

Appendix 8: Shallow Subtidal Habitats of Coastal Wetlands

of the *Wetlands on the Edge: The Future of Southern California's Wetlands Regional Strategy 2018*



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In order to implement interim Objective 4(A), “Protect 100% of existing shallow subtidal habitats associated with coastal wetlands”, the WRP needs a better understanding of the existing subtidal habitats. This section is meant to describe important subtidal habitat elements, highlight the importance of these habitats, and call attention to subtidal habitat degradation and future stressors ultimately to inform the implementation of Objective 4(A). This chapter will provide recommendations for how best to protect existing subtidal habitat. The focus of these recommendations are the enclosed bays, lagoons, and estuaries that make up the WRP’s wetland archetypes, and “subtidal habitat” includes all submerged areas within these wetlands.

Limits to Our Understanding

Prior to modern development, the most common coastal wetland habitat type was vegetated wetlands (i.e. salt or brackish marsh), followed by unvegetated intertidal flats and subtidal waters and (see page 25). But subtidal habitats were not mapped well historically, and that remains true today. The understanding of the distribution of subtidal habitats is limited by the fact that these habitats are typically mapped as uniform open water, with little detail on the distribution of key sub-habitat types and even bathymetry. Further, the state of knowledge about subtidal habitats in coastal wetlands lags behind relative to other habitat types, leaving managers and government agencies lacking crucial information about subtidal extent and function. As a result, it is hard to determine exactly where or what should be protected and restored.

Subtidal Habitat Types

Subtidal habitats in Southern California are extremely diverse in nature depending on their geomorphic setting and the level of human development and interference in the area. Habitats can range from sessile species attached to harbor pilings to extensive eelgrass beds in estuaries. These habitats are critical in terms of food web, fisheries, shoreline stabilization, and numerous other ecosystem services and functions. However, specific physical and chemical tolerances in Southern California’s subtidal

communities remain unknown and the potential direct and synergistic effects of climate change are also unknown. Clearly more research is needed, but in the meantime it is crucial that these habitats are conserved today and that subtidal restoration is incorporated into larger coastal wetland projects in order to provide the habitat connectivity needed for adequate ecosystem resilience to sea-level rise.

Subtidal habitat is generally recognized as the area of a coastal wetland that is permanently covered by water. However, a mosaic of complex habitat lies beneath the surface, often invisible to the eye. These habitat types, defined by gradients in hydrology, landforms, and water chemistry can be further separated into pelagic (water column) and benthic (bottom) habitats. Substrates of subtidal habitats are typically soft bottom, interspersed with rocky areas and occasionally artificial substrates. Biological communities, such as shellfish and submerged aquatic vegetation (SAV) beds, can further enhance the structural complexity of subtidal habitats, creating three-dimensional relief and areas of refuge. For the purposes of this chapter, estuarine subtidal areas will be discussed in the following commonly used habitat categories:

- Soft Substrate: unconsolidated sediments with less than 10% colonization by Submerged Aquatic Vegetation (SAV). These unvegetated habitats range in depth from shallow to deeper habitats, with varying ecosystem functions.
- Submerged Aquatic Vegetation (SAV): Any combination of submerged vegetation that covers 10-100% of an unspecified substrate.
- Reef/Hardbottom: hard substrate composed of exposed bedrock or created through depositional cementation of sediment and includes corals and flat bedrock.

Subtidal Habitat Setting

The subtidal habitat types occur across every coastal wetland archetype found within Southern California. However, their relative importance, key characteristics, persistence over time, and biological composition can vary among wetlands, seasons and from year-to-year.

Many of the region's coastal wetlands experience seasonal or multiyear mouth narrowing or closures, limiting tidal exchange, affecting the frequency and duration of tidal inundation. In open states, such estuaries may contain extremely shallow subtidal habitat. As the tidal inlet narrows or closes, this habitat becomes deeper, with extended residence time of water. When closed, these estuaries can form sizeable submerged aquatic beds of *Ruppia maritima* (widgeongrass) and other brackish water SAV species, in addition to floating mats of macroalgae or phytoplankton blooms. Abrupt opening of the tidal inlet due to storm events or management actions can completely change tidal elevations and salinity regimes, effectively replacing or restructuring over a period of days the dominant species.

Gradients in parameters such as temperature, turbidity, and salinity exert a key control on the composition of diverse biological communities found within subtidal habitats. For instance, salinity averages and ranges can be variable among wetland archetypes, but generally, the estuarine subtidal habitat experiences salinities greater than 15 practical salinity units. Physical and chemical gradients can structure the dominant forms of primary producers as well as the benthic and pelagic invertebrates and

vertebrate species. For example, shallow lagoons with relatively clear water, such as Batiquitos Lagoon, provide ideal habitats for SAV and attached algal forms. In intermittently open estuaries, such as the Santa Clara River, there is limited SAV extent due to the instability of bottom sediments and variable salinity and turbidity.

Ecosystem Functions and Services

The subtidal habitat of coastal wetlands provides a tremendous diversity of ecosystem services. Ecologically and commercially-important fish rear in warm estuarine waters, rich with small invertebrates. Many of these species such as yellowfin croaker, California halibut and diamond turbot reproduce in the ocean, then as small juveniles migrate into estuaries to rear, and as larger juveniles migrate back to the ocean (Allen et al. 2006). Southern California subtidal habitats also serve as migration corridors for Southern California steelhead (National Marine Fisheries Service 2012). Shallow subtidal habitat in Upper Newport Bay supports extremely high annual fish production compared to other comparable estuaries (Allen 1982).

SAV is a critical habitat as it serves as nursery habitat, foraging grounds, and refuge for fish; thriving SAV habitat promotes fish diversity and shapes trophic relationships (Robbins and Bell, 1994). Habitat complexity from SAV root structure and plant debris also enhances infaunal biomass and abundance (Castel et al., 1989). SAV in particular also removes nutrients and suspended sediments from the water column, improving water clarity and enhancing its own growth through increased light availability in a positive feedback loop (van derHeide et al., 2007). Much of the remaining SAV habitat found in Southern California estuaries are those which have commercially important ports, marinas, and harbors.

Competition among ecosystem services has often been the driving factor behind habitat type conversion and degradation. Ecosystem services have also been a focal point when considering restoration options involving subtidal habitat especially in terms of the need to support pelagic fish nurseries and migration corridors. With the important fish species present in Southern California's wetlands, several subtidal restoration efforts have resulted in primarily deeper subtidal habitats as opposed to other potential habitats (e.g. oyster reefs and shallow soft-bottoms). Competing ecosystem services provided by subtidal areas for commercially important ports, marinas, and harbors, has led SAV to be a focal point in restricting activities or in restoring SAV habitat to mitigate impacts of such activities.

Generically, these ecosystem services include (SFEI Subtidal Goals Project 2010):

- **Provisioning Services:** products obtained such as food (e.g. fishing), commercial harvest and aquaculture (i.e., fishing), and navigation (shipping, ports, marinas);
- **Regulating Services:** benefits obtained through ecosystem processes (e.g., maintenance of water quality, erosion control, climate regulation, storm protection, conveyance and disposal of human pollution);
- **Cultural Services:** non-material benefits from recreation, ecotourism, and aesthetic experiences, maintenance of educational values and cultural diversity;

- **Supporting Services:** services that are necessary for the production of all other ecosystem services (e.g., biodiversity, primary production, nutrient cycling, etc.).

Impacts to Subtidal Habitats

Since human interference, there has been drastic habitat type conversion and degradation in subtidal habitat primarily due to dredging activities and urbanization. To a lesser degree, trade-offs between habitat types in restoration and mitigation projects have also impacted shallow subtidal habitats.

Recent mapping efforts show an increase in subtidal habitat since approximately 1850 (see page 26), most often due to significant expansion of navigable waters to accommodate harbor and port development. However, several thousands of acres of shallow subtidal habitat have also been lost to port development (NOAA unpublished data). In addition, subtidal habitat has experienced declines in extent and quality due to shoreline, intertidal, and shallow subtidal development.

Shoreline armoring, dredging and filling activities, and overwater structures are the primary causes of subtidal habitat alteration within Southern California coastal wetlands. At the Ports of Long Beach, Los Angeles, and San Diego, increasing global economic trade has resulted in the need for larger, deeper draft ships to transport cargo. This has led to a demand for new construction dredging to widen and deepen channels, turning basins, and slips to accommodate these larger vessels. These activities have led to a permanent loss of shallow water habitats and chronic effects on sediment and water quality. Although shoreline armoring is extensive in urban areas globally, the ecological consequences are poorly documented (Morley et al. 2012). The process of shoreline armoring is often associated with removal of riparian vegetation, decreased habitat complexity, reduced habitat connectivity (Peterson et al. 2000; Romanuk and Levings 2003). Armoring along a coast alters hydrodynamics, modifies water flow, and affects sediment dynamics (e.g., Fletcher et al. 1997; Miles et al. 2001; Runyan and Griggs 2003; Martin et al. 2005). Although ecological responses vary with engineering purpose of structures (e.g. slowing or stopping water flow) (Dugan et al. 2016), studies have shown that the impacts to neighboring subtidal habitat include reduced epibenthic invertebrate densities and richness, decreased neuston invertebrate richness (Morley et al. 2012), reduced organic matter production and detritus export (Brinson et al. 1995). As active areas of sediment and organic matter exchange between terrestrial and subtidal habitats (Lubbers et al. 1990; Ruiz et al. 1993), embayment edges with shoreline armoring can alter this crucial land-water interface and alter habitat quality for intertidal and supratidal species (Rice 2006).

Sedimentation regimes in coastal embayments have been highly altered as a result of upstream development and construction, which impacts subtidal habitats. Across all wetland archetypes, some systems are sediment-rich while others are sediment-starved (Rosenkranz et al. 2016). For example, Onuf (1987) showed a 40% decrease in the volume of Mugu Lagoon due to anthropogenic increases in sediment input. In addition, high levels of sedimentation from the Tijuana River watershed has filled subtidal channels and impacted both intertidal and subtidal habitats (SFEI Tijuana Valley Historical Ecology Investigation 2017). On the opposite end of the spectrum, man-made structures such as inland dams decrease natural nutrient-rich runoff and sediment supply while also cutting off fish migration routes, curbing freshwater flow, and potentially increasing the salinity of coastal waters.

Impacts of Global Climate Change on Subtidal Habitats

As is demonstrated in the *Regional Strategy* (2018), absent any intervention sea-level rise will result in substantial losses of coastal wetlands across the region. While these wetland losses suggest a gain in subtidal habitat, the future quality and functioning of that subtidal habitat is unknown. Further, this report focused on sea-level rise as the driving climate change stressor to coastal wetlands, while several other projected changes (Table 1) may have a direct and synergistic effects on subtidal habitat.

Table 1. Long-term changes estimated to occur in subtidal habitats in Southern California.

Driver	Hypothesized Consequence
Sea level rise	Habitats will increase in depth. Increase in turbidity. Landward shift limited by shoreline development
	Higher tide and tidal range may increase erosion and alter shorelines, habitats, and subtidal SAV and animal distributions
	Increased tidal range could increase strength of tidal currents
Temperature increase	Change in phenology of SAV and biogeography of estuarine and marine species
	Species introductions and local extinctions
	Reduced survival, reproduction and growth of eelgrass and oysters
	Increased dominance by more ruderal species (e.g. <i>Ruppia maritima</i>)
Total precipitation	More total flow and lower salinity if increased precipitation
	Increased period of drought with decreases in salinity or altered runoff patterns
Wind speed	Increase resuspension of sediments leading to reduced light penetration and changes to SAV
Storm frequency	Predicted to increase in frequency with altered storm patterns (e.g. wave direction). Altered estuary mouth dynamics
Ocean acidification	Could hurt shell-forming subtidal species
	eelgrass could provide an OA refuge
Increased CO ₂	Increased CO ₂ could increase eelgrass productivity
Population growth	Increased pressure on subtidal habitats (pollution, dredging, fishing and other exploitative activities)
Sediment starvation	Less sediment from watershed (combined with wind waves) could increase erosion of subtidal habitats
Introduced Species	Increased spread of invasive species with potential negative consequences for subtidal organisms
Development	Further restrict migration room for subtidal estuarine habitat

Management Recommendations

The following management recommendations were developed to address the stressors facing subtidal habitats:

- Create/maintain dynamic subtidal habitats capable of being resistant and resilient to change;
 - Increase connectivity among habitats (i.e. subtidal, intertidal, and upland transition zone for adequate sea-level rise migration);
 - Increase elevations and/or sediment accretion of deep subtidal habitat;
- Improve quality of existing subtidal habitat by reducing and preventing stressors such as shoreline armoring, artificial structures, nutrient-rich effluent, and invasives species;
- Increase and improve understanding of the value (ecological, economic) of unvegetated soft bottom habitat and the ecotone between unvegetated and SAV habitat; and
- Prioritize data gathering that includes occurrence of invasive species.
- Where feasible, remove artificial overwater structures that overlay subtidal habitat and have negative or minimal beneficial habitat functions;
- Promote pilot projects to remove artificial structures at targeted sites in combination with a living shoreline restoration design that will use natural bioengineering techniques (such as native oyster reefs, stone sills, and eelgrass plantings) to replace lost habitat structure; and
- Re-establish and increase connectivity between subtidal habitat and intertidal habitats with removal of shoreline armoring when possible.

More specifically, the following recommendations were developed for each subtidal class:

Soft Substrate

- Encourage the application of sustainable techniques in restoration projects
- Consider specific, unique conditions of and improve habitat quality in intermittently open and closed estuarine systems

Submerged Aquatic Vegetation (SAV)

- Increase acreage of native SAV populations within suitable subtidal/intertidal areas using a phased approach under a program of adaptive management; and
- Quantify the available acreage of suitable subtidal/intertidal habitat for SAV (see Goal 4).

Reef/Hardbottom

- Increase native oyster populations through experimental and well-monitored projects within a framework of adaptive management and in conjunction with the goals to increase connectivity among habitats (e.g. eelgrass and intertidal zones); and
- Quantify the associated ecosystem functions of native oyster beds.

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