

Freshwater Marshes



Ecosystem Description

Freshwater marshes are non-tidally influenced wetlands that are perennially or seasonally inundated, with plant species composition dependent on water depth and the timing and length of inundation. In the Golden Gate Biosphere (GGB) region, a variety of wetland types support freshwater marsh vegetation, including seasonally-ponded or saturated depressions, low-gradient dune slacks/creeks, sag ponds, and groundwater-fed slope wetlands. These wetlands support multiple types and heights of hydrophytic vegetation, which provide physical structure and habitat for a variety of species, including aquatic macroinvertebrates, amphibians, birds, and mammals.

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Ecosystem Vulnerability - High

Sensitivity & Exposure - High

Projected Changes	Trend
Air & water temperature	▲ Increase
Precipitation	▲▼ Varies
Drought	▲ Increase
Sea level rise	▲ Increase
Storms and flooding	▲ Increase
Wildfire	▲ Increase

Potential Impacts:

- Reduced aquatic biodiversity and macrophyte growth due to depletion of surface water and groundwater, increased water temperatures, and reduced dissolved oxygen levels
- Decreased plant growth, increased mortality, and range contractions resulting in altered composition and structure of vegetation communities
- Increased wildfire risk due to drier conditions
- Erosion, sedimentation, increased pollutant loads, reduced water quality, and shifts in vegetative assemblages following severe disturbances

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

- *Development and roads* restrict hydrologic connectivity and movement of wildlife, cause habitat loss and fragmentation, and facilitate the introduction of invasive species
- *Agriculture and livestock* have resulted in loss and degradation of wetland areas, altering their hydrology in addition to causing erosion, soil compaction, and trampling of vegetation
- *Pollutants* degrade water quality, with potentially severe impacts on aquatic organisms
- *Water diversions* create barriers to aquatic species' movement and decrease water quality/supply
- *Invasive species* displace native species, alter ecosystem structure, modify food webs, and impact nutrient cycling



Freshwater marshes are sensitive to climate stressors and disturbances that impact water levels, hydroperiods, and water quality, which alter habitat suitability for wildlife and plant species and drive changes in structure and function.

Ecosystem Vulnerability - *High*

Adaptive Capacity - *Low*

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

Enhance:

- Diverse structural characteristics that support high plant and animal diversity
- Provide critical habitat for rare species
- Provide essential ecosystem services (e.g., nutrient cycling and water filtration)

Undermine:

- Reduced resistance to climate change in fragmented/degraded systems
- Many species are at the southern limit of their distribution

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

Enhance:

- Increasing public value for beauty and recreational opportunities
- Existing regulatory protections

Undermine:

- Draining and fragmentation of many systems due to human land-use conversion, reducing resilience to climate change



Many freshwater marshes have been lost or degraded due to human activities such as development and reservoir construction, leaving remaining systems more vulnerable to climate change impacts.



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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
Improve understanding of where high-priority ponds and wetlands are on the landscape	<ul style="list-style-type: none"> • Develop a high-resolution GIS map of pond and wetlands in the study region under high, medium, and low water levels (K) • Rank ponds and wetlands (e.g., prioritized based on species of special concern, drought risk, “old growth” ponds) to identify those that should be prioritized for conservation and restoration (K)
Prevent the introduction and establishment of invasive species and remove existing populations	<ul style="list-style-type: none"> • Remove non-native fish and bullfrogs that are likely to exacerbate the impacts of climate change on native species (e.g., frogs) (R)
Increase water supply, retention, and quality in freshwater systems	<ul style="list-style-type: none"> • Develop models based on geology and soils to identify aquifer recharge areas that can be prioritized for protection (R/K) • Promote beaver occupancy and/or install beaver dam analogs to slow flow velocity and increase landscape water storage and groundwater recharge (R)
Maintain and restore hydrologic connectivity	<ul style="list-style-type: none"> • Redesign and replace undersized culverts to allow the passage of aquatic and terrestrial wildlife and sediment/debris under projected flow conditions (R) • Remove dams to restore natural flow and sediment regimes (R)
Reduce contaminant and nutrient inputs to improve water quality	<ul style="list-style-type: none"> • Collaborate with farmers to reduce agricultural runoff that contains contaminants and excess nutrients (R/C)
Prioritize and maintain sites that may be more resistant to changes in climate	<ul style="list-style-type: none"> • Identify and protect potential refugia (e.g., historical floodplains along creek edges, wetland areas with groundwater inputs) (R/K)

Adaptation strategies and actions suggested by individual stakeholders (not discussed during the December 2023 adaptation workshop).