Ecological site group F004BA100CA
Beach Dunes

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Key Characteristics

- Hydrologic processes dominate the landscape – LRU A
- Beaches and dunelands
- Actively moving to stabilized beach dunelands

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

Beach dunes represent the more rapidly changing to older, more stabilized areas directly adjacent to the beaches in LRU A. They consist of actively moving to well vegetated dunes that are all oriented parallel to the prevailing winds. Many of the older, more stabilized dunes covered in coastal scrub and forest are being transitioned back to actively moving, poorly vegetated dunelands due to changing winds and human alterations and land uses. The extent of this ecological site concept stretches from the back side of the foredunes to the edge of the back dunes.

Climate

This ESG is characterized by frequent on shore winds that can carry airborne salt spray, generally mild to cool conditions with consistent temperatures and regular marine cloud cover due to the immediate proximity to the Pacific Ocean. 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 there is little rainfall in the summer. Snowfall is rare along the coast, and fog and low clouds are significant features that define this MLRA from other similar MLRAs. Nighttime 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).

This LRU is primarily influenced by hydrological processes and contains beaches, dunes, rivers, and marine terraces below 400 feet elevation. Wet forests, lakes, estuarine marshes, and tea-colored (tannic) streams are characteristic features of this LRU. Marshes and wetlands have been widely altered and/or drained with many converted to agriculture and urban developments. Soil moisture regimes are udic and aquic and soil temperatures are isomesic. Dune communities, grassland, coastal scrub, beach pine, bishop pine, and Sitka spruce on floodplain soils are more typical in this LRU, in comparison to the redwoods that dominate LRU I. Riparian areas contain red alder and salmonberry, and, in a few areas, some scattered redwoods. In California, the region includes the Crescent City Plain, and Humboldt Bay Flats and Terraces.

Soil features

The soils associated with this ESG range from isomesic to mesic depending on the degree of vegetation cover and stability. Soils that are representative of this ESG are the Lanphere and Samoa soils which are both Typic Udipsamments. They are generally deep soils that are somewhat excessively to excessively drained and have moderately rapid permeability.

Vegetation dynamics

This provisional ecological site concept covers a wide variety of dune dynamics and expressions that may need to be further refined to better represent dynamics on a smaller, more ecologically specific scale. For the purposes of this provisional concept, however, all that variation is lumped into one site concept.

This site has highly variable dynamics that include active dunes, dune mats, dune swales, and dune forests. The dominant community phase is the most stable community phase and is dominated primarily by the dune forest vegetation. These dune forests are found on the stabilized back dunes and are some of the most significant portions of intact dune forest left in California. It is dominated by two distinct and recognizable forest types, *Pinus contorta* spp. contorta (shore pine) dominated type, a *Picea sitchensis* (Sitka spruce) dominated site, and a mixed conifer type. *Pseudotsuga menziesii* (Douglas-fir) is found in the shore pine and spruce types, whereas *Abies grandis* (grand fir) is found in all three, but most dominant in the mixed conifer type. They are the most stable, having been dominated by significant tree cover for decades and have a variety of shrubs in the understory. Dominant species in the understory communities are commonly *Vaccinium ovatum* (California huckleberry), Myrica californica (California wax myrtle), *Gaultheria shallon* (salal), *Arctostaphylos uva-ursi* (kinnikinnick), and *Lonicera involucrata* (twinberry honeysuckle).

This ecological site is highly susceptible to invasives, especially in Community Phase 1.2, given the more transitory nature of these communities they are primed for openings by non-natives that can capitalize quickly on available resources much better than the native species can. The dune mat community is the most at-risk for invasion and is dominated by the aggressive *Ammophila arenaria* (European beach grass). It is native to Europe and is a successful sand-binder that monopolizes the dune mat communities and outcompetes the native beach grass and other native forbs. It alters sand movement, decreases invertebrate abundance and diversity, and most significantly builds a steep, continuous foredune replacing the low, hummocky foredunes that are representative of the reference state dunelands.

Abiotic Factors/Primary Disturbances

Salt spray, soil salinity, sea-water immersion and sand movement are the most critical abiotic factors for this ecological site concept, primarily in the context of geologic processes and coastline water and wind currents. The salt spray gradient is a function of wind speed, distance from the tide line, height above the ground, and microtopography. Hypertrophy (succulence) accounts for the ability of dicots to withstand salt spray, and grasses that lack this ability, rely on a thick cuticle instead. Salt spray tolerance dictates the species composition that dominates the different areas of this ecological site, but also impacts the structure of the vegetation expression as well. Although beach species are not obligate halophytes, they are tolerant of soil salinity and occasional seawater immersion. Germination and establishment phases of most beach species is when they are the most vulnerable to the soil salinity, and therefore depend on times that seawater immersion and impacts from salt water are minimal until after full establishment.

Water deposition, onshore winds, desiccation, nutrient limitations, and sand burial are the most important disturbances that naturally drive the dynamics of this ecological site concept. Adaptations to sand burial are key adaptations for vegetation in this ecological site, developing larger, heavier seeds that have the ability to emerge from much greater depths once germinated. These species have also adapted to planting themselves deeper in the sands to take advantage of higher soil moisture content and protection from the wind/sea salt spray. Other adaptations include plant morphologies and canopy densities. Different accumulations of sands occur with different plant canopies, for example plants with intermediate canopy densities with loose, cylindrical silhouettes cause a decrease in wind velocities within the plant canopy leading to accretion of fine sands and the formation of hummocks typical of this ecological site.

Desiccation is a major stressor to this ecological site, namely from intense solar radiation and evapotranspiration, seasonal drought, and low water-holding capacities of the sands typical of this ecological site. The species that dominate this ecological site are adapted to these conditions, using various rooting strategies, leaf morphologies that can withstand high levels of solar radiation, high light intensities for photosynthesis, and wind desiccation, and root and shoot strategies to ameliorate the low-fertility soil conditions.

Dune morphology begins when beaches with vegetation create shadow dunes or beach mounds. These shadow dunes occur when a plant causes wind to be deflected, slowing its speed and dropping sand particles into an elongated tongue of sand in the lee of obstacles. Changes in wind direction result in accumulations on all sides and

the formation of a beach mound. These can be easily blown out by wind gusts or winter waves. However, when they are built on relatively wide areas of beach, a foredune can develop. A foredune is a vegetated ridge of sand parallel to the beach, rising above the ordinary high tides. These foredunes support greater species richness and plant cover than the upper beach, but fewer species that are found just inland on dune ridges. These incipient shadow dunes and the briefly stabilized foredunes are a part of the other ecological site, R004BA200CA Beaches, which captures the areas of the coastline that are more rapidly changing and consistently impacted by seasonal storms and weather events, shifting the site back and forth between unvegetated beaches to reasonably stabilized beach foredunes only. Anything further away from the winter storm high tide marks that can develop into more stabilized, well vegetated sand dunes are a part of this ecological site concept.

Blowouts that occur in a continuous foredune may result in incipient parabola dunes that later stabilize with vegetation, becoming relatively narrow dune ridges. Ridges alternate with depressions classified as dune swales when they are deep enough to support distinct vegetation and can become classified as deflation basins that are poorly drained and support a distinct ecological site, R004BA206CA Deflation Basins site. Where large areas of mobile sand occur in combination with a wide receptive area and unidirectional winds, transverse dunes form. Crests of these dunes are sinuous, oriented perpendicular to wind direction, and of variable length. These transverse dunes form during low sea levels with abundant sand supply from prograding shorelines and the exposed continental shelf. These dunes move too rapidly to support all but transient vegetation and they may even become superimposed over the large-scale parabola dunes that are formed in areas of stabilized vegetation. These transverse dunes, parabola dunes, and large areas of sand sheets make up the active dune portions of this ecological site concept. In the stabilized, vegetated back dunes, older ridges and stabilized parabolas support forest dune vegetation and troughs support swale vegetation or deflation basin vegetation. This dune ecological site may need to be divided into more ecological site concepts based on more locally specific site dynamics and abiotic factors, but at this time these dynamics are all included in one provisional ecological site concept.

Major Land Resource Area

MLRA 004B
Coastal Redwood Belt

Stage

Provisional

Contributors

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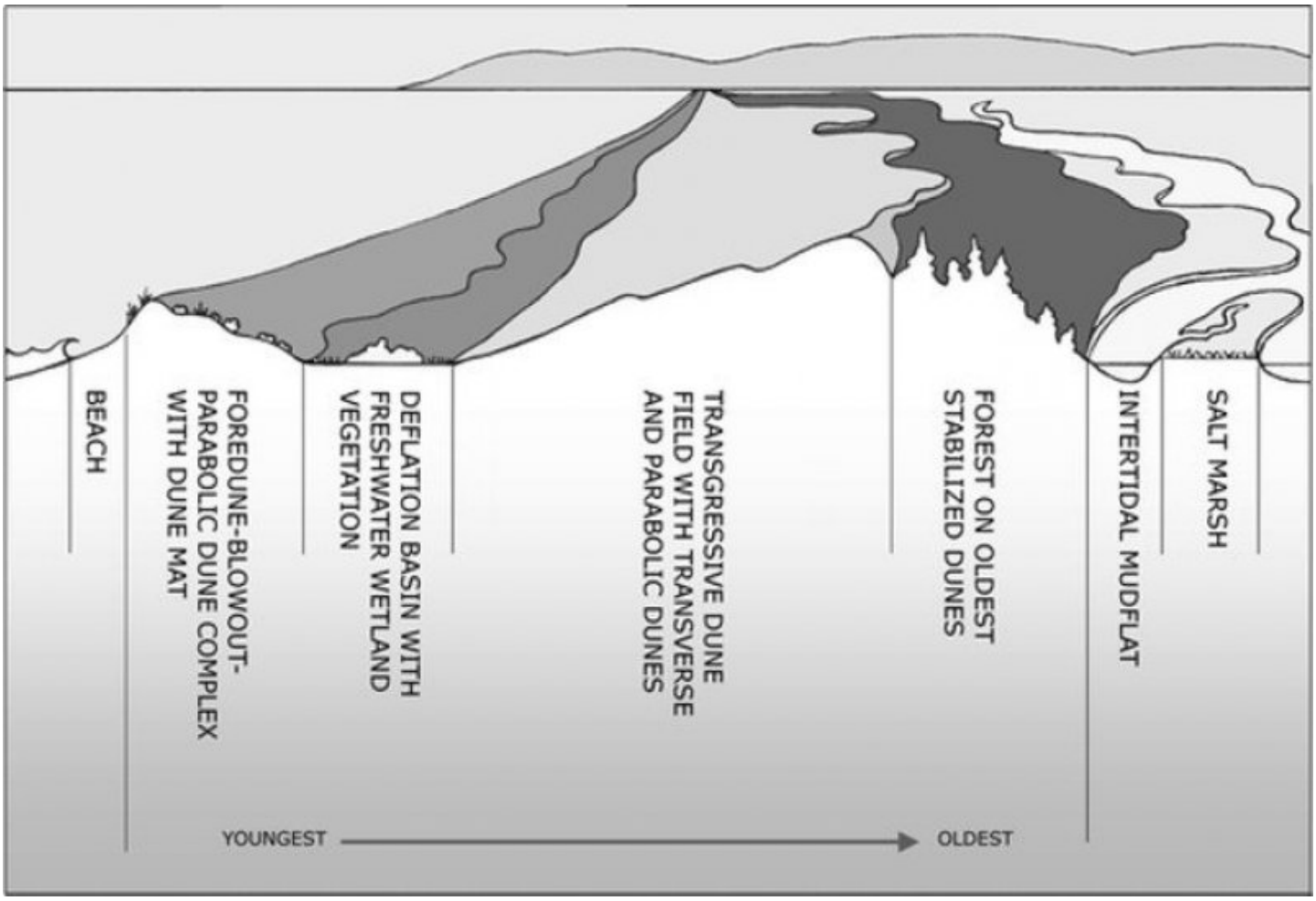
State and transition model



State 1
Reference State

Figure . Wind pruned Sitka spruce and beach (shore) pine across dunelands

Figure 1. Shrubland community

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) – This reference state includes the highly variable dynamics of the active dunes, dune mats, dune swales, and dune forests. These communities are all varied in size and extent, depending on the width of coastline available, the geologic history of the deposits, and long-term shifts in prevailing winds that impacted a specific area of coastline. The active dunes and dune mats are more transitory in nature, with the dune mats being of limited extent along dune ridges mostly. Dune forests are the more extensive and stabilized portions of this dune ecological site and are intermixed with the dune swale expressions. When the dune forests are disturbed they are easily impacted again by the coastal winds and begin to degrade into more transitory dunes again. At this very general scale, this reference state only really captures the generalities related to the functional groups that are most dominant and does not capture the more specific dynamics and patterns that would be found at the more detailed and refined ecological site scale that focuses on specific abiotic factors that drive some of these various complex plant expressions. More data and refinement is needed to capture the information needed in order to make specific land management decisions at the ecological site-component scale.

Dominant plant species

- Sitka spruce (*Picea sitchensis*), tree
- beach pine (*Pinus contorta var. contorta*), tree
- California huckleberry (*Vaccinium ovatum*), shrub
- California wax myrtle (*Morella californica*), shrub
- salal (*Gaultheria shallon*), shrub
- kinnikinnick (*Arctostaphylos uva-ursi*), other herbaceous
- twinberry honeysuckle (*Lonicera involucrata*), other herbaceous

Community 1.1
Stabilized dunelands

This community phase represents the more stable community phase dominated primarily by the dune forest vegetation. The dune forests are found on the stabilized back dunes and are some of the most significant portions of intact dune forest left in the state. This community phase is dominated by two distinct and recognizable forest types, but for the time being they are grouped into one ecological site concept. These forest types are a *Pinus contorta* spp. contorta (shore pine) dominated type, a *Picea sitchensis* (Sitka spruce) dominated site, and a mixed conifer type. *Pseudotsuga menziesii* (Douglas-fir) is found in the shore pine and spruce types, whereas *Abies grandis* (grand fir) is found in all three, but most dominant in the mixed conifer type. They are the most stable, having been dominated by significant tree cover for decades and have a variety of shrubs in the understory. Dominant species in the understory communities are commonly *Vaccinium ovatum* (California huckleberry), Myrica californica (California wax myrtle), *Gaultheria shallon* (salal), *Arctostaphylos uva-ursi* (kinnikinnick), and *Lonicera involucrata* (twinberry

honeysuckle).

Community 1.2
Active and semi-stable dunelands

This community phase represents the more varied and unstable community phase represented primarily by the active dune, dune mat, and dune swale or deflation basin vegetation. The dune mat is of rather limited extent in this ecological site, while the active dune and dune swale and deflation basin vegetation are more significant. This community phase exists in areas that have been more heavily impacted by winter storms that modify the dune environment and the prevailing winds for a significant time period that creates these more transitory communities. Even the swales can be rather transitory in nature, developing over time while water is available in the low portions of the dunes and then disappearing as the sands deposit into the swales when the winds shift, burying these swales and becoming active dunes and dune mats with new low lying areas that become new swales.

Pathway 1.1a
Community 1.1 to 1.2

This pathway occurs when an area of stabilized forest begins receiving sand depositions and heavy winds when the prevailing winds shift. This combination of salt spray and burial over time begins to kill off the trees and burying them, creating openings for new dunes to begin forming. This is a long-term pathway that is dependent on shifts in weather patterns over a significant amount of time. More information on this pathway is needed to make more detailed information about this process available.

Pathway 1.2a
Community 1.2 to 1.1

This pathway occurs as areas of the dunes that are not in the most active areas of the dunes that gradually stabilizes with vegetation cover and as it stabilizes more and more, the vegetation cover shifts from dune mat cover to shrubs and then to sea spray tolerant trees, and then eventually in some areas, less sea spray tolerant trees like Douglas-fir and grand fir. This is a long-term pathway that is dependent on shifts in weather patterns over a significant amount of time. More information on this pathway is needed to make more detailed information about this process available.

State 2
Invaded State

This state represents the community phases that have been invaded by non-native species. This ecological site is highly susceptible to invasives, especially in Community Phase 1.2, given the more transitory nature of these communities they are primed for openings by non-natives that can capitalize quickly on available resources much

better than the native species can. This state is currently only one community phase, representing all the different types of communities from the reference state and in the future more information and research should be done to determine more specific dynamics in this state that are more heavily related to the different community expressions within this state and the dynamics amongst them all.

Dominant plant species

- European beachgrass (*Ammophila arenaria*), grass
- veldtgrass (*Ehrharta*), grass
- ripgut brome (*Bromus diandrus*), grass
- hottentot fig (*Carpobrotus edulis*), other herbaceous
- English ivy (*Hedera helix*), other herbaceous
- yellow bush lupine (*Lupinus arboreus*), other herbaceous

Community 2.1
Invaded dunelands

This community phase represents all the different community expressions of an invaded state. The dune mat community is the most at-risk for invasion and is dominated by the aggressive *Ammophila arenaria* (European beach grass). It is native to Europe and is a successful sand-binder that monopolizes the dune mat communities and outcompetes the native beach grass and other native forbs. It alters sand movement, decreases invertebrate abundance and diversity, and most significantly builds a steep, continuous foredune replacing the low, hummocky foredunes that are representative of the reference state dunelands. Other common invasives to this ecological site include *Carpobrotus edulis* (hettentot fig), *Ehrharta calycina* (Veldt grass), *Hedera helix* (English ivy), annual grasses such as *Bromus diandrus* (ripgut brome) and *Vulpia bromoides* (brome fescue), and some native species that are not typical in this ecological site like *Lupinus arboreus* (yellow bush lupine). Yellow bush lupine is native in the Central and Southern California coast lines, but is not native to this ecological site on the North Coast and becomes invasive in this site when introduced. It causes rapid changes in species composition and structure, resulting in changes in soil chemistry that facilitates secondary invasions by exotic grasses such as brome fescue and ripgut brome.

State 3
State 3

This state represents the intensive land uses that have significantly altered this ESG in a myriad of ways including removal of topsoil, fertilizer additions and other topsoil manipulations, hydrologic alterations that remove native soil fauna, among many other things and is typically due to urban developments, recreational activities, and intensive agriculture. More information about this state is needed to flesh out the various impacts these types of land uses/alterations have had on the ecological site in order to better understand how to manage these areas or potentially attempt restoration of these areas where possible.

Community 3.1
Intensive disturbance

This community phase represents all the varied land uses that significantly alter this ecological site group. This is an extremely varied community phase that includes all types of alterations that so significantly alter the ecological site that it is permanently changed and no longer has typical or even representative ecological dynamics. Land use models would be an appropriate option to develop these types of variations in altered landscapes. At this scale of grouping, specific drivers and triggers and expressions of communities is too varied and broad to be more specific. More data collection and field verification is necessary.

Transition T1
State 1 to 2

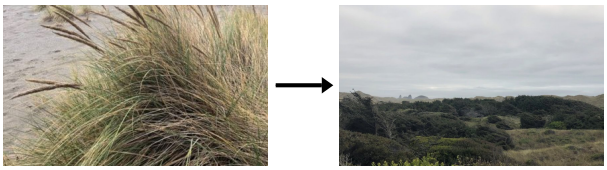
Reference State Invaded State

This transition occurs when the seed source is introduced to the ecological site. This ecological site is not highly resistant to outside pressures like invasive species, and in Community Phase 1.2 the site is most at-risk of this type of invasion. The threshold is crossed when feedback mechanisms shift from natural dynamics to feedback mechanisms that cater to the invasive species.

Transition T3
State 1 to 3

This transition is caused by significant human alterations that remove essential topsoil horizons, alter hydrologic functions, and/or add significant inputs that change soil chemistry and soil properties for housing developments, urban infrastructures or intensive cropping systems and force this ecological site over a threshold and change the function and structure of this site in extensive ways.

Restoration pathway R1
State 2 to 1



Invaded State Reference State

This restoration pathway occurs through the control of invasive species can potentially restore this ecological site to its reference state. It is more likely that the invasions are minimized and controlled, but complete removal of the invasives may not be possible without significant time and money inputs and repeated treatments.

Transition T2
State 2 to 3

This transition is caused by significant human alterations that remove essential topsoil horizons, alter hydrologic functions, and/or add significant inputs that change soil chemistry and soil properties for housing developments, urban infrastructures or intensive cropping systems and force this ecological site over a threshold and change the function and structure of this site in extensive ways.

Restoration pathway R3
State 3 to 1

This restoration pathway occurs only when significant time and money inputs that would require constant maintenance and weed management and should be focused on areas that have not been permanently altered by urban developments. This restoration pathway may be less likely than R2, since most of these very altered landscapes will be more hospitable to invasive species than to the native species that are more particular and require specific growing conditions that may not be replicable due to the alterations to the site that had occurred.

Restoration pathway R2
State 3 to 2

This restoration pathway occurs only when significant time and money inputs are focused on areas that have not been permanently altered by urban developments. This restoration pathway may be more likely than R3, since most of these very altered landscapes will be more hospitable to invasive species than to the native species that are more particular and require specific growing conditions that may not be replicable due to the alterations to the site that had occurred.

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