SCCWRP FACT SHEET

Making aquatic ecosystems resilient for a changing climate

Environmental managers are pursuing multiple types of solutions to help aquatic ecosystems cope in the face of climate change

Climate change poses a pervasive and intensifying threat to the health of aquatic ecosystems, manifesting as a range of environmental stresses that is affecting the ability of water bodies to support diverse plant and animal communities. To mitigate these stresses, Southern California's environmental management community is pursuing multiple solutions intended to make aquatic ecosystems more resilient in the face of climate change – a concept known as **climate resiliency**.

Photo credit: Kirk Gilligan

An endangered Ridgeway's rail tending to its nest is surrounded by high tide. Wetlands are among the aquatic ecosystems where researchers are exploring solutions for how to enhance resiliency in the face of a changing climate.

How the effects of climate change are manifesting

Climate change is responsible for causing and exacerbating multiple types of stresses on Southern California's aquatic ecosystems, including changes in water quality, water quantity (e.g., drought, flooding), increasing temperatures, and rainfall patterns. This fact sheet highlights three of these stresses; each corresponds to a subsequent section of the fact sheet highlighting potential climate solutions for offsetting the three stresses:

- **Changes in stream flow patterns**: A combination of climate-induced changes to rainfall patterns and changes in the timing of snowpack melt is causing streams to experience alterations to seasonal flow patterns. These flow changes adversely affect aquatic life, particularly when exacerbated by climate-driven increases in stream temperature. The flow changes also are affecting human recreation activities.
- **Rising sea levels**: As global climate change causes polar ice to melt and ocean water to expand as it warms, sea levels are rising. Southern California's low-lying coastal wetlands are at risk: About half of these ecologically important habitat areas are projected to become permanently submerged by 2100.
- **Ocean acidification**: The ocean is absorbing about one-third of carbon dioxide emissions from the atmosphere, which is causing seawater pH to drop via a phenomenon known as ocean acidification. As a result, minerals in seawater that shell-forming organisms depend on are becoming less available – which, in turn, is triggering shell dissolution and could lead to biodiversity losses if vulnerable marine populations collapse. Meanwhile, as climate change causes the ocean to warm, coastal waters are becoming more conducive to proliferations of ecologically disruptive harmful algal blooms, which – via complex ocean biogeochemical cycling processes – can further exacerbate coastal ocean acidification conditions.

CLIMATE SOLUTIONS FOR

Changes in stream flow patterns

Researchers are exploring multiple potential solutions for minimizing and offsetting climate-triggered changes to stream flow patterns. These solutions are being designed to mimic and complement natural features:

» **Flow controls**: Researchers are studying how to divert, impound and augment flows in streams – with a goal to re-create more natural flow patterns under future climate conditions.

» **Habitat restoration**: Researchers are exploring how to restore the physical habitat of streams to promote more natural flow patterns, including by adding native vegetation, constructing naturalistic side channels, and making changes to channel form that do not compromise the channel's flood control functions.

» **Changes in groundwater management practices**: Because routine groundwater pumping activities have the potential to adversely affect how water flows in adjacent surface-level streams, researchers are exploring how to adjust groundwater management practices in ways that will minimize disruptions to flowing surface waters and support more natural flow regimes in light of future changes in projected rainfall patterns.

CLIMATE SOLUTIONS FOR
Rising sea levels

As sea level rises, researchers are exploring multiple solutions for offsetting future projected losses of Southern California coastal wetlands. These potential solutions, which could come with challenges and drawbacks of their own, include:

» **Thin-layer sediment placement**: Researchers are exploring how and where to spread dredged sediment (i.e., sediment that is removed from the bottom of a water body by dredging) on top of wetlands to gradually raise wetland elevation to accommodate sea-level rise.

» **Strategic relocation**: Researchers are exploring if, how and where to establish new wetlands at higher elevations that could replace areas that become submerged.

» **Living shorelines**: Researchers are exploring if, how and where to stabilize shorelines using native, sediment-trapping plants and other techniques that help insulate wetlands from rising sea levels.

Photo credit: Christine Whitcraft, California State University, Long Beach

Sediment is spread on top of a wetland to raise its elevation – a potential solution for preventing it from becoming permanently submerged by rising sea levels.

CLIMATE SOLUTIONS FOR
Ocean acidification

As ocean acidification in Southern California's coastal ocean intensifies, researchers are exploring two major classes of climate solutions that could help offset and mitigate seawater chemistry changes:

» **Land-based nutrient management**: Researchers are studying the influence of land-based nutrient discharges on coastal acidification, with the goal to understand if reducing these discharges could mitigate acidification's trajectory – and if so, where, when and by how much. Computer modeling of the coastal ocean is helping researchers to make these predictions.

» **mCDR**: Researchers are examining a disparate collection of climate solutions collectively known as marine carbon dioxide removal (mCDR) that may be able to offset and help reverse coastal ocean acidification by removing dissolved carbon dioxide from seawater. Computer models of the coastal ocean are being adapted to investigate the efficacy of implementing mCDR solutions at commercial scales. Researchers also are evaluating these solutions for a wide range of possible unintended ecological consequences. mCDR solutions being explored in Southern California include:

- **Kelp farming** uses the photosynthetic power of giant kelp to naturally remove carbon dioxide from seawater. Thus, kelp farming has the potential to help buffer against the effects of acidification – while simultaneously oxygenating the water column and removing nutrients.
- **Direct ocean capture** is a class of technologies that directly removes dissolved carbon dioxide from seawater – such as via electrochemical processes – thereby enabling the ocean to absorb more carbon dioxide from the atmosphere. In the process, direct ocean capture may be able to mitigate acidification-triggered changes to seawater chemistry.
- **Ocean alkalinity enhancement** is an approach that involves adding alkaline minerals to seawater to draw down carbon dioxide levels, thus enabling the ocean to absorb more atmospheric carbon dioxide. Like direct ocean capture, alkalinity enhancement also may be able to mitigate coastal acidification.

Photo credit: Captura Corporation

Southern California is exploring the efficacy of direct ocean capture solutions like electrodialysis, above, for removing carbon dioxide from seawater.

More reading

[California's Climate Adaptation Strategy](#)

[SCCWRP's Climate Resiliency Research Plan](#)