrative Description

For the purposes of tidal marsh ecosystem recovery in San Francisco Bay, critical habitats at the bay's margin are defined as those occurring between high marsh or the zone of regular flooding, through estuarine-terrestrial transitional habitats (transitions), and some portion of adjacent terrestrial habitats. Their existing and potential extent (i.e. connected to the estuary or behind levees) can be mapped at the landscape level between a half meter above Mean Higher High Water to a few decimeters above the Highest Observed Water Level for the transition zone, and beyond into terrestrial habitats as specified below.

The bay's margin must contain plant communities dominated by native species in order to provide the functions needed by tidal marsh fauna (author's hypothesis). Diversity is critical to proper function (Traut 2005), and impacts to these habitats have reduced their diversity. There is a host of plant species that once thrived in these habitats, and may have played a role in providing functions to the tidal marsh ecosystem (as indicated in Table 1.3, Baye 2000). Transitions are the intergradation of two adjacent plant communities, so they require adjacent terrestrial plant communities of reasonable quality to be self-sufficient (i.e. not require active management). Plant cover must be entire (or nearly so) throughout the year, and reach above one-third of a meter in height (which remains emergent through the highest tides) so that small marsh mammals and secretive marsh birds can find cover from predation. Vegetation must also provide adequate forage for marsh fauna (Shellhammer, pers. com.).

The bay's margin needs sufficient depth (marsh backshore to upland width) to provide adequate acreage for plant communities to be self-sufficient, and they must be tens of meters deep in order to minimize the impact of predation pressures (Block & Shellhammer, pers. coms.). Predation is known to be facilitated by steep levee flanks, which create narrow vegetation zones that are likely easily hunted. For tidal marshes that do not contain high marsh, habitats on slopes above the marsh plain become even more important, as the only adequate high tide refugia during events that swamp all vegetation within the marsh plain. Furthermore, the bay's margin must provide adequate acreage for landward transgression of tidal marshes during rapid sea level rise (SLR) events that threaten to negatively impact marshes.

Working List of Habitat Characteristics at the Bay's Margin

1) **Transitional Depth** (i.e. width from tidal marsh to upland)
   a) Depth refers to a distance needed by tidal marsh fauna and transitional flora
   b) Contrast gently sloping alluvial plains (ecoclines) & abrupt levee flank slopes (ecotones)
   c) Historic reports: some are hundreds to thousands of feet wide - Collins & Grossinger (2004)
      i) Broad transitions provided optimal EHT refugia,
      ii) would provide best-case-scenario SLR adaptation, and
      iii) should provide adequate acreage for plant community.
   d) Contemporary condition: a site in Palo Alto that was ~2.5m wide - Harvey et al (1978)
      i) Narrow transitions do not provide adequate EHT refugia,
      ii) would not provide any SLR adaptation, and
      iii) cannot provide adequate acreage or conditions for native plant communities.
   e) Management recommendation: at least 10s of meters deep for refugia to hundreds deep for SLR adaptation (*Shellhammer* pers. com.)
      i) Moderate transitions should provide adequate EHT refugia,
      ii) would provide some SLR adaptation, and

iii) may provide adequate acreage for native plant communities.

f) Actual needs for Sea Level Rise adaptation TBD (predicted) by modeling

g) Influence of width on stability of plant community TBD (estimated) through discussion

h) Influence of width (and other metrics) on predation pressures (terrestrial, aerial) TBD by study

2) **Transitional Elevation** (in relation to the tides)

a) High tide refugia

i) Height above MHHW of plant community for daily high tide cover

ii) Height above EHT of plant community for extreme events

iii) Contrast historic marsh's against centennial marsh's functions

b) Historic condition: diurnal and most extreme tide refugia provided throughout the marsh plain - see Hidden Ecologies pictures (Appendix D) & Atwater et al (1977)

c) Current State: few remaining historic marshes with this characteristic, so perception of functions muddied (i.e. centennial marsh characteristics)

d) Management Recommendation: create adequate upland transitional habitat AND enhance marshes with high tide refugia (marsh mounds - Overton's design)

i) Note relation to Sea Level Rise adaptation (as width is a function of slope, the rate of elevation change)

ii) Harvey et al (1978) based on a priori plant community <5% rule (OBL/UPL) found transitional habitat to occur between 1.25 +/-0.26m and 0.83+/-0.12m above MHW at a site in Palo Alto (Note: heights are site specific)

iii) Based on Harvey et al (1978) the height of the tidal marsh proper ends perhaps 0.5m above MHHW, but tidal datum modeling is inadequate (not modeled across complex tidal marsh geometries) for our purposes so we are exploring other data sources

3) **Transitional Plant Community** (speciation/diversity, structure, seasonality)

a) Native high marsh species are common in salt marshes if mature

i) Example: compare/contrast Laumeister (historic), Faber (41yo restoration), and Cooley Pond (12yo mitigation)

ii) Quality defined by gumplant, but saltgrass, alkali heath, seaside arrowgrass, and sea lavender are important species along with pickleweed

b) High tide refuge degradation by perennial pepperweed questionable?

c) Native-dominated tidal marsh-upland transitional plant communities are extremely rare

i) loss of the gently sloping alluvial floodplains (ecoclines) once dominant the South and North Bays

ii) levees (sharp ecotonal transitions) create conditions that impair plant communities

iii) changes are pervasive and have drastically altered the transitional habitat mosaics that once occurred (seasonal pannes, high/low marsh throughout the plain, marsh ponds, etc.)

d) Diversity of native and exotic species and the influence on stand structure

i) Some exotic species seem benign (do not create monotypic stands)

ii) Other exotics significantly alter the plant community structure and therefore the functions it provides to native transitional plants as well as tidal marsh fauna

e) Needs of native plant species

i) Soils

1) Historic soils should be characterized for creating project specifications

2) Organic content

3) Salinity

4) Other abiotic (& biotic?)

5) Salinization may be useful or required to re/create appropriate conditions

6) Soil ecology studies may be needed to characterize important fauna and flora for plants

ii) Hydrology

1) Riverine floodplains may be unlikely or impossible to create or reconnect, and habitats may need to default to drier communities

2) Steep slopes create poor conditions for plant community restoration and stability, exacerbated by aspect

iii) Transitional size, shape, distribution

1) Some threshold of transitional plant community abundance likely exists where they will become able to self-propagate

2) There may be some site size that improve s site performance

3) Site shape likely influences vegetation (thin, linear features (edges) can be problems)

iv) Active Management

1) Significant populations of many transitional plant species are rare throughout the region, so

2) active vegetation management is required to recreate historic communities, and

3) may continue to be needed until they attain adequate distributions to self-propagate and compete well with exotic species.

f) Requirements of tidal marsh fauna for cover, forage, and other needs

i) Escape Cover Structure - similar to tidal marsh structure?

ii) Ex. SMHM: 0.5-2' high, dense cover of SAPA with DISP and GRST nearby (in marsh plain)

1) Forage Species - pickleweeds and others?

2) Other Needs - ex. grasses for nesting materials - saltgrass and others?

4) **Adjacent Terrestrial Habitats and Connectivity**

a) Adjacent Habitats

i) Adjacent land uses - akin to riparian corridor setback analysis

ii) Developed Area(s) [Distance, Land Use Types and Variety of transitional habitats]

iii) Open Space [Distance, Types and Variety of transitional habitats]

iv) On-site uses - public access (trails) as disturbances or other predator facilitation

b) Habitat Connectivity

i) Large marshes would likely have (1) larger populations of SMHM and hence less likelihood of suffering loss of genetic variability due to random genetic drift and (2) more slope on which to continue to evolve as sea level rises. (Shellhammer pers. com.)

ii) Connectivity implies larger populations, which could improve the recovery of species

iii) *Should we address regional distribution and diversity in the definition?*

iv) Larger marshes may need to be prioritized for management ahead of smaller marshes

v) And some believe that upland Transitional habitat restoration should include creating more of their historic characteristics - creating the matrix of habitats once found in and around transitions

Annotated Citations

Albertson, J. (2012) Personal Communication on California Clapper Rail Ecology.

Atwater, B. et al. (1977) History, landforms, and vegetation of the estuary's tidal marshes, a chapter in the book *San Francisco Bay: The Urbanized Estuary*

- a summary description of the tidal marshes in SF Bay, containing important information on their mature forms that are critical to understanding their dynamics

Baye, P. 2000. Tidal Marsh Plants of the San Francisco Estuary (Table 1.3), a chapter in the Species and Community Profiles companion report to the Baylands Ecosystem Habitat Goals by the San Francisco Bay Area Wetlands Ecosystem Goals Project. U.S. Environmental Protection Agency, San Francisco, Calif./S.F. Bay Regional Water Quality Control Board, Oakland, Calif.

- a compendium of the CNPS-rated rare, threatened, endangered, extirpated, or extinct species once found in the Transitions; important for appreciating the scope of impacts in Transitions & critical to informing their restoration

Baye, P. 2004. Vision for Restoration of South Bay Salt Ponds: dream or fugue?. Special insert in the Winter 2004-05 Save Wetlands newsletter of the Citizens Committee to Complete the Refuge. 8pp.

- a summary of that author's observations and concerns about management of the Baylands, which contains important observations on the character of the tidal marshes and their upland Transitions

Block, G. (2010) Personal Communication on the results of San Pablo Bay NWR Salt Marsh Harvest Mouse trapping.

Bloom, V. et al. (2013) US Fish & Wildlife Service Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California. Sacramento, California.

- USFWS recovery plan - blueprint - for the tidal marshes, which could not address the Transitions beyond noting their importance to the ecosystem

Callaway, JC, VT Parker, MC Vasey, LM Schile, 2007. Emerging issues for the restoration of tidal marsh ecosystems in the context of predicted climate change. Madrono 54:3, 234-248
- summary of potential impacts of climate change (SLR and salinity patterns) on tidal marsh ecosystems that does not rely on marsh response models

Collins, J. & Grossinger, R. (2004) Synthesis of Scientific Knowledge: for maintaining and improving functioning of the South Bay Ecosystem and Restoring Tidal Salt Marsh and Associated Habitats over the next 50 years at Pond and Pond-Complex Scales. A report to SBSPRP

- an excellent summary of historic accounts on Transitions (among other things)

Goals Project. (1999) Baylands Ecosystem Habitat Goals. A report of habitat recommendations prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. U.S. Environmental Protection Agency, San Francisco, Calif./S.F. Bay Regional Water Quality Control Board, Oakland, Calif.

- management guidance for the estuary, which could not address the Transitions beyond noting their importance to the ecosystem

Grossinger, R. & Baye, P. (2004) Once and Future Bay: Lessons from History for Revitalizing the Bay. Bay Nature Magazine (Oct.-Dec. 2004) 3pp.

- a beautiful poster showing the variety of landforms once common in and around tidal marshes, including transitions

Harvey, T. et al. (1978) Determination of transition zone limits in coastal California Wetlands. Report to the EPA

- an attempt to create a legally defensible method for delineating Transitions (edge of coastal wetlands), and provides some data on them in Palo Alto, CA

Josselyn, M. (1983) Ecology of SFB Tidal Marshes, a community profile. A report to USFWS

- the USFWS tidal marsh ecosystem description, which notes Transitions and their importance to tidal marsh fauna

Kent et al., 1997. Landscape and plant community boundaries in biogeography. Progress in Physical Geography September 1997 vol. 21:3 pp.315-353

- a summary on the science of Transitions in biogeography or phytosociology, which clarifies the subject of terminology and provides important guidance on sampling and data analysis

National Academy of Sciences, (2012) Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future. Committee on Sea Level Rise in California, Oregon, and Washington, Board on Earth Sciences and Resources and Ocean Studies Board, Division on Earth and Life Studies. http://www.nap.edu/catalog.php?record_id=13389, 250 pages.

- current SLR estimates for the region

Overton, C. (2012) Personal Communication on California Clapper Rail ecology.

Philip Williams & Associates, Ltd., and P. M. Faber (2004). Design Guidelines for Tidal Wetland Restoration in San Francisco Bay. The Bay Institute and California State Coastal Conservancy, Oakland, CA. 83 pp.

- the only known published guidelines for tidal marsh-upland transitional habitat restoration, that did not cover the subject in full detail

Save the Bay, 2007. Greening the Bay: Financing Wetland Restoration in San Francisco Bay. Technical Report.

- an estimate of the costs for restoring tidal marshes

Schaeffer, Michiel; Hare, William; Rahmstorf, Stefan; Vermeer, Martin; 2012. Long-term sea level rise implied by 1.5C and 2C warming levels. Nature Climate Change 2, 2012/12/12, p867-870 http://www.nature.com/nclimate/journal/v2/n12/abs/nclimate1584.html

- SLR projections through 2300 based on warming scenarios

Shellhammer, H. 1982. Management problems associated with the recovery plan for the salt marsh harvest mouse and California Clapper Rail. California-Nevada Wildlife Transactions.

- a summary of that author's concerns with the former recovery plan, which includes several important observations on Transitions

Shellhammer, H. (2012) Personal Communication on the value of European grasses to small marsh mammals.

Traut, B. (2005) Role of coastal ecotones: a case study of the salt marsh/upland transition zone in California. Journal of Ecology 93:279-90

- the only known local study of Transition, with many important observations on their ecology

Appendix A. Terms and their Definitions

The purpose of this document is to reach consensus on habitat descriptions that explicitly characterize tidal marsh-upland transitions to guide management of the Tidal Marsh Ecosystem. An important part of this process is agreeing upon terms for reasons that will become clear below. A summary of local perceptions of these habitats is presented in Appendix B (complete excerpts in Appendix C) that may help clarify this discussion. Here is a summary of relevant terminology as understood by phytosociologists (i.e. plant geographers):

Ecotone - this term may have been coined by Clements in 1901 (or at least by Livingston in 1903) and has since been defined by Kent et al. (1997) as "a zone of relatively rapid change between two plant communities and a dynamic zone of interaction which, as a consequence, is often unstable."

Ecocline - this concept was first proposed by Whittaker in 1960 as "coenocline" and has since been defined by Kent et al. (1997) as "a more gradual gradient of vegetation change between two plant communities corresponding to a progressive spatial change in one or more underlying environmental or biotic factor(s)".

Mosaic - this term was introduced by Whittaker (1953) as part of his climax pattern hypothesis: "a pattern of intergrading communities corresponding to a pattern of environmental gradients". Kent et al. (1997) state that "... most, if not all, transitional areas contain a degree of mosaicking...," so this should be considered a characteristic of the continuum between the other two terms.

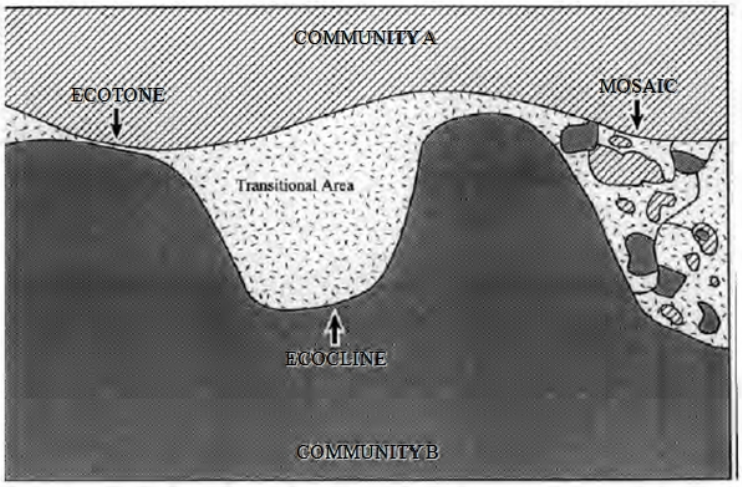


Figure 7 The linear nature of transitional areas demonstrating the varying widths of ecotones and ecoclines with mosaicing superimposed upon them

From Kent et al. (1997) depicting the terms.

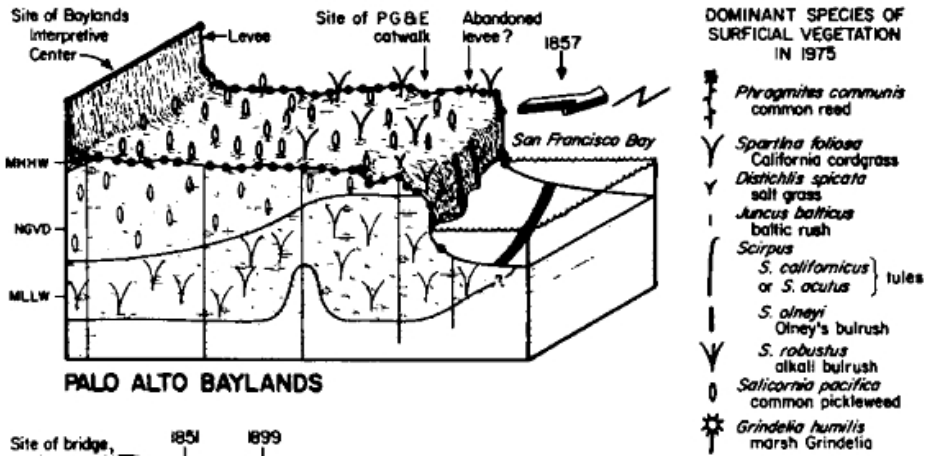
Transitional Area - this term is recommended as a substitute for the others (Kent et al. 1997). It contains the ecotone/ecocline/mosiac concepts defined above.

The local vernacular varies, but there are quite a few references to these habitats as "upland ecotone", so there is concern that a change in terminology may create confusion or interfere with this definition's use. I am trying to show here that utilizing the term "ecotone" in reference to all transitions is not in line with common scientific usage, which might cause confusions, and these terms as commonly used are descriptive of conditions that provide useful clarity to their management. Using the terms above I can say we have lots of "ecotones", sharp transitions created by levees that are unstable and do not provide good habitat now nor SLR adaptation in the future. We prefer to have "ecoclines", gradual transitions historically found in many parts of the estuary that provide good habitat and SLR adaptation. And we should investigate the restoration of habitat "mosaics" that likely provide more functions.

Appendix B. A published history of the local Upland Transition concept

History of interest in the tidal marsh's "upper zones"

Although Tom Harvey may have first used the term ecotone to refer to tidal marsh-upland transitions during attempts to devise a legally-defensible wetland delineation strategy in 1978, it appears some subsequently referred to Transitions with less technical terms, like "upper zones of marshes" (Shellhammer, 1982). Perhaps Mahall and Park's 1976 series on the ecotone between Spartina and Salicornia in the estuary brought the term back into fashion. The following excerpts provide some understanding of local perceptions on Transitions over the past century.



Part of Fig. 7 from Atwater et al. (1979) - Note: MHHW

• "... When botanist Cooper (1926) interviewed longtime local resident GF Beardsley about Santa Clara Valley in the vicinity of Palo Alto to Mountain View circa 1870, he described the area above the Salicornia-dominated marsh plain and the salinas: 'The saltmarsh region. First there was the great salt marsh, with all its winding sloughs and creeks, covered with samphire grass [Salicornia] and tufts of Grindelia; next was a line of natural salt pan; next again was a strip of land of varying width, from a few hundred yards to one fourth mile, with a short wiry hard grass [Distichlis] and a plant (composite) growing from six to 15 inches high, densely covered with short leaves [Frankenia?]...'" (from Collins and Grossinger, 2004)

• "... testimony by local farmers in the Berryessa land grant case documents conditions further east, between Coyote Creek and Guadalupe River, several decades earlier. They describe a zone of similarly intermediate characteristics, comprising 'marshy land' with 'nothing but salt grass,' extending all the way to the Milpitas-Alviso Road (approximately present-day Highway 237) and above the road in places (SFEI 1999). In this area, the transitional salt grass zone was 1000m or more in width. ..." (from Collins and Grossinger, 2004)

• Atwater et al.'s *History, landforms, and vegetation of the estuary's tidal marshes* (1979) did not address Transitions directly but stated: "... Within uncertainties of measurement, most of the broad surfaces (Fig. 7) are probably situated within a few decimeters of MHHW. This coincidence implies a widespread tendency of tidal marsh surfaces to approach high-tide levels. ..."

• Harvey et al. (1978), while trying to determine "transition zone limits in coastal California wetlands" for the purposes of jurisdictional determinations found: "... Based on the salt marshes studied, aspects of their flora can be used to identify the transition zone. The zone appears to be a relatively narrow band (about 2.5m wide) and it occurs about 1m above MHW. ..."

• Josselyn, in his 1983 community profile of San Francisco Bay Tidal Marsh Ecology for FWS, stated: "... The transition zone represents the change in plant species composition from typical wetland species (hydrophytes)

to upland species. ... The transition zone is significant ecologically. Of the six animals listed as rare or endangered in bay tidal marshes, four utilize the region between MHW and the upland for breeding and/or feeding. Both plant species listed as rare or endangered occupy the transition zone. Many other animals use the transition zone to escape extreme high tides or winter floods. ..."

• Collins and Grossinger, in their 2004 synthesis for SBSP, stated: "... Tidal Marsh-Upland Ecotone - The transition between tidal marsh and adjacent terrestrial habitats comprises a zone of varying width depending upon adjacent topography. Since most of the South Bay's tidal marshlands were bordered by nearly flat or gently sloping alluvium, the associated upland ecotones constituted broad, distinctive habitats occupied by both salt-tolerant and upland plant species and flooded by only the highest tides. ... "

• Traut (2005) stated: "The high marsh can be considered an ecotone because it is a transition zone (1-80 m wide) between two adjacent ecological communities (marsh plain and upland) with a distinct plant community and unique physicochemical characteristics. ... One of the most threatened features of Pacific coast salt marshes is the high marsh/upland ecotone (James 2001). ..."

Though these quotes give an overview of some of the most significant features in the evolution of local perceptions on Transitions, there is no clear description that could guide characterization, delineation, and mapping. A definition is required to describe its historic extent, which will inform goals for assessment, and prioritization of its current extent, which will inform management action.