RIVERS, STREAMS, AND FLOODPLAINS

Climate Change Vulnerability and Adaptation Strategies for the Santa Cruz Mountain Region

Habitat Description

Rivers and streams in the Santa Cruz Mountains region are characterized by rain-dominated hydrological regimes, with variable flows and frequent disturbances. Low-lying floodplains adjacent to river and stream channels experience periodic flooding, and often include riparian vegetation such as willow (*Salix* spp.), white alder (*Alnus rhombifolia*), Fremont's cottonwood (*Populus fremontii*), and western sycamore (*Platanus racemosa*), among others.

Habitat Vulnerability

Sensitivity & Exposure

Projected Changes	Trend
Streamflow	▲▼
Precipitation/Runoff	▲▼
Drought	▲
Water temperature	▲
Soil moisture	▼
Storms/Flooding	▲
Wildfire	▲

Potential impacts:

- Altered channel structure due to changing patterns of sediment deposition/erosion and vegetation encroachment
- Increased floodplain disconnection, creating isolated pools with high temperatures, low oxygen, and increased risk of harmful algal blooms
- Direct and indirect impacts to aquatic organisms that may result in population declines and range contractions
- Decreased plant growth and increased mortality, resulting in altered composition and structure of riparian vegetation
- Loss of riparian vegetation, altered stream channels, increased risk of landslides/debris flows, higher water temperatures, and reduced water quality following severe disturbances

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

- *Pollutants* reduce water quality, with potentially severe impacts on aquatic organisms
- *Roads, highways, and trails* increase runoff, increase sediment and restrict its movement, and contribute to channel incision and floodplain disconnection
- *Dams and water diversions* impact flow volume and timing in rivers and streams, affecting thermal regimes, sediment/erosion processes, and habitat continuity
- *Residential/commercial development* has resulted in significant habitat loss and fragmentation
- *Agriculture* and *livestock grazing* are associated with water withdrawals that reduce flow volume; livestock trampling compacts soils and reduces vegetation, increasing erosion/channel incision
- *Timber harvest* increases water temperatures where shade is lost, and is associated with increased erosion and debris slides that reduce water quality

Rivers, streams, and floodplains are most sensitive to climate stressors and more frequent/severe disturbances that impact hydrology, water quality, and the structure, composition, and distribution of riparian vegetation.

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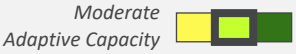
Adaptive Capacity



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

- ▲ Dynamic systems that are well-adapted to recover from disturbances
- ▲ High physical heterogeneity supports diverse aquatic communities
- ▼ Most rivers, streams, and floodplains in the region have been degraded
- ▼ Reduced recovery and high vulnerability to ecological collapse in degraded systems

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

- ▲ Highly valued for water supply, recreation, and other critical ecosystem services
- ▲ High societal support for habitat protection and management

Although rivers, streams, floodplains, and associated riparian areas are naturally dynamic systems well-adapted to disturbances, recovery is reduced or eliminated where anthropogenic stressors have significantly impacted ecosystem processes and habitat continuity.

Key Climate Vulnerabilities: **Salmonids**

The Central California Coast sub-populations of coho salmon (*Oncorhynchus kisutch*) and steelhead (*O. mykiss*) utilize a wide range of freshwater and estuarine habitats as well as marine areas, and are highly dependent on habitat connectivity and availability of suitable conditions for each life stage. Generally, salmonids are considered highly sensitive to climate stressors that drive altered flow regimes and warmer water temperatures, which impact habitat availability and quality as well as fish survival, recruitment, and migration. Other critical impacts may include:

- Reduced availability of sandbars and protected lagoons used for rearing habitat due to sea level rise
- Increased mortality risk due to storm-related flooding and landslides, wildfire, and disease
- Changes in ocean conditions (e.g., sea surface temperature, acidification, currents) that impact prey availability as well as the distribution of competitors and potential predators
- Interactions between climate changes and non-climate stressors (e.g., development, agriculture, dams/water diversions, environmental contaminants, and timber harvest, among others) that increase mortality, reduce habitat availability and suitability, or limit habitat connectivity

Factors that enhance or undermine adaptive capacity:

- ▲ High life history, phenotypic, and behavioral diversity enhances their ability to adapt to changing conditions
- ▲ High public and societal value increase support for management
- ▲ Regulatory support due to federal listing under the Endangered Species Act
- ▼ At or near the southern extent of their geographic range
- ▼ Dramatic population declines and associated decreases in genetic diversity in both species due to a combination of habitat fragmentation/ degradation and severe climate events (e.g., drought, heat waves)

Adaptation Strategies for Rivers, Streams, & Floodplains

Management practices for rivers, streams, and floodplains that reduce vulnerability to climate change are likely to focus on enhancing structural and functional integrity. These include restoring variable flow regimes and increasing flow volumes in areas impacted by dams and water diversions, reducing nutrient inputs to minimize the risk of harmful algal blooms, restoring incised stream channels, and reconnecting floodplains with mainstem rivers.

Management strategies for salmonids include many existing restoration activities, such as improving access to critical spawning areas and coldwater refugia, enhancing habitat complexity and heterogeneity, and restoring natural flow regimes within aquatic systems.

ADAPTATION APPROACH	ADAPTATION STRATEGIES
Resistance strategies: Maintain current conditions by limiting change *Near-term approach*	• Improve water storage, conservation, and efficiency • Prioritize infrastructure upgrades/retrofits in highly erosive areas • Modify water rights (e.g., apply for new appropriated rights for winter water; add beneficial use to rights for instream flows) • Improve access to habitats by removing barriers to aquatic organism passage
Resilience strategies: Accommodate some change while enabling a return to prior conditions *Near- to mid-term approach*	• Restore natural sediment transport processes (e.g., by removing instream structures) • Improve stream habitat by building up the streambed and water table and creating pools • Implement thinning and other vegetation management in riparian habitats
Response strategies: Intentionally facilitate or direct change to adaptively respond to new conditions *Long-term approach*	• Consider transporting fish to other aquatic habitats/areas if current locations dry up or flows are too low • Identify and protect high-elevation streams and other potential refugia that may be resistant to the effects of climate stressors* • Source riparian and wetland species for plantings from areas lower in the watershed that are warmer and drier*
Knowledge strategies: Gather information about climate changes, impacts, and/or management effectiveness *Near- to long-term approach*	• Create regional watershed maps of landownership, development, land use, and water use to better understand impacts of upstream actions on downstream areas* • Increase temperature and streamflow monitoring across basins and watersheds to inform connectivity planning and identify high quality habitat (e.g., potential coldwater refugia)* • Monitor fish and wildlife abundance and activity before and after restoration efforts to support adaptive management*
Collaboration strategies: Coordinate management efforts and/or capacity across boundaries *Near- to long-term approach*	• Increase education with landowners about likely climate impacts to streams as well as management actions that increase water availability/reliability while also providing fish habitat* • Work with farmers to reduce agricultural runoff that contains contaminants and excess nutrients*

** Future management strategies (not currently occurring)*

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Further information and citations can be found in the source reports of the Santa Cruz Mountains Climate Adaptation Project, available online at http://ecoadapt.org/programs/awareness-to-action/santa-cruz-mountains.