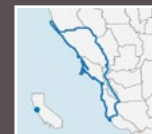


Coastal Dunes



Ecosystem Description

Coastal dunes range from mobile foredunes to semi- or fully-stabilized dunes dominated by dune grasses and, eventually, later-successional coastal scrub vegetation and oak woodlands. Dune morphology is strongly impacted by wind and waves that move sand inland from the beach, as well as land-use change, management activities, and other processes that impact sand movement and vegetation development. Vegetation is characterized by species tolerant of low nutrient availability, high water drainage, salt spray, wind desiccation, and periodic erosion and burial.

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Ecosystem Vulnerability - High

Sensitivity & Exposure - High

| Projected Changes | Trend |
|-------------------|------------|
| Sea level rise | ▲ Increase |
| Precipitation | ▲▼ Varies |
| Stream flows | ▲▼ Varies |
| Air temperature | ▲ Increase |
| Storms | ▲ Increase |

Potential Impacts:

- Increased coastal erosion and inundation of dunes due to sea level rise and storm surge, reducing extent and continuity
- Reduced growth, survival, and recruitment of native dune vegetation as a result of increased temperatures and water stress
- Likely expansion of invasive dune plants in response to wetter winter and drier summer conditions
- Changes in patterns of runoff from upland areas, altering sediment transport and supply

Non-climate stressors may interact with climate stressors and disturbance regimes:

- *Land-use conversion* and *roads* have degraded and fragmented coastal dunes across the region, and constrain inland dune migration in response to sea level rise
- *Invasive plants* displace native species and inhibit natural sand movement in response to wind and waves, anchoring dunes and limiting inland migration of the system
- *Recreational activity* (e.g., foot traffic, off-road vehicles) contribute to vegetation loss and increased erosion via trampling in coastal dunes, in addition to disturbing nesting shorebirds
- *Dredging and sand mining* are associated with altered patterns of sediment transport, erosion, and accretion within the region, and directly reduce material available to replenish eroding dunes



Increased temperatures and altered precipitation patterns are likely to stress native dune vegetation and accelerate the expansion of invasive plants. The combination of sea level rise and storm surge is also expected to reduce dune extent, particularly where inland movement is constrained by human development.

Ecosystem Vulnerability - High

Adaptive Capacity - Moderate

Intrinsic factors (i.e., inherent characteristics) that enhance or undermine adaptive capacity:

Enhance:

- Dynamic systems well-adapted to harsh conditions and natural disturbances
- Relatively high physical and topographic diversity, supporting many rare and specialized species

Undermine:

- Significant loss, fragmentation, and degradation of coastal dunes in the region
- Reduced resistance to sea level rise where geomorphic processes are altered
- Many native species at high risk of extirpation

Extrinsic factors (i.e., management potential) that enhance or undermine adaptive capacity:

Enhance:

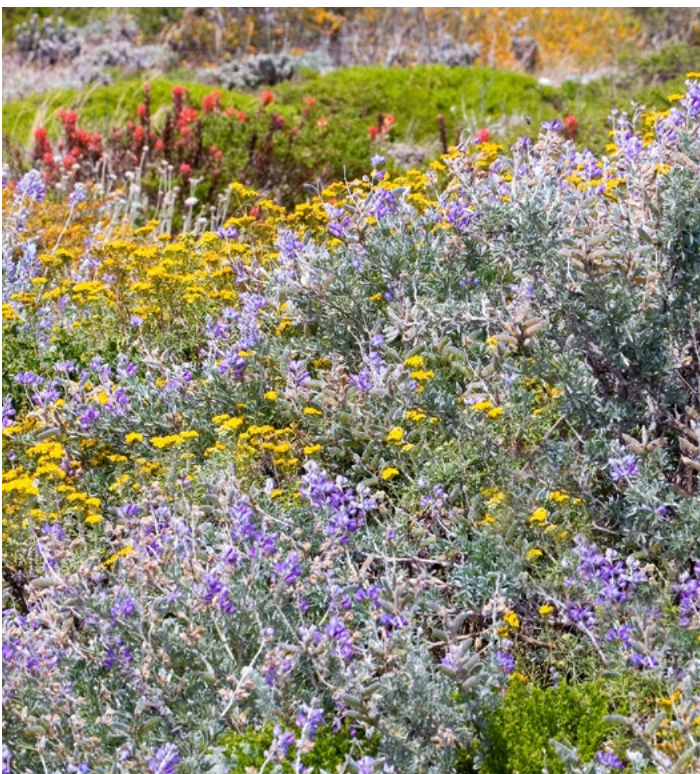
- Highly valued by the public
- High societal support for dune protection to protect inland communities from flooding

Undermine:

- Long-term success of management efforts is dependent on natural or human barriers that limit sediment deposition and dune migration



Although coastal dunes are well-adapted to natural disturbances, degradation and altered natural geomorphic processes likely reduce the resilience of these ecosystems to climate change.



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Adaptation Strategies & Actions

Adaptation strategies can reduce climate change vulnerability of a given ecosystem or species by addressing any or all of the three components of vulnerability (i.e., by reducing sensitivity, reducing exposure, and/or increasing adaptive capacity). The table below presents examples of adaptation strategies and actions, which fall within five categories, or approaches: Resistance/Resilience **(R)**, Acceptance **(A)**, Direct/Response **(D)**, Knowledge **(K)**, and Collaboration **(C)**. *Please note that the strategies and actions provided here should not be considered a checklist or plan, but rather as a set of examples for land managers to consider for further study when developing site- or species-specific actions.*

| Adaptation Strategies | Adaptation Actions |
|---|---|
| Protect dune ecosystems from human disturbances | <ul style="list-style-type: none"> • Consolidate foot traffic where feasible (R) • Prohibit off-leash dogs (R) • Post educational signage to increase understanding about the effects of human disturbances on dune systems (R) |
| Maintain and restore dunes and natural dune processes | <ul style="list-style-type: none"> • Remove invasive plants to allow for the recovery of native vegetation and natural sand movement (R) • Implement active revegetation and ongoing stewardship (R) • Mobilize volunteer forces for removal of invasives and site maintenance (R/C) |
| Reduce land use that constricts inland migration of dunes & plan for relocation and/or removal of roads and infrastructure | <ul style="list-style-type: none"> • Identify areas most vulnerable to sea level rise (K) • Identify the functional value of dune systems (i.e., habitat, recreation, flood protection, connectivity) to support protection of a “balanced portfolio” of dunes (K) • Map out opportunities for collaboration and partnership, specifically as they relate to relocation and removal of roads and infrastructure (D/K/C) • Identify and carry out collaborative land acquisition opportunities (e.g., land swaps, purchases) to proactively address dune loss due to sea level rise (D/C) • Downscale infrastructure as a precursor to retreat (D) |

Adaptation strategies and actions generated both through breakout group exercises during a December 2023 adaptation workshop as well as through suggestions from individual stakeholders.



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