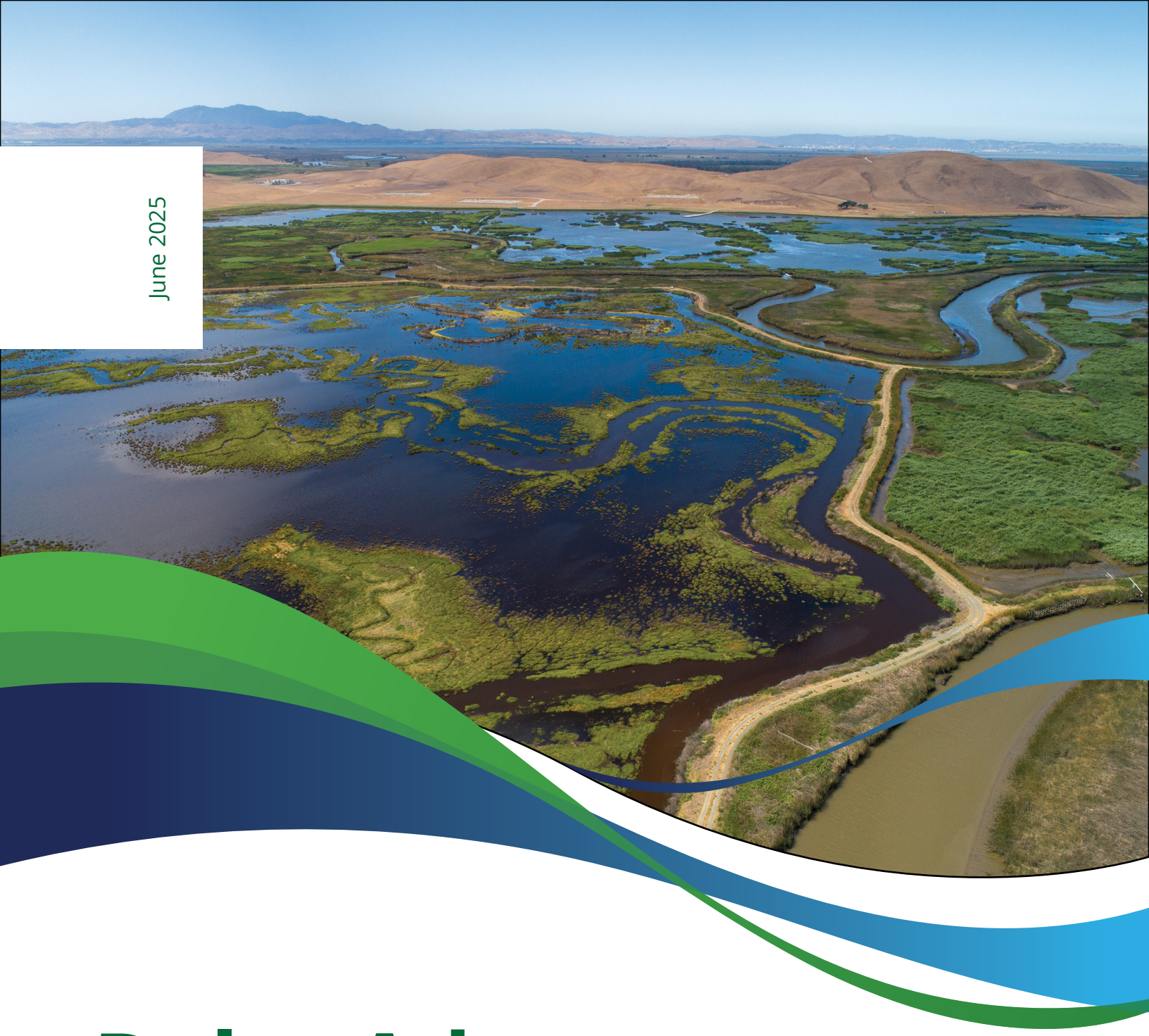

June 2025

# Delta Adapts:

## Creating a Climate Resilient Future

### Adaptation Plan

Delta Stewardship Council

A CALIFORNIA STATE AGENCY

# Delta Adapts:

## Creating a Climate Resilient Future

Sacramento-San Joaquin Delta Climate Change Adaptation Plan

June 2025

For assistance interpreting the content of this document, please contact Delta Stewardship Council staff. Email: accessibility@deltacouncil.ca.gov or call 916-445-5511. For any content questions regarding this document please contact climatechange@deltacouncil.ca.gov.

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# Project Team

## Delta Stewardship Council

Jeff Henderson, AICP
*Executive Sponsor*

Morgan Chow
*Project Manager*

Ashok Bathulla, P.E., CFM, D.WRE
*Flood Risk Reduction Technical Lead*

James Edwards, P.E.
*Water Supply Reliability Technical Lead*

Erin Mullin, P.E.
*Supervising Engineer*

Daniel Constable
*Ecosystems Technical Lead*

Jessica Rudnick, Ph.D.
*Former Sea Grant Extension Specialist*
*Agricultural Technical Co-Lead*

Chris Kwan, Ph.D.
*Agricultural Technical Co-Lead*

Annie Merritt
*Outreach Lead*

Dylan Chapple, Ph.D. and Stephen Elser, Ph.D.
*Ecosystem Support*

Annika Ragsdale and Audrey Cho
*Adaptation Plan Support*

Former Council Staff and Fellows: Harriet Lai Ross *(former Project Manager)*; Cory Copeland; Anthony Navasero, P.E.; Andrew Schwarz, P.E.; Avery Livengood, CFM, AICP; Aaron Angel; Charnelle Wickliff; Annika Keeley, Ph.D.; Kaylee Griffith; Ron Melcer Jr.; Kate Anderson; Molly Williams

## Consultant Team

Justin Vandever, P.E.
*Project Manager, AECOM*

Shelley Jiang, Sonia Aronson, Luisa Torres-Duenas, Pavel Ozeruga, Ann Campbell, Emily Schwimmer, Annie deBoer, Alison Nemirow
*AECOM*

Richard McCann, Ph.D., Alec Fleischer
*M.Cubed*

Steve Deverel, Ph.D., P.G., Marc Olds, Jose Diaz, Liyi Monier
*HydroFocus*

Ben Gettleman, Nahal Ipakchi, Marlys Jean, Brita Romans
*Kearns & West*

## Stakeholder Workgroup, Technical Focus Groups, Environmental Justice Expert Group, and Consulting Tribes

The Delta Adapts team would like to thank the members of the Stakeholder Workgroup, technical focus groups, Environmental Justice Expert Group, and consulting tribes that participated in the Delta Adapts initiative and provided valuable input and feedback.

# Acronyms and Abbreviations

| | |
|---|---|
| **AB** | Assembly Bill |
| **ART** | Adapting to Rising Tides |
| **BCDC** | San Francisco Bay Conservation and Development Commission |
| **CalEPA** | California Environmental Protection Agency |
| **CALFED** | CALFED Bay Delta Program |
| **CalOES** | California Governor's Office of Emergency Services |
| **CARB** | California Air Resources Board |
| **CBO** | Community-based organization |
| **CCVA** | Climate Change Vulnerability Assessment |
| **CDFA** | California Department of Food and Agriculture |
| **CDFW** | California Department of Fish and Wildlife |
| **CDPH** | California Department of Public Health |
| **CEQA** | California Environmental Quality Act |
| **CFM** | Certified Floodplain Manager |
| **CNRA** | California Natural Resources Agency |
| **COG** | Council of Governments |
| **Council** | Delta Stewardship Council |
| **CRS** | Community Rating System |
| **CVFPB** | Central Valley Flood Protection Board |
| **CVFPP** | Central Valley Flood Protection Plan |
| **CVP** | Central Valley Project |
| **Delta** | Sacramento-San Joaquin Delta |
| **Delta Conser-vancy** | Sacramento-San Joaquin Delta Conservancy |
| **DLIS** | Delta Levees Investment Strategy |
| **DPC** | Delta Protection Commission |
| **DPIIC** | Delta Plan Interagency Implementation Committee |
| **DPWD** | Del Puerto Water District |
| **DSC** | Delta Stewardship Council |
| **DWR** | California Department of Water Resources |
| **EFO** | Ensemble Forecast Operations |
| **EJ** | Environmental justice |
| **EO** | Executive Order |
| **EPA** | Environmental Protection Agency |
| **ESA** | Endangered Species Act |
| **FEMA** | Federal Emergency Management Agency |
| **FIRO** | Forecast-Informed Reservoir Operations |
| **Flood-MAR** | Flood Managed Aquifer Recharge |

| | |
|---|---|
| **GHAD** | Geologic Hazard Abatement District |
| **GHG** | Greenhouse gas |
| **HAB** | Harmful algal bloom |
| **ISB** | Delta Independent Science Board |
| **IPCC** | Intergovernmental Panel on Climate Change |
| **LCI** | Governor's Office of Land Use and Climate Innovation |
| **NDWA** | North Delta Water Agency |
| **NFIP** | National Flood Insurance Rate Program |
| **NMFS** | National Marine Fisheries Service |
| **NOAA** | National Oceanic and Atmospheric Administration |
| **NRCS** | Natural Resources Conservation Service |
| **NVRRWP** | North Valley Regional Recycled Water Program |
| **OES** | Office of Emergency Services |
| **OPC** | Ocean Protection Council |
| **RCD** | Resource Conservation District |
| **SACOG** | Sacramento Area Council of Governments |
| **SAFCA** | Sacramento Area Flood Control Agency |
| **SFEI-ASC** | San Francisco Estuary Institute - Aquatic Science Center |
| **SJAFCA** | San Joaquin Area Flood Control Agency |
| **SJCOG** | San Joaquin Council of Governments |
| **SMPA** | Suisun Marsh Protection Act |
| **SMPP** | Suisun Marsh Protection Plan |
| **SPFC** | State Plan of Flood Control |
| **SVI** | Social vulnerability index |
| **SWG** | Stakeholder Workgroup |
| **SWP** | State Water Project |
| **SWRCB** | State Water Resources Control Board |
| **TPL** | Trust for Public Lands |
| **UC** | University of California |
| **UHI** | Urban Heat Island |
| **USACE** | United States Army Corps of Engineers |
| **USBR** | United States Bureau of Reclamation |
| **USDA** | United States Department of Agriculture |
| **USFWS** | United States Fish and Wildlife Service |
| **USGS** | United States Geological Survey |
| **WSAFCA** | West Sacramento Flood Control Agency |
| **WSR** | Water supply reliability |

# Executive Summary

**The Sacramento–San Joaquin Delta is of critical importance to California's people, ecosystems, and economy.** The Delta provides sanctuary for more than 750 plant and animal species, including critical and endangered migratory birds and salmon, whose lifeway is sacred to many tribes. Much of the state relies on the water conveyance infrastructure that runs through and from the Delta, supplying a portion of the drinking water to 27 million people and irrigation to farms throughout the Central Valley. Today, over 550,000[1] people live in the Delta, in environments that range from rural agricultural landscapes, small towns, and urban areas (**Figure ES-1**).

It is important to acknowledge, however, that the Delta once was home to, and stewarded by, Native Peoples, including the Bay Miwok, Coast Miwok, Plains Miwok, Maidu, Nisenan, Ohlone, Patwin, Pomo, Wappo, Wintun, and Yokuts. Their ancestral homeland remains a landscape of cultural and traditional significance for tribal people, represented by various tribes and groups today, only some of whom have received federal recognition.

Today, the Delta – like the entire state – is facing the accelerating impacts of climate change. Many impacts are already being felt. Rising sea levels, extreme heat, flooding, drought, changes in precipitation, and upstream fires and air quality impacts all threaten the people, ecology, industry, agriculture, infrastructure, and economy of the Delta. Droughts and salinity intrusion from sea level rise already do and could continue to disrupt harvests and the long-term viability of the agricultural economy, while flooding could overtop levees, endanger communities, and disrupt the conveyance infrastructure supplying water to millions of Californians. Socially vulnerable communities within and beyond the Delta are particularly at risk, both from short-term disasters and long-term, cascading impacts. **As the Delta continues to feel the pressures of climate change, regional adaptation rooted in collaborative, science-based decision making, community knowledge, and lived experiences is more important than ever.**

**The Delta Stewardship Council (Council) was established, in part, to provide sustainable management for the Delta ecosystem, and climate adaptation is a critical consideration to achieve that mission in future decades.** To respond to the challenge of climate adaptation,

### Delta Reform Act Coequal Goals

The Delta Reform Act (2009) establishes two coequal goals: secure a reliable water supply for California and protect and restore the Delta ecosystem, and the fish, wildlife, and recreation it supports, in a manner that protects and enhances the Delta as a unique and evolving place.

1 This number is based on the 2010 U.S. Census Bureau. Using U.S. Census Bureau 2020 data indicated the legal Delta population is closer to 650,000 people. However, due to the boundaries of the legal Delta not aligning with census tracts, block groups, or counties, this is an approximate value.

the Council developed this initiative, Delta Adapts: Creating a Climate Resilient Future (Delta Adapts). Climate change must be considered to attain the state's coequal goals, as established by the 2009 Delta Reform Act: securing a reliable water supply for California, protecting and restoring the ecosystem and wildlife it supports, and enhancing the Delta as a unique place, with its community, tribal, and agricultural heritage. The Council adopted the Delta Plan, which has regulatory policies that protect land for restoration and agriculture, help manage flood risk, and improve water supply reliability.[2] The Delta Plan directs the Council to guide and regulate actions of the 200+ state and local agencies in the Delta to ensure they support statewide water supply reliability and Delta ecosystem restoration.

Through the Delta Plan, the Council established a model for science-based decision-making, coordination, and collaboration between the many partners in the Delta that can serve as a model for adapting to climate change. **Delta Adapts builds on the Delta Plan through a first-ever comprehensive, regional approach to climate resilience and a commitment to collaborating on adaptation activities across federal, state, local, and regional levels for the Delta and Suisun Marsh (collectively, "the Delta").**

## Goals and Objectives

The Council is uniquely equipped – and authorized – to steward the Delta toward resilience. **The Council serves as a manager with the authority, responsibility, accountability, scientific support, and funding to achieve the state's policy goals for the Delta.** Much of this is accomplished through the implementation of the Delta Plan.

Initiated in 2018 by the Council, Delta Adapts began with a **Climate Change Vulnerability Assessment (CCVA)** to understand how regional climate impacts will affect the Delta's ecosystems, water supply, infrastructure, agriculture, and communities, including socially vulnerable communities (defined in **Chapter 1).** Now, this Adaptation Plan builds upon the CCVA and proposes strategies to address how Delta communities, infrastructure, and ecosystems can adapt to climate change in a manner consistent with the Council's resilience goals (see **Section 1.2).**

Notably, **Delta Adapts is the first climate adaptation plan encompassing the entire Sacramento-San Joaquin Delta, considering climate resilience from the perspectives of communities, watersheds, ecosystems, and critical infrastructure.** Delta Adapts combines cross-cutting strategies and approaches that identify priority actions, costs, and responsible entities – developed through rigorous and new formats of engagement – all in one place.

2 Specific projects, as they relate to proposed strategies and actions, must be consistent with existing Delta Plan policies.

Delta Adapts recognizes the critical components for regional adaptation are already key pillars of the Council's work and the Delta Plan. These include adaptive management, use of best available science, reduced reliance on the Delta for water supply, and strategic land use planning. Similarly, the partnerships established through the Delta Plan will be invaluable in supporting the actions needed at all levels (local, regional, state, and federal) to implement the strategies outlined in Delta Adapts, as well as build the necessary governance, financing, and implementation tools.

Delta Adapts supports and responds to numerous other state efforts, including California's Water Resilience Portfolio and Water Supply Strategy, as well as executive orders from Governor Newsom and past governors. Simultaneously, many regional and local authorities have begun to incorporate climate change into their planning and policy frameworks, and Delta Adapts can support, guide, and inform these efforts (see **Section 1.1).**

The historic district of Locke, California

## Outreach and Engagement

A deep foundation of community outreach and engagement (see **Chapter 2)** informed the development of the Delta Adapts Adaptation Plan. Council staff convened a Stakeholder Workgroup and focus groups comprised of technical experts to review climate vulnerabilities; discuss values, desired adaptation outcomes, and adaptation priorities; and provide input on adaptation strategies.[3]

A core part of community outreach was Council staff's engagement with community-based organizations (CBOs) that serve socially vulnerable communities, including partnering to hold community workshops, one-on-one meetings, and presentations at existing meetings and events. Additionally, an Environmental Justice (EJ) Expert Group – established primarily to inform the Council's Tribal and EJ Issue Paper- and a series of both formal and informal tribal consultations informed the development of the Adaptation Plan.

Other outreach activities included interviews with Delta growers; regular briefings and meetings with state, local, flood, and water agencies; presentations at agency meetings and events; and consideration of key findings from a 2023 Delta Residents Survey (Rudnick et al. 2023) to incorporate input from as wide an audience as possible.

3 Since we formed the Stakeholder Workgroup, our understanding of the word "stakeholder" has changed. Some scholars note that this term overlooks the cultural and spiritual significance of land and non-human species to the decision-making process (Reed et al., 2024). Moving forward the Council intends to move away from this word towards more inclusive terminology (DSC 2025a).

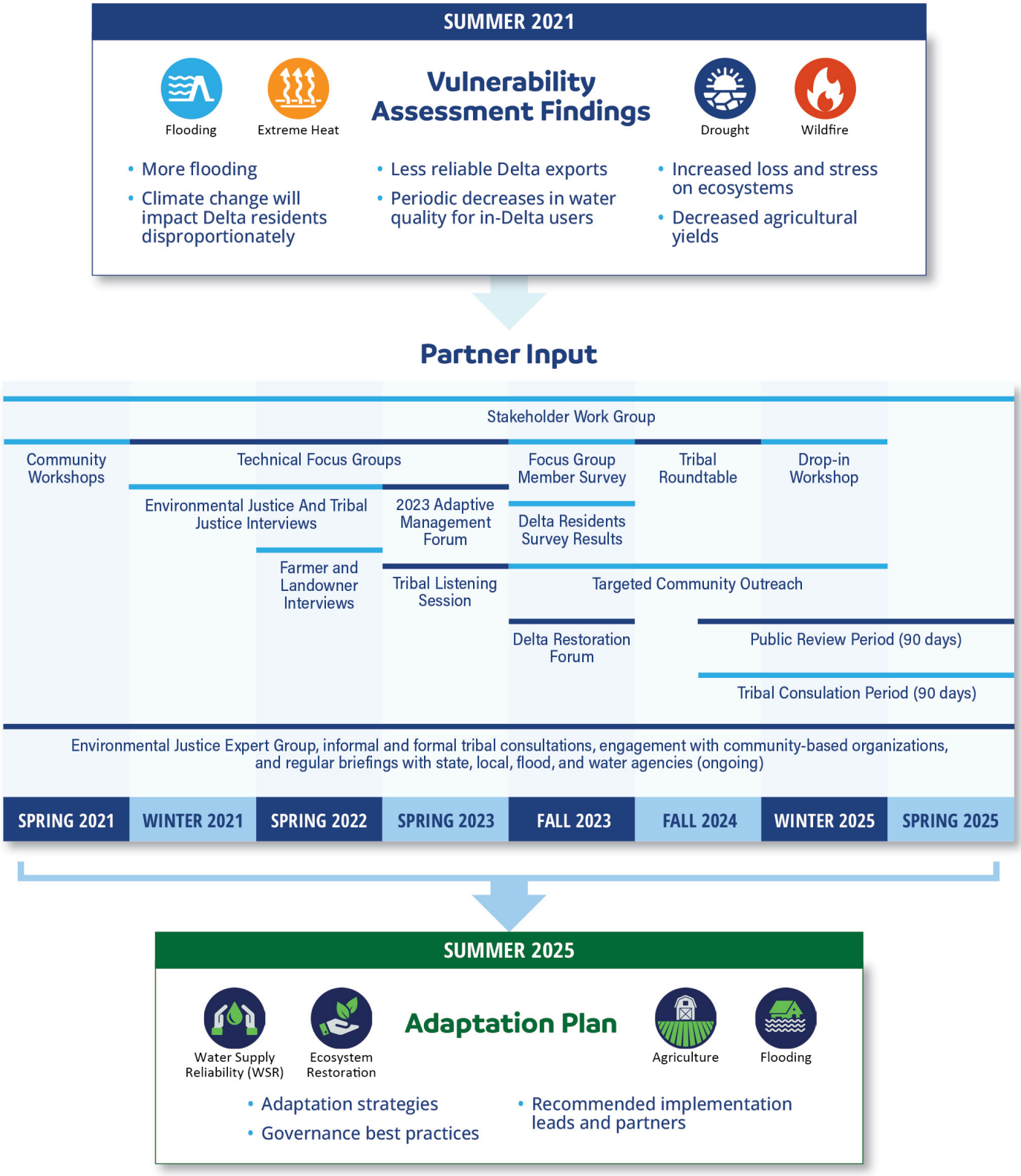


**Figure ES-1** Outreach and Engagement Efforts That Informed the Adaptation Plan

## Equity and Delta Adapts

Council staff incorporated equity in this initiative in several ways. First, as part of the CCVA, staff developed a social vulnerability index to identify communities and populations who are most vulnerable to climate hazards due to socioeconomic factors (DSC 2021b). These communities can be found throughout the Delta; those with the highest scores in the social vulnerability index (see **Section 2.2)** include neighborhoods in Antioch, Pittsburg, and Stockton, where residents are likely to have high sensitivity and low adaptive capacity to extreme heat, flooding, and other climate impacts. Key vulnerabilities and adaptation priorities for these three communities are highlighted in **Section 2.2.**

> **Equity** is the just and fair inclusion into a society in which all can participate, prosper, and reach their full potential (LCI 2018b; PolicyLink 2018).

This photo from 1969 illustrates floodwaters from a levee breach inundating Sherman Island and the former Antioch Bridge

Community and tribal feedback informed development of the Delta Adapts adaptation strategies, including equity considerations and participatory governance best practices including but not limited to incorporating diverse perspectives and other ways of knowing.

**Equity considerations are embedded throughout the adaptation strategies and implementation actions.** Each strategy considers how its implementation may support improved health, economic stability and prosperity, physical and emotional wellbeing, and social justice for vulnerable communities. Increasing representation of those who have been historically left out of government procedures and decision-making (representational justice) is also integrated within governance best practices (see **Chapter 10).** These recommendations aim to ensure that public processes and decision-making bodies include the communities they serve, and that the communities most impacted by decision-making can meaningfully participate throughout the process (*procedural equity).* This requires agencies to listen to communities regarding their priorities and needs and develop projects in partnership with community members and tribes rather than presenting nearly finalized ideas.

## Costs and Benefits of Adaptation

Implementing the strategies recommended in this Adaptation Plan would require a sustained commitment of resources. As part of the Adaptation Plan, Council staff evaluated potential costs to implement levee improvements and ecosystem restoration – two major sources of costs in implementing this plan – to address climate vulnerabilities through 2050 (see **Chapter 9).** While other strategies have costs as well, the scope of staff's costing evaluation was limited to levee improvements and ecosystem restoration, due to their larger relative costs and available models and resources. Levee improvements focus on crest raising to accommodate projected water level increases in the Delta due to sea level rise and changes in watershed hydrology. Levee cost estimation methods are detailed in the **Delta Adapts - Scenario Evaluation Metrics Results Technical Memorandum (DSC 2023).** Ecosystem restoration costs were estimated for a range of acreages to meet Delta Plan and California Air Resources Board (CARB) 2022 Scoping Plan targets (60,000 to 80,000 restored acres) (DSC 2023; CARB 2022). Per acre cost estimates were developed using available historic restoration project costs and grant funding amounts, input provided by the Department of Water Resources (DWR), and estimates from the Bay Delta Conservation Plan. Restoration costs can vary widely, and therefore a range of costs is considered to capture this uncertainty (see **Table ES-1**). Total estimated levee improvement and restoration costs through 2050 range between $5.7 billion to $8.5 billion, with the variation largely driven by the number of acres targeted for ecosystem restoration. Climate adaptation strategies can reduce risk, avoid damages, and maximize co-benefits. A recent study found that every $1 spent on climate resilience and preparedness in the Sacramento area results in $10.80 in economic savings, including reduced damages, cleanup costs, and economic impacts (U.S. Chamber of Commerce 2024). See **Chapter 9** for more information on these cost estimates and the benefits of proactive adaptation.

**The funding need is substantial, and there is a critical need to identify sustainable funding sources, prioritize investments, and generate additional revenue to fund implementation of the strategies identified in this Adaptation Plan.**

It will require time, effort, and funding to carry out the actions in this plan. The pace of implementation will depend upon the availability of resources and competing priorities among federal, state, and local partners. Implementation may require new and existing funding mechanisms, innovative approaches, and collaborative partnerships.

**Table ES-1** Projected Delta Ecosystem Restoration and Levee Adaptation Costs Through 2050 (from DSC 2023)

| Cost or Funding Source | Low-Cost Scenario | High-Cost Scenario |
|---|---|---|
| Levee Improvements | $3.2B | $3.3B |
| Habitat Restoration | $2.5B | $5.2B |
| **Total Costs** | **$5.7B** | **$8.5B** |

## Adaptation Approach

Council staff developed adaptation strategies for state, tribal, and local decisionmakers and land managers to reduce climate vulnerabilities for Delta communities, infrastructure, and ecosystems. The strategies are informed by the principles of best available science and the "One Delta, One Science" approach to strengthen coordination between scientists, agencies, and interested parties (see **Chapter 2**). Adaptation strategies are categorized according to four focus areas: **flood risk reduction, ecosystems, agriculture, and water supply reliability.**

Council staff identified 30 adaptation accelerator[4] actions that should be addressed first in the implementation of the Adaptation Plan. These 30 actions should begin by 2030. These 30 actions meet the following requirements:

1. **These actions need to happen now:** Some actions must be implemented sooner rather than later because they have a narrow window for implementation. If the action is not started soon, it may be too late, either because the action is no longer possible or because the intended benefits cannot be realized.
2. **These actions have widespread support:** These actions are included in other agency plans or existing initiatives and are based on established science.

Council staff recognize that it will require time, effort, and funding to carry out these adaptation accelerator actions. The pace of implementation will depend upon the feasibility and availability of resources among federal, state, and local partners.

**Chapter 4** through **Chapter 7** present adaptation strategies that lay out a series of actions to increase climate resilience in the Delta, organized within each of the four focus areas.

Although strategies are designed to achieve multiple resilience goals and co-benefits, or beneficial outcomes beyond the primary purpose of the strategy, some strategies may potentially lead to tradeoffs between priorities and should be carefully planned and implemented to minimize these tradeoffs or negative consequences to communities.

Crews perform levee maintenance and infrastructure improvements at New Hope Tract in San Joaquin County

4 This term is commonly used in the field of adaptation when referring to initiatives, programs, or projects designed to speed up and scale up effective climate adaptation solutions and practices, often targeting vulnerable communities and regions.

The Delta and Suisun Marsh share many common challenges, but regions within the Delta also have their own unique challenges, considerations, priorities, and appropriate adaptation strategies. For example, the North Delta offers opportunities for multi-benefit restoration projects that incorporate integrated farming practices, while activities in the Central Delta must prioritize halting subsidence. Salinity management is a priority for the South Delta and Suisun Marsh (as well as the protection of transition zones and enhanced wetland management). Other strategies, such as aquifer recharge, increasing regional water supply self-reliance, and upstream habitat restoration, should be implemented outside of the Delta. These regional considerations for adaptation strategies are covered in more detail in **Chapter 8.**

## Understanding the Difference Between Climate Adaptation and Mitigation

Both **adaptation** – the process of adjusting to current or future expected climate change and its effects on natural, built, and human systems – and **mitigation** – actions that reduce the severity or compensate for the effects of climate change – are critical for addressing the climate challenge. This report focuses on adaptation but recognizes that adaptation and mitigation can go hand in hand when actions that lessen the impacts of climate change also reduce greenhouse gas (GHG) emissions, such as sustainable farming practices or wetland restoration that also reduces flood risk.

An overview of the adaptation approach within each of the four focus areas is provided below.

### Flood Risk Reduction

The Delta is a complex system whose water levels are influenced by riverine flows, tides, storm surge, flood hazard management, and water supply operations. Climate change will affect many of these factors, increasing the risk of flooding and placing greater stress on the Delta's aging flood management system. The consequences of floods and inadequate recovery from flood events can devastate communities. The Adaptation Plan reduces flood risk through a series of actions focused on **in-Delta levee improvements and land use changes,** implementation of **nature-based solutions** to support flood mitigation and ecosystem services, **improved emergency preparedness and response,** improved communication, and **upstream management of reservoirs** to control flood flows into the Delta **(Figure ES-2).** This work has shown that investing in levee improvements now is a cost-effective adaptation approach that brings several co-benefits.

Flood damage caused by the Jones Tract levee breach in 2004

## Flood risk reduction adaptation accelerator actions include:

- Integrate climate change and socio-economic factors into flood risk management (**FL-1-1**)
- Strengthen collaboration and dialogue on flood risk reduction (**FL-1-2**)
- Integrate climate risks and equity into the Delta Levees Investment Strategy (**FL-2-2**)
- Ongoing inspections and maintenance considering future climate conditions (**FL-2-3**)
- Support for levee improvements and multi-benefit projects (**FL-2-4**)
- Provide 200-year protection for key islands and 100-year protection for others (**FL-2-5**)
- Prioritize levee improvements in socially vulnerable communities (**FL-2-6**)
- Appropriate funds for local agencies to upgrade levees (**FL-2-8**)
- Implement advanced monitoring technologies for inspections (**FL-2-9**)
- Identify emergency planning gaps and update response plans (**FL-4-1**)
- Raise awareness about flood insurance availability and importance (**FL-4-6**)
- Develop clear communication channels and protocols for timely flood warnings (**FL-6-1**)
- Improve flood risk communication and information dissemination (**FL-6-2**).


## Vulnerabilities

Climate-induced hydrologic variability and sea level rise are expected to **intensify flooding** across the entire Delta region

The Delta's **1,100 miles of levees** are designed to operate under historical conditions that did not consider climate change, which will stress the whole system

## Strategies

- Develop climate-informed understanding of Delta flood dynamics
- Strengthen and upgrade Delta levee system
- Restore ecosystems for flood mitigation
- Improve emergency preparedness and response
- Manage and expand upstream water storage capability
- Use technology and land use planning to reduce risk

## Example Actions

- Integrate climate change into risk assessment models (**FL-1-1**)
- Integrate climate risks and equity into the Delta Levees Investment Strategy (**FL-2-2**)
- Monitor and evaluate the effectiveness of multi-benefit projects for flood risk reduction (**FL-3-2**)
- Raise awareness about the availability and importance of flood insurance (**FL-4-6**)
- Use excess floodwater to recharge underground aquifers (**FL-9-2**)
- Develop communication channels and protocols for flood warnings and advisories (**FL-6-1**)

**Figure ES-2** Flood Risk Reduction Focus Area - Key Vulnerabilities, Strategies, and Example Actions

This graphic highlights key vulnerabilities related to flooding, and strategies and example actions to address flooding, such as integrating climate change into risk assessment models.

### Ecosystem

Human conversion of the Delta landscape and pressures on its natural systems have severely reduced the extent and quality of Delta ecosystems, increasing their vulnerability to climate change. Temperature changes, more variable precipitation extremes, flooding, sea level rise, and salinity changes are increasingly impacting ecosystem health and leading to habitat transition. Without adaptation, Delta ecosystems will face further challenges due to biodiversity decline, expansion of invasive species, loss of critical habitats, and reductions in ecosystem function. The strategies in this Adaptation Plan strengthen the adaptability of Delta ecosystems by **restoring and connecting habitats** to meet Delta Plan goals, implementing **functional flows, halting or reversing land subsidence, and protecting native species and improving ecosystem health (Figure ES-3).** Through implementation of the strategies in this Adaptation Plan, a broad range of co-benefits can be realized, including flood risk reduction, water quality improvement, increased public and tribal access, and GHG sequestration.

The Lookout Slough Tidal Restoration Project

## Ecosystem adaptation accelerator actions include:

- Prioritize multi-benefit projects (**ECO-1-4**)
- Restore natural stream flows and functions (**ECO-1-10**)
- Incentivize land use that halts and reverses subsidence (**ECO-2-1**)
- Incentivize tidal wetland restoration at tidal elevations in the North Delta and Suisun Marsh (**ECO-2-2**)
- Work with tribes to implement nature-based solutions and identify opportunities to co-manage restored public areas (**ECO-3-2**)
- Streamline environmental review and permitting while maintaining procedures for environmental protection; Establish program-level endangered species permitting tools (**ECO-3-7**)
- Expand public-private partnerships upstream of the Delta that provide ecosystem functions (**ECO-3-10**)
- Explore opportunities for a comprehensive ecosystem restoration, maintenance, and monitoring funding strategy (**ECO-3-11**)


## Vulnerabilities

Land development and insufficient shallow water areas **leave little room for habitats and species to migrate**

Increasing heat, variable precipitation, sea level rise, and climate extremes impact **ecosystem health and biodiversity**

## Strategies

- Restore ecosystems to adapt and support native species
- Build capacity and partnerships for ecosystem resilience
- Protect ecosystems by halting and reversing subsidence
- Use nature-based solutions to increase resilience of developed areas

## Example Actions

- Restore more natural stream flows and functions (**ECO-1-10**)
- Prioritize nature-based solutions and multi-benefit projects (**ECO-1-4**)
- Partner with and fund tribes to identify and implement nature-based solutions (**ECO-3-2**)
- Prioritize and incentivize land use types that halt or reverse subsidence (**ECO-2-1**)
- Increase tree canopy cover and other green spaces in developed areas (**ECO-4-2**)

**Figure ES-3** Ecosystems Focus Area - Key Vulnerabilities, Strategies, and Example Actions

This graphic highlights key vulnerabilities related to ecosystems, and strategies and example actions to support ecosystem resilience, such as working with tribes and tribal communities to interweave Traditional Knowledge in consultation with tribes and knowledge holders.

## Agriculture

Indigenous people have managed lands in the Delta since time immemorial, including harvesting plants, hunting, and fishing for subsistence. This historical land stewardship was disrupted by colonization and settlement, and most of the Delta's wetlands have been drained and farmed (DSC 2025a). Today, agriculture is a significant part of the Delta's history, culture, and economy, represents the predominant land use in the Delta, and is recognized as a central feature of the Delta in the Delta Reform Act. Climate change poses a range of threats to Delta agriculture, including increased precipitation variability, saltwater intrusion, polluted water, flooding, extreme heat, and reduced chill hours, all of which can reduce crop yield and quality. Delta farmers are the experts at handling the unique challenges of farming, but they too will need to adjust and adapt to prepare for the compounding effects of climate change. While the cooperative identification of strategic land retirement opportunities, in partnership with interested landowners in areas that are no longer well-suited to farming or economically viable, may be one strategy, it is not the primary agricultural strategy recommended in this adaptation plan. Instead, this Adaptation Plan takes a holistic approach to agricultural resilience and leads with and focuses on actions that support the resilience of the Delta's agricultural economy. This includes actions that support **more efficient agricultural water use, building healthier soils** through actions for both peat and non-peat soils, and **conversions to climate-resilient crops (Figure ES-4).** Through implementation of these strategies, a broad range of co-benefits can be realized, including increased food security, strengthening the local economy, halting or reversing land subsidence, reducing GHG emissions, and providing habitat for a diverse range of species.

### Agricultural adaptation accelerator actions include:

- Improve and expand irrigation efficiency management practices (**AG-1-1**)
- Create training, employment, and land access programs and opportunities for the next generation of farmers (**AG-2-2**)
- Support and fund environmental credits (e.g., carbon credits or wildlife-friendly farming incentives) (**AG-3-3**)
- Support continued resources for land transition (**AG-4-4**)

Rice fields just north of Sacramento


## Example Actions

- Improve and expand irrigation efficiency practices (**AG-1-1**)
- Create training, employment, and land access opportunities for the next generation of farmers (**AG-2-2**)
- Support and fund environmental credits (**AG-3-3**)
- Support continued resources for land transition (**AG-4-4**)

**Figure ES-4** Agricultural Focus Area - Key Vulnerabilities, Strategies, and Example Actions

This graphic highlights key vulnerabilities related to agriculture, and strategies and example actions to support agricultural resilience, such as improving and expanding irrigation efficiency.

### Water Supply Reliability

The Delta supplies water to 27 million Californians and more than 3.7 million acres of agricultural land. Warming temperatures, decreased snowpack, shifts in the timing and magnitude of runoff, increased precipitation variability, and sea level rise will stress the Delta and its greater watershed. The Delta's network of water conveyance infrastructure is at risk from levee failure and salinity intrusion. Reducing water supply reliance on the Delta is an existing requirement for certain water suppliers, but it represents a critical step toward climate resilience for everyone. This climate adaptation approach supports the state's policy of reduced reliance on the Delta and the Delta Reform Act's coequal goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The Adaptation Plan re-doubles the Council's reduced reliance efforts by working with partners to **increase water conservation, expand surface and groundwater storage and regional water supplies, modernize Delta conveyance systems, improve upstream reservoir operations, and consider updating water quality standards** to account for the impacts of climate change **(Figure ES-5).**

The State Water Project, on the left, and the Central Valley Project, on the right

## Delta Plan Connection

*Dual Conveyance in the Delta*

The Council's **dual conveyance approach** is outlined in the 2018 amendment of Chapter 3 of the Delta Plan, per the recommendation to develop new and improved infrastructure related to water conveyance (WR R12a). The recommendation notes that this should be accomplished through a **combination of through-Delta conveyance and isolated conveyance** to allow for operational flexibility. This recommendation for infrastructure needs is distinguished from the Council's regulatory role in reviewing specific conveyance projects as covered actions.

## Water supply reliability adaptation accelerator actions include:

- Support pilot projects (**WSR-1-2**)
- Invest in Flood-MAR (**WSR-2-4**)
- Improve Delta levees (**WSR-3-1**)
- Coordinate with USACE to review and update flood space reservation guidelines (**WSR-4-1**)
- Coordinate with all partners to review Bay-Delta Plan water quality standards (**WSR-5-2**)


**Figure ES-5** Water Supply Reliability Focus Area - Key Vulnerabilities, Strategies, and Example Actions

This graphic highlights key vulnerabilities related to water supply, and strategies and example actions to support water supply resilience, such as promoting urban and agricultural water conservation.

## Next Steps

The adaptation strategies set out in Delta Adapts provide a roadmap and critical steps toward adapting the Delta to be resilient to current and future climate change impacts. The strategies aim to address key focus areas for the Delta while prioritizing socially vulnerable communities throughout all actions. The Adaptation Plan also explores a range of approaches, both new and existing, to implement the strategies and catalyze innovative sources of adaptation funding.

**Adapting the Delta to climate change will require unprecedented levels of funding, collaboration, and action across state, federal, and local agencies, tribes, academia, non- profit organizations, landowners, the private sector, and residents.** As community members have recommended, a holistic, systemic approach to adaptation will be most effective, but this requires deep conversations, meaningful collaboration, trust, and commitment from everyone. Council staff will work to bring partners together from existing collaboratives, such as the Delta Plan Interagency Implementation Committee (DPIIC), to coordinate efforts, align visions, and outline common pathways to advance the strategies set forth in this Adaptation Plan. Council staff will first convene willing parties to memorialize our collective commitment to implementing Delta Adapts and assign specific roles to agency partners. A critical component of this convening will include addressing the needs of socially vulnerable communities and tribes, who have for too long been excluded from this work. **Together, we can achieve a more resilient, safer Delta, and restore the promise of a California for all.**

Migratory water birds rely on the Delta's wetlands

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# Chapter 1 Introduction

## 1.1 Purpose

California relies on the Sacramento–San Joaquin Delta (Delta) in many ways. It supplies a portion of the drinking water for 27 million Californians and more than 2 million acres of farmland, fuels California's economy, and is a biodiversity hotspot for more than 750 plant and animal species. It is home to more than 550,000 people spread across rural agricultural landscapes, small towns, and urban areas including Sacramento, West Sacramento, Stockton, Lathrop, Manteca, and the eastern Bay Area. This ancestral homeland is of cultural significance to numerous tribes and tribal groups, both federally recognized and unrecognized. Impacts from climate change are being felt today, and projected changes in California's climate put the Delta, its people, and all of its resources and uses at risk.

As California continues to face the pressures of climate change – such as sea level rise, changes in precipitation patterns, and warming temperatures – regional adaptation rooted in science-based decision-making and community knowledge and lived experiences is more critical than ever to build resilience for the Delta while addressing community needs. Individual jurisdictions in the Delta and Suisun Marsh have led their own climate vulnerability assessments and adaptation plans, but there has not been an integrated regional assessment and adaptation plan for the Delta, until now.

### The Delta…

- Holds cultural significance for various tribes and tribal groups
- Provides critical habitat
- Supports agriculture
- Supplies water
- Provides ecosystem services
- Purifies air and water
- Absorbs carbon
- Reduces flood risk
- Supports recreational activities

**Delta Adapts: Creating a Climate Resilient Future (Delta Adapts)** is a comprehensive, regional approach to climate resilience that commits to collaboration across federal, state, local, and regional levels for the Delta and Suisun Marsh (collectively, "the Delta"). The Delta Stewardship Council (Council) initiated Delta Adapts in 2018 to improve the Council's understanding of regionally specific climate change vulnerabilities and risks, and address

how Delta communities, infrastructure, and ecosystems can adapt to future conditions.

Delta Adapts will help prioritize future actions and investments, provide climate information for communities and agencies at all levels, inform future Delta Plan amendments, and serve as a framework for future work by the Council and others.

## Background

The Council is conducting this Delta Adapts initiative following the climate change vulnerability and adaptation conceptual framework outlined in **Figure 1-1**, in two phases:

- Phase 1: A **Climate Change Vulnerability Assessment** (CCVA), completed in 2021, that improves the understanding of regional vulnerabilities to protect vital resources the Delta provides to California and beyond, with state interests and investments top of mind. This corresponds to Steps 1-4 in the climate adaptation conceptual framework in **Figure 1-1**.

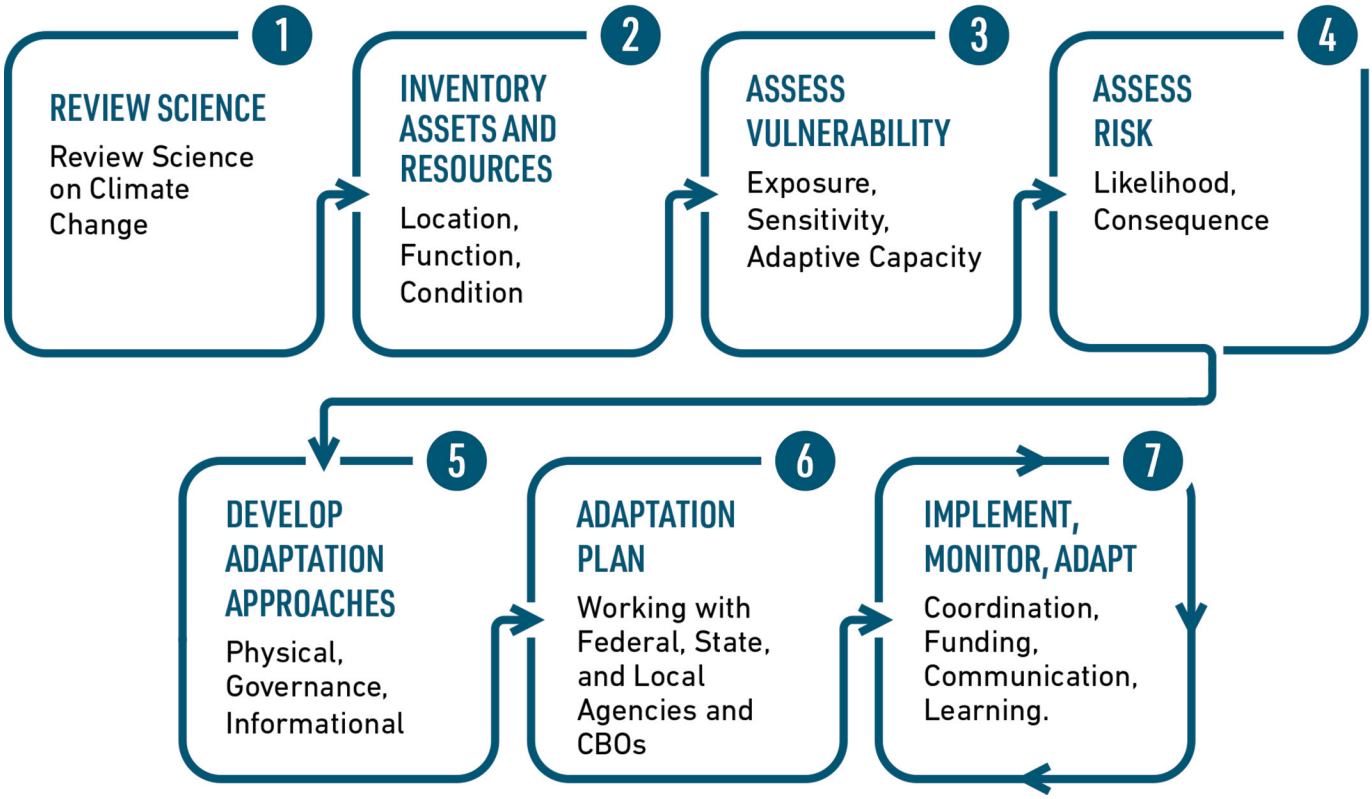


**Figure 1-1** Climate Change Vulnerability and Adaptation Conceptual Framework Applied in Delta Adapts

- Phase 2: An **Adaptation Plan** (this document) detailing strategies and actions that the Council and partners can take to help communities and ecosystems thrive in the face of climate change, while protecting critical infrastructure and economic activities from damage and loss. This addresses Steps 5-7 in **Figure 1-1**.

**Examples of key State of California goals and policies which Delta Adapts supports:**

The **Delta Reform Act**, passed by the California Legislature in 2009, which mandates the consideration of "the future impact of climate change and sea level rise" in restoration planning and identifies a restoration planning horizon of 2100. The Delta Reform Act specifies that the state's "coequal goals" for the Delta are to provide a more reliable water supply for California and protect, restore, and enhance the Delta ecosystem in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place. The Delta Reform Act also mandates development of the **Delta Plan**, which was first adopted by the Council in 2013 and serves as California's roadmap for the region in support of the state's coequal goals for the Delta. Climate change science has advanced significantly since the Delta Plan's adoption, with important implications for the Council. The Council has already started to address climate change vulnerability and adaptation through amendments to the Delta Plan, including a June 2022 amendment that established a vision for a restored, more resilient Delta ecosystem. This amendment includes policies and describes targets necessary to restore ecosystem processes and functions. The updated Delta Plan informs aspects of this Adaptation Plan and will support the Delta to be more resilient to climate change. Specific projects identified in Delta Adapts must be consistent with existing Delta Plan policies.

- **State Plan of Flood Control (SPFC)** (developed in 1917) encompasses a vast flood management system with 1,600 miles of levees, weirs, dams, and other infrastructure. It plays a crucial role in flood management across more than 2.2 million acres in California's Central Valley, including facilities within the Delta.
- **Suisun Marsh Protection Act (SMPA)**, passed in 1974 as the Nejedly-Bagley-Z'berg Suisun Marsh Preservation Act (SMPA 1974), which directed the San Francisco Bay Conservation and Development Commission (BCDC) and the Department of Fish and Wildlife to create the Suisun Marsh Protection Plan (SMPP). Once the SMPP was complete, the SMPA of 1977 was enacted with the goal of protecting the unique values of the Marsh and protecting it from development.
- The **California Global Warming Solutions Act** of 2006 established greenhouse gas (GHG) monitoring, regulation, and reporting requirements for the state. The legislation also required that the California Air Resources Control Board (CARB) develop and update a Scoping Plan every five years, which lays out pathways to reduce GHG emissions. The 2022 Scoping Plan provides a path toward achieving carbon neutrality and leveraging natural and working lands to sequester carbon.
- The **California Climate Adaptation Strategy**, first released in 2008 and defined in § 75125 of the Public Resources Code, is updated by the California Natural Resources Agency (CNRA) every three years to establish state adaptation priorities and encourage collaboration and accelerated climate action across California's regions and sectors.


**Figure 1-2** Examples of California state plans and initiatives that supported the creation of, or will be informed by, Delta Adapts

- The California **Cutting the Green Tape** initiative, which was established by Executive Order N-82-20, to "implement actions to increase the pace and scale of environmental restoration and land management efforts by streamlining the state's process to approve and facilitate these projects." CNRA released a memorandum in 2021 directing agencies to begin taking action to reduce regulatory burdens and CNRA is tracking progress on this initiative.
- **Central Valley Flood Protection Plan (CVFPP)** (adopted in 2012 and updated every five years) serves as California's strategic blueprint to improve flood risk management in the Central Valley. It prioritizes the state's investment in flood management over three decades, promotes multi-benefit projects, and integrates ecosystem functions associated with flood risk reduction projects. The CVFPP also established the **Small Community Flood Risk Reduction Program** which aims to reduce flood risk for small communities protected by SPFC facilities. It focuses on communities with populations between 200 and 10,000 residents.
- **Governor's Executive Order B-30-15**, signed by Governor Brown in April 2015, which requires California state agencies to incorporate climate change into planning and investment decisions. It also requires agencies to prioritize natural infrastructure and actions toward climate preparedness among the most vulnerable populations.
- **Senate Bill 337**, passed in 2023, which sets a goal of conserving at least 30% of the state's land and coastal waters by 2030. Amending the Public Resources Code § 71450, the statute requires that CNRA and other agencies work toward the 30x30 goal by incentivizing innovative actions and use of natural and working lands to boost biodiversity and climate resilience.
- **California's Water Supply Strategy: Adapting to a Hotter, Drier Future**, published in August 2022 and produced by CNRA, California Environmental Protection Agency (CalEPA), the Department of Water Resources (DWR), the State Water Resources Control Board, and the California Department of Food and Agriculture (CDFA), outlines California's priority actions to adapt and protect water supplies, including through groundwater recharge, water recycling, and modernizing water conveyance infrastructure in the Delta.
- The **Water Resilience Portfolio**, produced by CNRA, CalEPA, and the CDFA in 2020, which serves as California's roadmap to building water resilience through a diverse set of actions that will prepare the state's water systems to support the growing state in a warmer, more variable climate.
- The **Natural and Working Lands Climate Smart Strategy** was established in 2023 by CNRA and partner agencies, and includes carbon dioxide removal targets for 2030. Codified in § 38561.5 of the Health and Safety Code, the strategy required that CNRA set targets for 2030, 2038, and 2045. It also required CARB to develop methods for agencies to track progress towards emissions reductions from natural and working lands.

- **California's Fifth Climate Change Assessment**, led by the Governor's Office of Land Use and Climate Innovation in partnership with the California Energy Commission, CNRA, and California Strategic Growth Council, contributes to the scientific foundation for understanding climate-related vulnerability throughout California.
- **California Water Supply Solutions Act of 2023 (SB 659)**, which requires counties to address how populations with access and functional needs are served by emergency communications, evacuation, and sheltering plans in the next update of their emergency plans.

## The Council's Role Leading Adaptation in the Delta

Within California and in the Delta, a multitude of federal, state, regional, and local authorities have begun to integrate climate change considerations into their policy frameworks (for more detail see Chapter 1 of the CCVA (DSC 2021a)). These agencies are at varying stages of planning for climate change, with varying roles and authorities. The Council was created as an independent agency with the authority to manage the Delta and coordinate efforts across agencies. Understanding agency roles and responsibilities supports the Council's role as a leader in climate adaptation in the Delta through the implementation of Delta Adapts.

As an agency of experienced planners, engineers, scientists, and communicators, the Council is well-equipped – and authorized – to steward the Delta toward resilience. The Council both guides and regulates actions of the 200+ state and local agencies in the Delta

The junction of the Sacramento River and Georgiana Slough in Sacramento County

to ensure they support statewide water supply reliability and Delta ecosystem restoration. Delta Adapts provides the information needed to guide climate adaptation in the region. Through strong working relationships with government agencies at the federal, state, regional, and local levels, the Council can influence action in the Delta to improve resilience over time and communicate the statewide implications of anticipated regional impacts.

The Council's Delta Science Program was established to provide the best possible scientific information and synthesis to inform water and environmental decision-making in the Delta. By funding research, synthesizing and communicating information to decision-makers and the community, promoting independent scientific peer review, and coordinating across the Delta to promote science-based adaptive management, the Delta Science Program will provide an essential and evolving knowledge-base upon which the strategies described in Delta Adapts can rely.

The Council serves as a manager with the authority, responsibility, accountability, scientific support, and funding to achieve the state's policy goals for management of the Delta (Water Code § 85001(c), 85020(h)). Specifically, the Council's role in Delta Adapts has several core elements.

- The initiator of a regional planning process,
- The convener bringing various partners together to work as part of a broader team,
- A leader in collaboration with a robust group of experts and interested parties to gather and synthesize existing research and data, identify knowledge gaps, develop methods to fill data gaps, complete technical analyses, and summarize results,
- A synthesizer of a wide body of climate change science, distilling and tailoring findings to the needs of the Delta's unique geographies and characteristics, with the goal of developing and sharing the best-available, reliable projections of climate impacts to the Delta for local agencies, communities, and interested parties,
- An advocate for regional- and state-level policies that align with the recommendations from Delta Adapts and further its objectives, and
- A communicator that actively engages with the public, interested parties, and decision-makers to communicate, inform, and educate on the findings of Delta Adapts, including climate change impacts in the Delta and the importance of adaptive strategies.

This Adaptation Plan recommends both leadership and partnership roles for various federal, state, regional, and local agencies within and outside the Delta to increase the Delta's resilience to climate change. Successful implementation of the recommendations in this Adaptation Plan will require close coordination and collaboration across all levels of government, tribes and tribal communities, community-based organizations (CBOs), and other non-governmental organizations.

Farmland and developed areas along the Sacramento River in Sacramento County

## 1.2 Resilience Goals

As part of Delta Adapts, the Council adopted a set of Climate Change Resilience Goals to provide a long view toward Delta regional values and priorities. The resilience goals were used by the project team as a framework for developing Delta Adapts to focus methods and recommendations. Guided by these goals, this Adaptation Plan identifies adaptation strategies that agencies at all levels can adopt and implement and considers how tradeoffs could be navigated equitably.

The resilience goals build upon California's coequal goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The resilience goals also contribute to protecting and enhancing the Delta as an evolving place, including its unique culture, communities, economy, and history, which in turn supports coequal goals. Additionally, Delta Adapts builds off the sustainability framework used by the San Francisco Bay Conservation and Development Commission (BCDC) Adapting to Rising Tides (ART) regional climate change adaptation planning program. This framework is organized around the following themes: water, environment, society and equity, economy, and governance.

### What is Resilience?

**Resilience** is the capacity of any entity – an individual, a community, an organization, or a natural system – to prepare for disruptions, to recover from shocks and stresses, and to adapt and grow from a disruptive experience (LCI 2018b).

### Water

- Promote statewide water conservation, water use efficiency, and sustainable water use (Water Code § 85020(d)).
- Improve water quality to protect human health and the environment consistent with achieving water quality objectives in the Delta (Water Code § 85020(e)).
- Improve the water conveyance system and expand statewide water storage (Water Code § 85020(f)).

### Environment

- Restore the Delta ecosystem, including its fisheries and wildlife, as the heart of a healthy estuary and wetland ecosystem (Water Code § 85020(c), 85302(c)).
- Restore critical physical and biological processes, connectivity, complexity and diversity, and redundancy, at large scales with a long time horizon in mind (Water Code § 85022(d)(1)).

## Society and Equity

- Protect and enhance the unique cultural, recreational, and agricultural values of the California Delta as an evolving place (Water Code § 85020(b)).
- Reduce risks to people, property, and state interests in the Delta by effective emergency preparedness, appropriate land uses, and investments in flood protection (Water Code § 85020(g)).
- Increase the resilience of Delta communities, especially those with characteristics that make them more vulnerable to climate risk due to physical (built and environmental), social, political, and/or economic factors (Water Code § 85020(b)). These factors include, but are not limited to, race, class, sexual orientation and identification, national origin, and income inequality (LCI 2018a).
- Prioritize actions that protect the most vulnerable populations (Governor's EO B-30-15).

## Economy

- Maintain and improve local economic vitality and access to diverse employment opportunities by preserving and growing, where appropriate, key economic and employment drivers and associated infrastructure that support the Delta economy and communities.
- Promote the development of urban growth strategies that reduce climate risks by focusing new development in more resilient areas, enhancing the Delta ecosystem, and supporting resilient farming and recreation activities.
- Improve and enhance the resilience of the Delta transportation network while supporting the achievement of regional and statewide GHG reduction targets.

## Governance

- Foster collaboration and build capacity among federal, state, and local agencies, non-governmental and private organizations, tribes, and tribal communities in the Delta.
- Serve as a model for how to restore trust and participation of communities in government.
- Commit to working cooperatively to identify and mitigate climate change impacts and risks.
- Improve coordination among regulatory agencies to reduce program or legal barriers to addressing current and future flood, drought, wildfire, and other risks that will be exacerbated by climate change (Water Code § 85001(c), 85020 (h)).
- Incorporate climate change into state and local Delta planning and investment decisions (Governor's EO B-30-15).
- Prioritize actions that incorporate natural and green infrastructure solutions (Governor's EO B-30-15).
- Define the Council's role in coordinating adaptation responses in the Delta.

## 1.3 Geographic Setting

The Delta is located at the convergence of the state's two largest rivers – the Sacramento River flowing from the north and the San Joaquin River flowing from the south (**Figure 1-3** and **Figure 1-4**). The Delta lies between the Sierra Nevada to the east and the Coast Range to the west. Rainfall and snowmelt in the mountains collect in tributaries that flow into these rivers and ultimately support the Delta, along with brackish water carried by tides from San Francisco Bay. The Delta is situated 40 miles inland from the Pacific Ocean, connecting to San Francisco Bay via the narrow Carquinez Strait, west of Suisun Marsh. In this location, the Delta serves as a key conduit in the state's water supply system, an important link in the routes of migratory fish and bird species, and the location of critical infrastructure such as transportation networks, electrical, and gas pipelines. The Delta's warm temperate climate and access to fresh water and rich alluvial soils provide excellent components for life to thrive. This historically fertile landscape evolved in response to California's dynamic annual precipitation variability, through periods of drought and flood.

The landscape of the Delta watershed, inhabited and managed by Indigenous peoples since time immemorial, was transformed to what it is today by Euro-American colonization and settlement (see **Section 1.5 Tribal History in the Delta**). While historically a majority of the Delta consisted of tidal marsh, most of the Delta's marshland has been "reclaimed" (drained and converted to agriculture) and leveed, its waterways channelized. As a result of conversion to agriculture and resulting oxidation of peat soils, much of the Central Delta has subsided to below sea level today. Studies indicate that reversing subsidence through managed wetlands would take from 50 years on the edges of the Delta to up to 250 years in the deeply subsided Central Delta (Deverel et al. 2014).

The reclamation efforts that began in the 1850s and 1860s continue today, via levee maintenance and drainage actions, carried out in large part by Reclamation Districts along with federal and state agencies. Today, the Delta covers approximately 1,300 square miles and is made up of a network of channels, levees, subsided islands, sloughs, rivers, and tributaries across six counties (Yolo, Sacramento, Solano, San Joaquin, Contra Costa, and Alameda). Due to its location at the confluence of the Sacramento and San Joaquin Rivers and its role today in conveying water supplies, the Delta is the central hub of California's current water system. Rivers and dredged channels act as conveyance canals, and pumping plants provide the momentum to move stored water to areas south. Within the Delta, the extensive levee system protects urban and rural communities, including legacy communities, critical infrastructure, and vital ecosystems. The system also protects against salinity intrusion and allows for freshwater exports via the State Water Project (SWP) and Central Valley Project (CVP) and other water suppliers' pumps located throughout the Delta (DSC 2021c). For these reasons, maintaining the levee system is paramount to the whole of the Delta and the system will need to remain in place for the foreseeable future.

The Delta Adapts project area focuses on the legal Delta and Suisun Marsh. The legal Delta boundaries were established as part of the 1959 Delta Protection Act (Wat. Code § 12220). Existing conditions in the Delta are described in more detail in Chapter 2 of the CCVA (DSC 2021a). See **Section 1.5** for information on the tribal history of the Delta watershed. For more details on the history of the Delta watershed, including the reclamation, industrialization, redlining, and the development of the Delta's major water infrastructure, refer to the Council's Tribal and Environmental Justice Issue Paper (DSC 2025a).

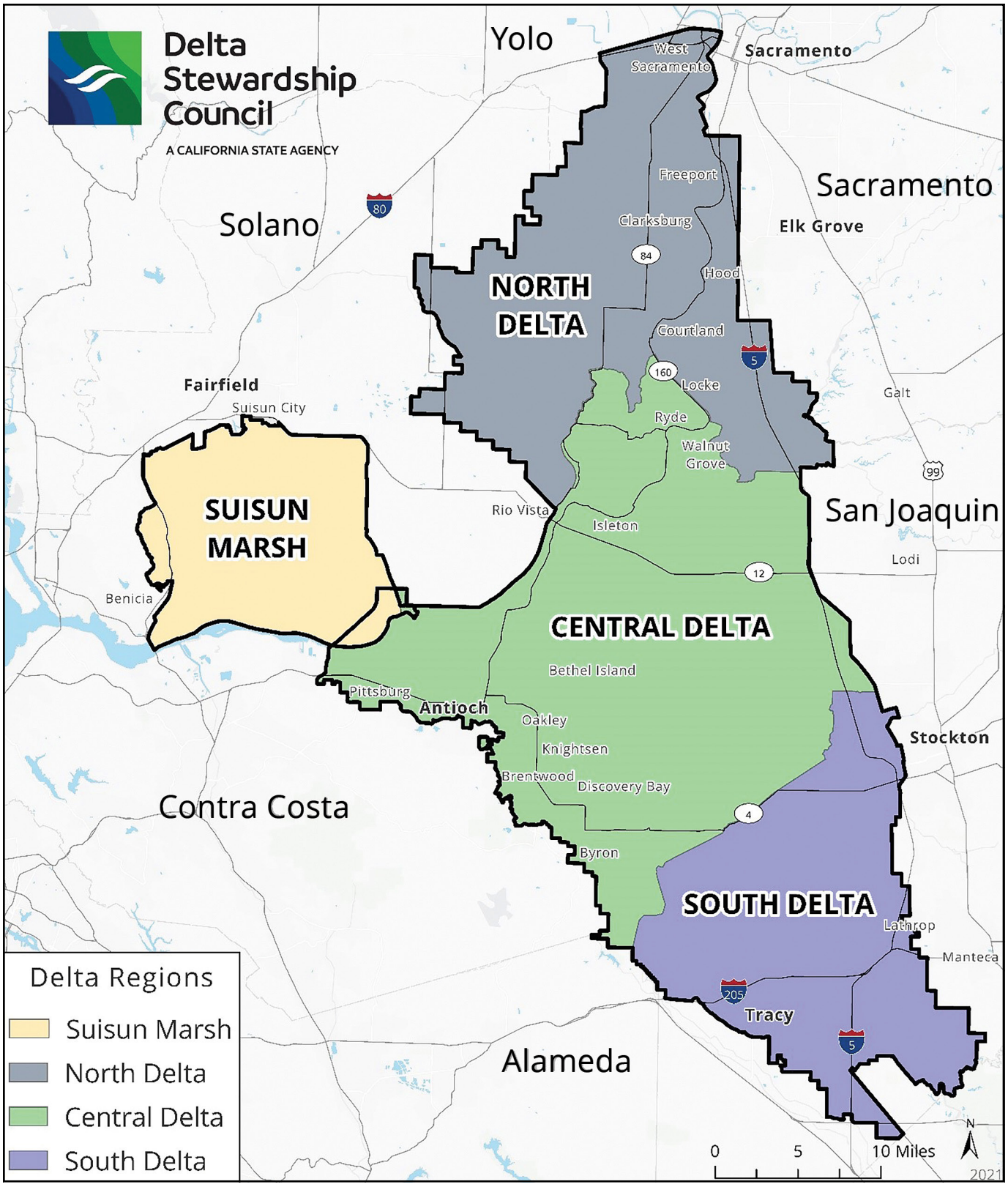


**Figure 1-3** Map of the Legal Delta Regions, Suisun Marsh, and County Boundaries

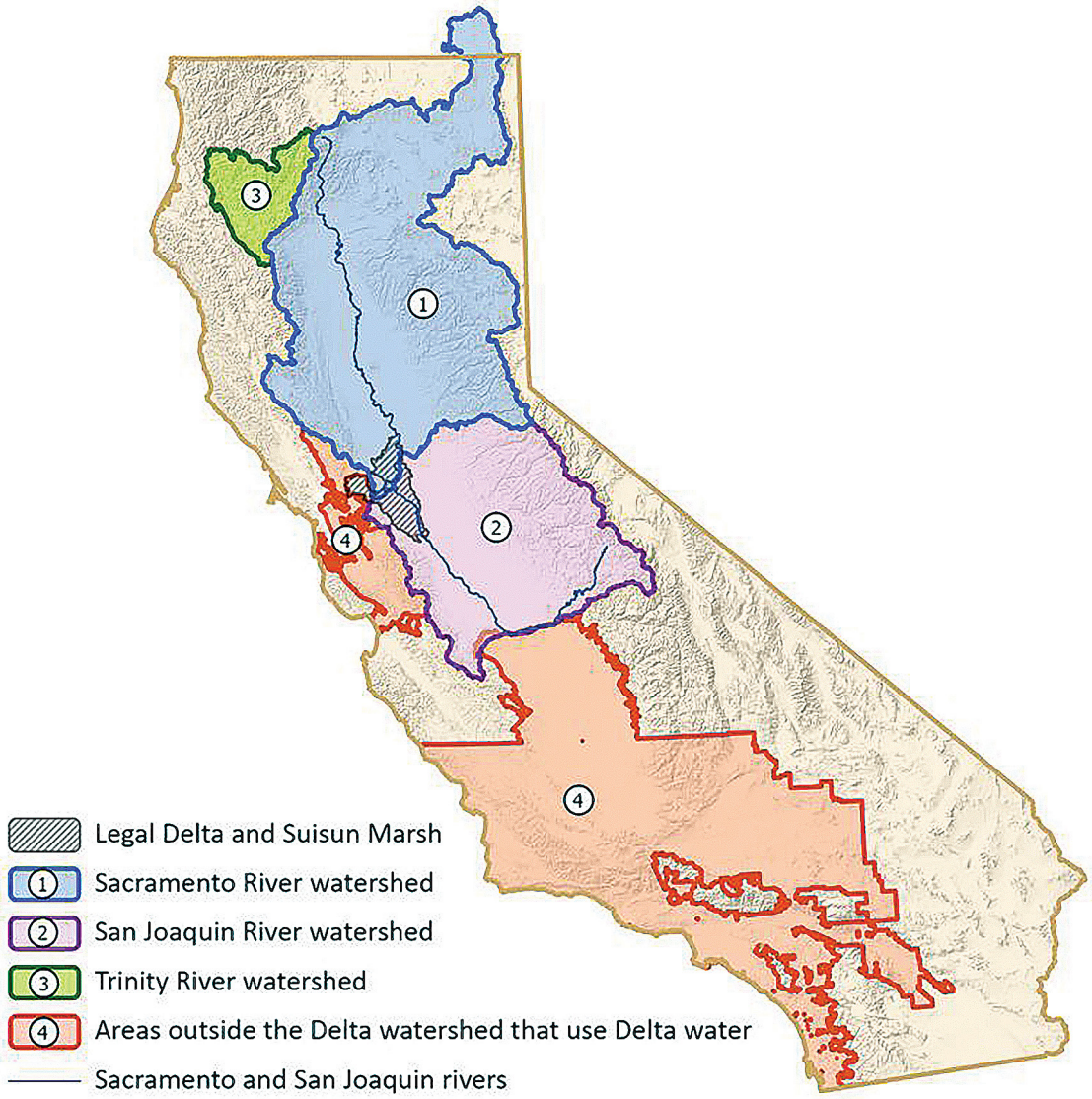


**Figure 1-4** The legal Delta and Suisun Marsh shown in relation to the rest of the state, including the Delta watershed, Trinity River watershed, and areas outside the Delta watershed that use Delta water

## 1.4 Equity Considerations

Communities are likely to have greater vulnerability to climate change as a result of their susceptibility to harm (sensitivity) and limited ability to adjust and respond (adaptive capacity), due to compounding factors such as historical exclusion, environmental and systemic racism, physical and mental disabilities, and generational poverty. **Figure 1-5** shows this intersection of exposure, sensitivity, adaptive capacity, and vulnerability. Because vulnerable communities are likely to be disproportionately impacted by climate change, California state agencies, and many regional and local agencies, have made equity and climate justice foundational priorities in climate policy and programs (LCI 2018b; PolicyLink 2018; Governor's EO B-30-15).

Council staff have incorporated equity into Delta Adapts by identifying the communities and populations with the highest social vulnerability (greatest sensitivity and lowest adaptive capacity) to climate hazards in the Delta and the potential impacts of those hazards (see the CCVA and its **Equity Technical Memorandum (DSC 2021b)** for more details about this process). Throughout development of this Adaptation Plan, the Delta Adapts team hosted and attended a series of community meetings and events across the Delta, with a focus on socially vulnerable communities, to hear directly from community members, CBOs, and other interested parties. In addition, staff engaged tribes through both formal consultation and other tribal engagement activities (see **Chapter 2** for details). This input informed the development of equitable adaptation strategies and governance best practices for the Adaptation Plan.

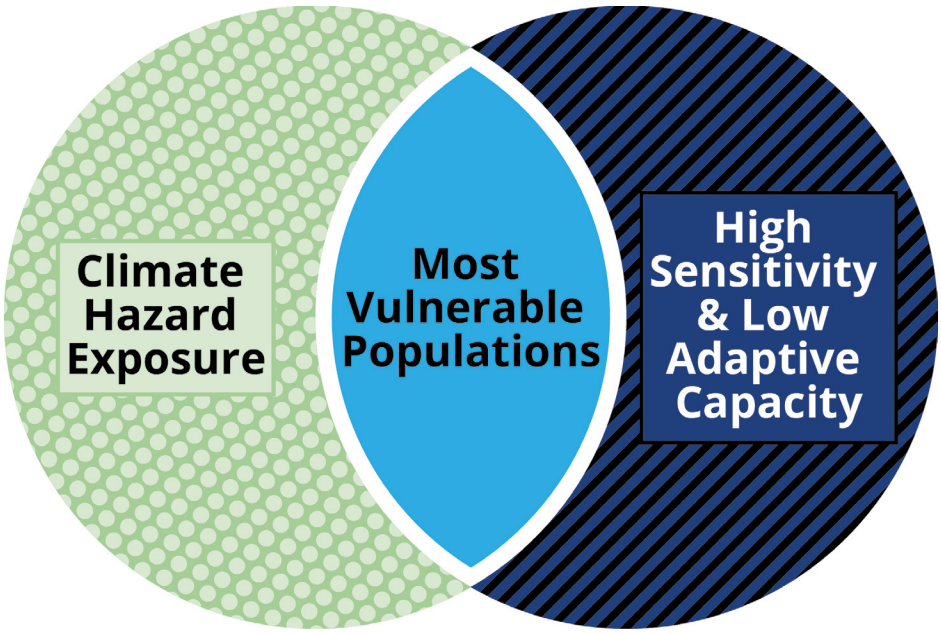


**Figure 1-5** Conceptual Model of Vulnerability

Equity considerations are embedded throughout the adaptation strategies and implementation actions. Each strategy considers how its implementation may support improved health, economic stability and prosperity, physical and emotional wellbeing, and social justice for vulnerable communities. For some strategies, considering equity also means evaluating how to avoid or mitigate negative unintended consequences for vulnerable communities. The adaptation strategies and governance best practices aim to increase representation of those that have been historically left out of government procedures and decision-making (representational justice) (see **Chapter 10).** These recommendations aim to ensure that the public process and decision-making bodies are inclusive of the communities they serve, and that the communities most impacted by decision-making can meaningfully participate throughout the process (procedural equity). This requires agencies to listen to communities regarding their priorities and needs and develop projects in partnership with community members and tribes rather than presenting nearly finalized ideas.

## Example Equity Strategies

- Amplifying communication and education to increase awareness and knowledge of flood risks and mitigating actions (see **FL-6**).
- Identifying opportunities for tribal co-management and access to traditional homeland (see **ECO-1**).
- Increasing public access to green space and parks in socially vulnerable communities (see **ECO-4**).
- Developing multi-benefit projects that provide jobs and improve air and water quality (see **ECO-3**, **AG-4**).
- Incorporating equity-weighted benefit-cost analyses into project development (see **FL-2**).
- Supporting local agriculture and food access (see **AG-2**).

## Delta Residents Survey

*Key Takeaway*

A collaborative research team, funded by the Delta Science Program, conducted a survey in 2023 to assess Delta residents' well-being (Rudnick et al. 2023). The survey results offer new insights into residents' sense of place, quality of life, values, climate risk-related priorities and concerns, and perceptions on governance. The survey sets the stage for future engagement and helps the Council and its partners better understand how residents may engage and respond to future adaptation planning efforts in the Delta. Key takeaways from the survey are highlighted throughout this plan.


Thousands attend the annual Crawdad Festival in Isleton, Sacramento County.

## 1.5 Tribal History in the Delta

Indigenous peoples have inhabited and managed the Delta landscape since time immemorial. The Delta watershed and larger Bay estuary were occupied by the Native Peoples of the numerous villages and tribes of the Bay Miwok, Coast Miwok, Plains Miwok, Maidu, Nisenan, Ohlone, Patwin, Pomo, Wappo, Wintun, and Yokuts. Each nation had its own unique languages and cultural sub-groups across the Delta and Central Valley regions (Zedler and Stevens 2018; Stuart 2016a). However, it is important to note that while these tribes were physically located in and around what is defined as the Delta today, tribes throughout the California region viewed and still view the watershed that runs from Mount Shasta to the Tulare Basin as one interconnected system that cannot be demarcated into sections (heard in consultations with tribes).

> "For millennia, [Plains Miwok] have asserted the ancestral responsibility to ensure the balance and stewardship of land and water is maintained. Within this context, water is a sacred element of life, and this view is shared by many other Indigenous people around the world; it is a lifegiving force to which all creation is connected" (Hankins 2018).

These communities were semi-sedentary and harvested over 500 species of plants. They fished and hunted to meet cultural, spiritual, ceremonial, and subsistence needs in a reciprocal relationship with the ecosystem they actively managed. This relationship with the ecosystem altered and supported the diversity and abundance of plant and animal species present in the region when settlers arrived (Stuart 2016a; Zedler and Stevens 2018). These tribes used water to support their cultural, spiritual, ceremonial, subsistence, and/or traditional practices.

Spanish and American settlement devastated the Native populations of the Delta. Despite resistance and retreat, tribal peoples were decimated by violent displacement and land dispossession, introduction of disease, slavery, forced assimilation, and genocide (Sze et al. 2009; Stuart 2016b; Zedler and Stevens 2018; Dillon 2022). The arrival of Spanish colonists in the late 18th century led many coastal tribal nations to retreat to the Delta's tule wetland and riparian corridors as places of refugia to escape Spanish militias (Garone 2011). Entire villages succumbed to malaria, cholera, and smallpox, and surviving tribal members were captured and forced into slavery in Spanish missions, where casualty rates under brutal conditions were extremely high (Zedler and Stevens 2018). The arrival of U.S. settlers in California, drawn by the Gold Rush, was no less brutal, as they forcibly removed tribes from their native lands for settlement, western expansion, and the establishments of public lands for conservation.

The state also sponsored extermination and cultural erasure campaigns against California tribes, funding "expeditions against the Indians," which forcibly removed California tribes from their traditional lands and separated generations of families through kidnapping and indentured servitude (Judicial Branch of California 2025). The state convinced

the United States Senate to not ratify 18 treaties signed by the federal government in 1851 and 1852 with California tribes to reserve 7.5 million acres of land for tribes (Judicial Branch of California, 2025).

The forcible relocation of Native populations from their ancestral homelands has had long-lasting implications, and today many descendants of the original inhabitants of the Delta live in surrounding areas outside of the legal Delta (Stuart 2021).

And yet tribes have survived. Today, there are 109 federally recognized tribes and 62 non-federally recognized tribes in California, and many California Native American people both within and outside the boundaries of the legal Delta have ancestral ties to the Delta watershed.

The historical and present-day management of the Delta, its waters, and ecosystems continue to disrupt the cultural, historical, and lifestyle use of resources for Indigenous communities. Among the most significant of these disruptors were the "Reclamation Era" actions, which followed California's statehood and included incentivizing large-scale reclamation (draining, leveeing, and farming) of Delta lands as well as the CVP and SWP, which have reconfigured the watersheds, ecosystems, and hydrological systems of the Sacramento and San Joaquin River watersheds. The dispossession and displacement of tribes has enabled the expansion of agriculture in the Delta and the Central Valley, which in turn eliminated Indigenous ecologies, stewardships, lands, and salmon-based lifeways. Another challenge is that many tribes with ancestral ties to the Delta lack federal recognition, which limits access to funding, resources, and land, reduces their rights, and critically, does not allow them to govern their people as a sovereign nation.

As a result of the federal Swamp Lands Act and the incentivized land reclamation mentioned above, Delta land today is primarily privately owned. This reality makes it difficult for tribes to access traditional locations for ceremony, subsistence, and stewardship (heard in tribal consultation on Council initiatives).

For tribes, the Delta remains a sacred and culturally significant landscape whose boundaries extend beyond the legal Delta, encompassing the Sutter Buttes, Tulare Lake, and upstream tributaries. The Delta landscape is central to the identity of tribal people, as a place for livelihood, ceremony, spirituality, heritage, and Traditional Knowledge. Rivers have spiritual meaning to tribes and are part of larger tribal cultures as they relate to creation stories, afterlife, ancestors, and a means of transport for deities and ancestors. Specific plants and animals were used by tribes for subsistence, craft, education and knowledge, and ceremony. Today, tribes continue to recognize their stewardship responsibilities in the Delta, and practice stewardship in private and public ways. When possible, tribes continue cultural and ceremonial practices such as traveling with seasonal salmon runs, gathering plants, fishing and hunting, maintaining traditional cultural and ecological knowledge, and holding community gatherings (heard in tribal consultation on Council initiatives).

In this context, adaptation to climate change for the Delta means protecting the Delta as a tribal homeland and a culturally significant landscape, including its rivers, ceremonial places, cemeteries, villages, plant and animal species, and ancestral connections. It also means partnering with tribes to identify appropriate ways to interweave Traditional Knowledge into adaptation in the Delta in consultation and reciprocal partnership with tribes and knowledge holders (using the principles identified in **Section 10.4**). To do so, tribes should be involved as early as possible, and tribal Traditional Knowledge respected and interwoven where appropriate, in a reciprocal way, throughout the adaptation process, from planning to project implementation. Opportunities for the return of tribal traditional homelands, or co-management and access to that land, should also be prioritized when feasible to ensure that Native peoples, as the traditional stewards of the land, are leaders in climate adaptation in the Delta.

## What is Traditional Knowledge?

Traditional Knowledge is "a body of observations, oral and written knowledge, innovations, practices, and beliefs that promote sustainability and the responsible stewardship of cultural and natural resources through relationships between humans and their landscapes. [It] cannot be separated from the people inextricably connected to that knowledge. It applies to phenomena across biological, physical, social, cultural, and spiritual systems. Indigenous Peoples have developed their knowledge systems over millennia, and continue to do so based on evidence acquired through direct contact with the environment, long-term experiences, extensive observations, lessons, and skills" (Daniel et al. 2022). These systems of knowledge developed by Indigenous peoples and tribes can improve the understanding of climate change vulnerability and strengthen climate adaptation strategies (CTKW 2014).

## 1.6 Summary of Key Vulnerabilities

Chapter 5 of the CCVA identified a number of key climate vulnerabilities for the Delta through mid- and end-of-century, and the communities, geographies, and ecosystems that will be most affected. The adaptation strategies in this Adaptation Plan focus on addressing these vulnerabilities, which are summarized below. However, the specific results from the CCVA are more applicable to project planning, (e.g., when considering future flood heights or extents for a restoration project), while the proposed strategies and actions in this plan address the identified vulnerabilities at a higher level.

**Flooding will continue to get worse.** Flood risk is one of the most pressing threats to the Delta and will continue to worsen in the future. The central and southern Delta will face the greatest impacts, especially in the Stockton area. This risk underscores the importance of investment in levee maintenance and improvements over the coming decades (see **FL-2** for more detail).

**Climate change will not impact Delta residents equally.** Approximately 65 percent of the Delta's population that could be exposed to a 100-year flood event by 2050 reside in areas with high concentrations of socially vulnerable residents. Vulnerable residents may lack resources to prepare for floods and other hazards, vehicles for evacuation, and information on flood risks due to linguistic isolation. These factors make recovering from flood events challenging, perpetuating inequities and vulnerability and making improvements to flood emergency preparedness and response an important strategy (see **FL-4** for more detail). Extreme heat will also disproportionately affect certain populations, such as outdoor workers, people who are unhoused, older adults, children and infants, and individuals with chronic illnesses. While people vulnerable to heat live and work throughout the Delta, Stockton and Tracy have the highest vulnerability to extreme heat impacts, highlighting the importance of increasing climate resilience via enhanced ecosystems in developed areas and nature-based solutions (see **ECO-4** for more detail).

### Delta Residents Survey

*Key Takeaway*

Over three-quarters of respondents believe climate change is caused by humans. However, relative to other issues such as aging infrastructure, transit options, affordability of basic needs, and public safety, climate threat is currently a lower priority. This underscores a critical need to raise awareness of the threats posed by climate change and engage residents in adaptation planning for a resilient Delta.

**Delta water exports will be less reliable in the future.** Climate change will reduce Delta exports and reservoir storage in all water year types, with greater impacts in dry years, increasing drought vulnerability. Projected reductions in Delta exports of approximately 10 to 20 percent annually by 2050 (or approximately 500,000 acre-feet per year) will have far-ranging consequences for water users throughout the state. It is critical for Delta water users to continue planning for future drought conditions, because when Delta water is needed the most, it will likely be less available. Part of that planning includes reducing reliance on the Delta by improving regional self-reliance (see **WSR-1** for more detail).

**The existing water supply system lacks sufficient storage to capture anticipated increases in runoff due to more variable precipitation.** As temperatures increase, more precipitation will fall as rain and less as snow in the Sierra Nevada, diminishing the snowpack and increasing runoff during core winter months. Greater variability in precipitation will increase the likelihood of extremely wet and extremely dry years, but there is insufficient storage to capture the additional precipitation from a very wet year such as 2022-2023. Our water supply system will require significant modifications, including changing how reservoirs are operated (see **WSR-4** for more detail), to adapt to changing climate conditions while maintaining water supply reliability.

## Delta Residents Survey

*Key Takeaway*

**Environmental impacts experienced**

Nearly half of residents reported experiencing extreme heat, while about one-third noticed worsening air quality in their area. More than a quarter of residents indicated they hadn't yet experienced any direct impacts from climate change in their region.

**Concerns and beliefs about climate change and environmental hazards.**

The vast majority of residents acknowledged that climate change is happening. Residents expressed strong concern about drought, water quality, wildfires, and air quality. About half of residents said they were very concerned about heat waves, while others expressed serious concerns about floods (33%) and rising sea levels (26%). 68% of residents strongly agreed that California should prepare more for severe droughts.

**Higher temperatures, changing precipitation and runoff patterns, and sea level rise all make maintaining Delta water quality more challenging.** Decreased flows from upstream reservoirs during drought years may increase salinity intrusion in the Delta, affecting water quality. In-Delta water uses, such as agriculture, may be threatened by episodic water quality declines. These threats necessitate careful review and possible modification of Delta water quality standards using best available science (see **WSR-5** for more detail).

**Delta ecosystems are vulnerable to climate change.** Over the past two centuries humans dramatically transformed the Delta landscape, resulting in the near total elimination of natural wetland, riparian, and floodplain ecosystems. This conversion has degraded the ecological health of the Delta. By 2085, rising sea levels will cause all critical remaining tidal wetland ecosystems to transition to different plant communities or drown, underscoring the need to improve the capacity of ecosystems to adapt to and thrive under future conditions (see **ECO-1** for more detail). Ecosystems protected by levees will be at risk of flooding due to levee overtopping. Increasing drought and extreme heat will stress Delta plant and wildlife species, reduce biodiversity, alter ecosystem dynamics, and increase invasive species.

**Agricultural production trends will shift with climate change.** Agriculture is the prevailing land use in the Delta, serving as the cultural backbone and economic driver of the region, making a sustainable and equitable regional food system even more important (see **AG-2** for more detail). Most Delta crop yields are projected to decrease due to longer, hotter summers. Warmer winters with fewer chilling hours will reduce yields of most fruit and nut trees. However, as the Delta is likely to remain cooler than the Central Valley, the region may serve as a thermal refuge for crops.

# 1.7 Organization of Adaptation Plan

## 1.7.1 Plan Organization

This Plan provides a roadmap and critical first steps for adaptation for the Delta and is organized as follows:

- **Chapter 2 – Strategy Development and Outreach:** Describes the outreach and engagement process that informed development of the strategies and actions in the Adaptation Plan and provides profiles for Delta communities with the highest social vulnerability.
- **Chapter 3 – Navigating the Strategies:** This chapter introduces the strategy format for the reader. This chapter also discusses tradeoffs between adaptation strategies and co-benefits.
- **Chapter 4 – Flood Risk Reduction Strategies:** Summarizes the adaptation approach to flood risk reduction and presents strategies and actions to reduce flood risk.
- **Chapter 5 – Ecosystem Strategies:** Summarizes the adaptation approach to ecosystems and presents strategies and actions to enhance ecosystem resilience.
- **Chapter 6 – Agricultural Strategies:** Summarizes the adaptation approach to agriculture and presents strategies and actions to support agricultural and community resilience.
- **Chapter 7 – Water Supply Reliability Strategies:** Summarizes the adaptation approach to water supply and presents strategies and actions to increase water supply reliability.
- **Chapter 8 – Implementation Roadmap:** Provides a geography-based roadmap for strategy implementation and describes the key considerations, vulnerabilities, priorities, and adaptation approach for each region in the Delta.
- **Chapter 9 – Costs and Benefits of Adaptation:** Summarizes adaptation costs and benefits in the Delta.
- **Chapter 10 – Governance:** Describes approaches to governance that can facilitate a robust and equitable response to climate adaptation for state and local agencies.
- **Chapter 11 – Conclusions and Next Steps:** Summarizes key strategies and findings from Delta Adapts and outlines next steps to move toward implementation.
- **Chapter 12 – References:** Documents cited in the Delta Adapts Adaptation Plan.
- **Chapter 13 – Glossary:** Definitions of key terms.
- **Appendices:** Planning Context; Community Engagement Summary Fall 2023–2025; Environmental Justice Expert Group.

## 1.7.2 How to Navigate the Plan

Delta Adapts presents multiple entry points to navigating the Adaptation Plan and proposed adaptation strategies. Readers who are interested in a particular **focus area** – Flood Risk Reduction (**Chapter 4**), Ecosystem (**Chapter 5**), Agriculture (**Chapter 6**), and Water Supply Reliability (**Chapter 7**) – can directly navigate to each of these chapters. The adaptation strategies presented in these sections are organized using identification numbers. For example, flood risk reduction strategies are titled **FL-1** through **FL-9**. Implementing actions nested under each strategy follow the same convention (e.g., **FL-1-1**).

**Chapter 8 – Implementation Roadmap** considers adaptation actions **by region** in the Delta. Users interested in a specific Delta region can explore this section to find key regional considerations, concerns, and adaptation priorities in the North, Central, and South Delta and Suisun Marsh, with notes on strategies relevant to each region.

Additionally, readers interested in holistic adaptation in the Delta can explore **co-benefits (Section 3.3) and cross-cutting themes (Section 8.6)** supported by the proposed adaptation strategies in **Chapters 4** through **7.** Example co-benefits include improving human health and well-being, increasing community cohesion, increasing public access, sequestering carbon, and reversing or halting subsidence. Example themes include strategies to integrate best-available science, promote soil health and sediment management, reduce regulatory burdens, and support more resilient land uses.

Readers interested in **equity and representational justice** can begin by learning about the social vulnerability index developed for Delta Adapts in **Section 2.2 – Socially Vulnerable Communities.** This section also describes the communities that had the maximum possible score on the social vulnerability index – neighborhoods in Antioch, Stockton, and Pittsburg – and includes key climate vulnerabilities and adaptation priorities for those communities. Equity considerations are also integrated into each adaptation strategy profile.

Users interested in **adaptation costs and benefits** can explore the analyses in **Chapter 9 – Costs and Benefits of Adaptation.**

Finally, **Chapter 10 – Governance** presents considerations for **participatory governance and adaptive management,** which are key to increasing representational justice and inclusive participation in public processes.

McCormack-Williamson Tract Levee Modification and Habitat Restoration Project in Sacramento County

# Chapter 2 Strategy Development and Outreach

## 2.1 Strategy Development

The Council advocates the concept of One Delta, One Science – the vision of an open scientific community that collaborates to build a shared body of knowledge to inform decision-making. This approach has informed the development of adaptation strategies presented in this plan. Building from the principles of best available science (see callout box), **One Delta, One Science** strengthens coordination between scientists, agencies, and interested parties to develop a well-funded, transparent, useful, dynamic, and objective science program to inform strategy development and implementation.

Strategy development began with the results of the CCVA, which describe how regional climate impacts will differentially affect Delta ecosystems, water supply, infrastructure, agriculture, and communities. The strategies address identified vulnerabilities at a high level, aligning with and building from the Delta Plan.

In addition, Council staff reviewed a range of resources to identify, evaluate, and refine the adaptation strategies. Some of these resources include:

- California Climate Adaptation Strategy (CNRA 2021)
- Natural and Working Lands Climate-Smart Strategy (CNRA 2022)
- Farmer and Rancher-Led Climate Change Solutions Listening Sessions (CDFA 2021)
- Strategic Plan to Protect California's Coast and Ocean 2020-2025 (OPC 2020)
- State Agency Sea-Level Rise Action Plan for California (OPC 2022)
- Pathways to 30x30 California (California Biodiversity Council 2022)
- California Water Resilience Portfolio (CNRA, CalEPA, and CDFA 2020)
- Central Valley Flood Protection Plan 2022 Update (DWR 2022) and Conservation Strategy 2022 Update (DWR 2022)
- Carbon Sequestration and Subsidence Reversal in the Sacramento-San Joaquin Delta and Suisun Bay: Management Opportunities for Climate Mitigation and Adaptation (Windham-Myers et al. 2023)
- 2022 Scoping Plan for Achieving Carbon Neutrality (CARB 2022)

See **References** for full list of literature cited in this Adaptation Plan.

## Delta Plan Connection

The Delta Reform Act requires the Council to use **"best available science"** in implementing the Delta Plan, and the Delta Plan outlines specific guidelines and criteria for categorizing scientific efforts (Delta Plan Appendix 1A (DSC 2015)). These specifications require scientists to use the best information and data to inform management and policy decisions. The required elements of best available science include well-stated objectives, outlined assumptions and limitations, use of a clear conceptual model, experimental design with standardized methods for data collection, sound logic for analysis and interpretation, and clear documentation of the entire process.

The Delta Plan's criteria for categorizing whether a body of work or project can be considered best available science include:

- Relevance
- Inclusiveness
- Objectivity
- Transparency and openness
- Timeliness
- Peer review

The Delta Plan includes Traditional Knowledge as one of the sources of best available science.

## 2.2 Outreach and Engagement Summary

Outreach and engagement in support of the Adaptation Plan built on prior engagement for the CCVA and informed the proposed strategies and actions presented in this plan, including the strategy equity considerations and governance best practices. In addition to the outreach activities summarized below, Council staff also held regular briefings and meetings with state, local, flood, and water agencies, and presented at external events and meetings to reach as wide an audience as possible; for example, attending a Suisun Landscapes Project joint community working group and advisory group meeting allowed staff to reach a wide variety of Suisun Marsh partners. A summary of the outreach and engagement efforts and the main takeaways that informed this plan are provided in this section.

Grizzly Island Wildlife Area in the Suisun Marsh

### 2.2.1 Stakeholder Workgroup

As was done during the CCVA development process, Council staff hosted two Stakeholder Workgroup (SWG) meetings during development of the Adaptation Plan.[1] SWG participants included state agencies, local and regional governments, reclamation districts, water agencies, flood boards, academia, non-profit organizations, and private sector representatives.

- **SWG Meeting #1** (November 16, 2021): Council staff shared an update on the Adaptation Plan development process, provided an overview of key findings from the CCVA, led break-out discussions on values and adaptation priorities, discussed high-level adaptation outcomes, and provided participants an opportunity to engage with future technical focus group meetings. This was a major step in the development of the plan's adaptation strategies. Participants highlighted the interconnectedness of climate impacts such as flooding and water supply reliability, shared their vision for a resilient Delta, and noted a preference for prioritizing multi-benefit projects.

1 As also noted in the Executive Summary, since we formed the Stakeholder Workgroup, our understanding of the word "stakeholder" has changed. Some scholars note that this term overlooks the cultural and spiritual significance of land and non-human species to the decision-making process (Reed et al., 2024). Moving forward the Council intends to move away from this word towards more inclusive terminology (DSC 2025a).

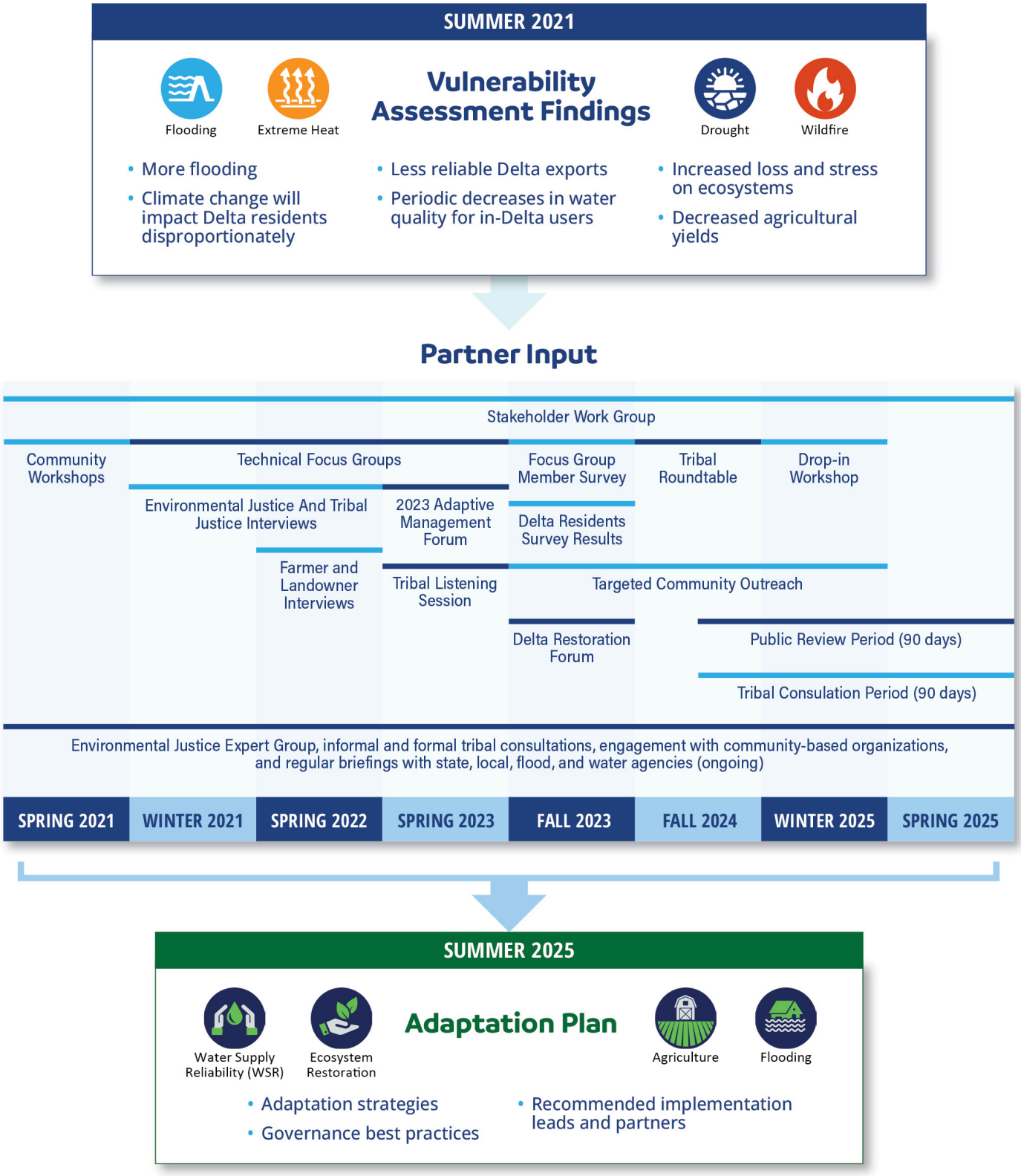


**Figure 2-1** Outreach and Engagement Efforts That Informed the Adaptation Plan

- **SWG Meeting #2** (June 6, 2023): Council staff provided an update on the Adaptation Plan development process, summarized feedback received from ongoing focus group meetings (see **Section 2.2.2**), evaluated landscape scenarios and tradeoffs (DSC 2023), and led break-out discussions on how to address major adaptation challenges. Council staff also hosted an interactive exercise for participants to provide input on early draft adaptation strategies within each of the four focus areas. Participants across all breakout groups noted the importance of prioritizing vulnerable communities, levee improvements and restoration, salinity management, coordination and collaboration, and the need for a systemic approach to adaptation.

### 2.2.2 Focus Groups

Council staff convened four focus groups aligned with adaptation focus areas in the Delta – ecosystems, agricultural resources, water supply reliability, and flooding. Focus groups consisted of representatives from local, state, and federal agencies, consulting firms, and other interested parties. These focus groups met several times between 2021 and 2023 and provided feedback on draft strategies through a survey in fall 2023. Survey comments informed strategy additions and changes such as: inclusion of specific case studies, attention to funding needs, and incorporating equity considerations. Members shared suggestions for coordination, steps needed to make progress on certain strategies, and important actions to emphasize.

Across all focus groups, participants emphasized the importance of taking a whole-systems approach to adaptation that employs multi-benefit, cross-cutting strategies, including nature-based strategies grounded in equity. Clear alignment of ecosystem restoration, flood management, water supply reliability, and agricultural interests was identified as a necessity.

Key insights drawn from each of the focus groups are summarized below:

- **Flooding:** Participants expressed that the Delta's levees are essential: water quality and reliability, ecosystem function, agriculture, key transportation corridors, legacy communities, and urban population centers all depend on levees – the backbone of the Delta. Developing levee projects that meet multi-benefit objectives, such as ecosystem restoration and water supply, will be critical for climate adaptation and ecosystem and community resilience. Participants also emphasized the importance of upstream flood and water supply management and the need to consider flow events at both extremes of the flow regime.
- **Agriculture:** Participants emphasized the central role of agriculture in the Delta's economy, culture, and land use, noting that adaptation efforts should leverage the agricultural system in adapting the Delta's landscape, while helping farms evolve with changing conditions. Though Delta landowners, farmers, and growers recognized that climate-related impacts such as increasing salinity, decreasing fog, and increasing levee seepage are already – and will continue – impacting their operations, they are often more challenged by immediate, short-term demands due to market changes, labor shortages, or other ongoing management decisions. Identifying adaptive management approaches that bridge the short- and long-term planning horizons is a key challenge for achieving economically viable climate-smart agriculture.

- **Ecosystems:** Primary concerns included saltwater intrusion, subsidence, sea level rise, and the ability of habitats to keep pace with climate impacts and invasive species. Many participants suggested prioritizing multibenefit projects and habitat types that help reduce flood risk. Others suggested addressing permitting and regulatory challenges, fiscal mechanisms, and aligning with Delta Plan targets and agricultural and flood risk reduction adaptation strategies. Halting and reversing subsidence was identified as a critical issue for the long-term resilience of the Delta, including its ecosystems. Other issues identified included inadequate sediment, prioritizing migration space, and the need to lay out a strategic vision for the Delta rather than just responding opportunistically.
- **Water Supply Reliability:** Participants highlighted concerns about climate impacts on water supply reliability, including reduced reservoir storage, increased demands on groundwater, heightened need for water transfers, and potential reductions in water supply to address water quality issues (i.e., salinity, algal blooms). Participants emphasized that these challenges should be addressed by a portfolio of actions, such as increased storage and supply, modifying reservoir operations, increased water self-reliance and conservation, and modified regulations.

### 2.2.3 Community Outreach

Throughout development of the CCVA and the Adaptation Plan, Council staff have been establishing relationships and engaging with community-based and service organizations that serve vulnerable populations to better engage with members of the most vulnerable communities. Through coordination and partnerships with CBOs, agencies can better understand how to communicate relevant information most effectively and accessibly and support outreach formats that enable meaningful and inclusive community participation.

As a core part of community outreach, Council staff worked with CBOs to hold several workshops in socially vulnerable communities upon the publication of the CCVA in 2021. These workshops provided insight as to the utility of the CCVA to community needs, and their hopes for next steps in the development of the adaptation plan.

At the 2021 workshops, community organizations discussed their priority initiatives, including youth empowerment, policy advocacy, urban greening, and adaptation planning. The workshops also shared the community outreach and advocacy work that community partners have carried out as part of Delta Adapts and provided ideas for collaborative adaptation projects. Participants explored mechanisms for community groups and local agencies to collaborate, leverage resources, and elevate priority concerns. Additionally, the workshops provided an opportunity for youth to gain experience engaging with state agencies on climate change by sharing their perspectives and feedback on the CCVA results.

Throughout development of this Adaptation Plan, Council staff also engaged CBOs and community members through one-on-one meetings and by attending existing community

meetings and events to hear from participants about their climate concerns and adaptation priorities. In addition to the earlier engagement activities discussed above, from fall 2023 through early 2025, Council staff presented or tabled at 36 meetings and events, hearing directly from community members, CBO staff, and other interested parties on this topic. **Appendix B** provides a detailed summary of input from fall 2023–2025 engagement activities.

### Key Feedback from Community Outreach

Participants emphasized that the most at-risk community members have other, more urgent considerations beyond GHG reduction and climate adaptation, and that agencies need to establish trust and address these other issues before communities can meaningfully engage on climate. Outreach and engagement should convey how climate change affects people's daily lives (e.g., health risks, public safety, economic disruption). Participants emphasized that engaging the most vulnerable residents requires continual effort, trust-building, and multi-pronged, multi-language strategies. Other priorities include:

- Use collaborative thinking and systemwide investments to prepare for future flood risks.
- Raise awareness about the need for more funding for flood risk reduction.
- Make outreach information accessible in communities with language and technology barriers and get residents more involved in adaptation.
- Coordinate across agency adaptation plans to avoid community participation fatigue.

## 2.2.4 Environmental Justice Expert Group

Council staff formed an Environmental Justice (EJ) Expert Group in June 2021 to inform the Council's EJ work and other Council-led initiatives, including Delta Adapts. This group was comprised of representatives from three CBOs and one tribal-serving organization that specialize in areas including community advocacy, building partnerships, tribal concerns, social and environmental sciences, and other topics related to the Delta. To form the EJ Expert Group, Council staff reached out to over 60 CBOs and more than 100 tribes and were intentional in the creation and design of this group, prioritizing building relationships, recognizing past disenfranchisement with government, establishing trust, and shared understandings of issues. The EJ Expert Group reviewed and provided input related to outreach and engagement, metrics related to equity, adaptation strategy language – particularly the equity considerations – and co-benefits. For more information about the EJ Expert Group, see **Appendix C**.

### 2.2.5 Tribes

Council staff reached out to tribes as part of an initial early pre-consultation and a formal consultation process on Delta Adapts to hear tribal perspectives on climate adaptation concerns, recommended adaptation strategies and considerations, and thoughts on interweaving Traditional Knowledge into and co-managing adaptation projects in the Delta.[2]

Council staff hosted a tribal roundtable in December 2024 and consulted with three tribes on the public review draft of the Adaptation Plan during a 90-day tribal consultation period. Staff also incorporated what was heard at the Council's **April 2023 Tribal Listening Session**. Feedback received from tribes in these processes included, for example, understanding that:

- The entire Delta is a culturally significant landscape, and projects can have a cultural impact whether or not they affect an archaeological asset,
- Social issues and climate change are inextricably linked – you cannot address one without the other, and
- The importance of distinguishing between commercial agricultural practices and tribal land stewardship.

The Council hosted representatives from Native American tribes during a Tribal Listening Session in April 2023.

### 2.2.6 Agriculture

Council staff conducted a range of outreach activities with Delta growers to understand their perspectives on climate impacts and adaptation strategies. Council staff, CDFA, and California Sea Grant collaboratively interviewed Delta growers regarding the climate and environmental changes they are already experiencing, how they are currently responding and adapting, and future needs. Overall, Council staff spoke with 35 Delta growers farming across the Delta, largely during in-person interviews at water agency and reclamation district meetings in April and May 2022.

In these interviews, Council staff learned that while climate change is a concern among farmers, shorter-term and more immediate factors, such as market forces, affect their year-to-year decisions. Growers shared their specific concerns around climate change including rising air temperatures, fewer freezing days, sea level rise, increased salinity, decreasing fog, drought and decreasing water supply, and secondary effects like more invasive species and crop mildew. These conversations were the primary drivers behind the proposed agriculture strategies and actions in this plan.

Additionally, Council staff also presented at several Suisun Resource Conservation District (RCD) Landowner meetings, which are typically attended by over 100 landowners, the majority of whom are duck club owners rather than growers. The attendees noted concerns around invasive species, particularly Phragmites, and the need for more dredging to stabilize levees.

2 A similar consultation process was also used to engage tribes on the Council's Tribal and Environmental Justice issue paper. Council staff consulted with five tribes on the Tribal and Environmental Justice Issue Paper, and feedback from those consultations informed Delta Adapts.

### 2.2.7 Other Engagement Activities

Council staff met with state and local government agencies, regional climate collaboratives, and non-governmental organizations throughout the Delta Adapts process. **Appendix B** includes feedback from discussions during fall 2023–2025. These meetings identified interested parties' priorities concerning land use decisions, primary concerns for adaptation, and highlighted adaptation projects and plans that are underway.

In addition, outreach also sought to understand local agencies' adaptation planning status and if they had identified any specific adaptation projects.

Some examples of priorities and concerns identified include:

- The importance of subsidence reversal projects for GHG emission reduction;
- Considerations for working on restoration projects with private landowners; challenges for funding restoration projects, particularly those involving setback levees;
- The need for actions that support food sovereignty and maintain prime farmland;
- Understanding the cumulative benefits and/or impacts of projects on flood risk, with attention to equity and impacts on small communities;
- Regulatory and cost challenges of levee maintenance;
- Consideration of land use change impacts to immediate neighboring parcels as well as regional impacts related to species, flood risk reduction, etc.

## Key themes, concerns, and challenges reported by growers across the Delta:

- Agriculture is the socioeconomic engine of the region and allows for schools and communities to live in the Delta. Changes to the agricultural landscape (e.g., land use change, crop change, etc.) drive changes in other aspects of the Delta's economy and social system.
- Economic factors, the market, water shortages, and regulation have a greater impact than climate change on day-to-day operations and year-to-year crop choices (see **AG-3** for more detail).
- Invasive species are a growing issue, including pests that no longer die off in the winter. Aquatic invasive vegetation impedes water pumping. Other issues include salt from the soil and from groundwater leaching, a reduction in fog, and decreased freezing temperatures (see **AG-1** for more detail).
- Experimenting with new crops and adaptation practices has greater financial risks for small family farms (see **AG-2-3** for more detail).
- In the South Delta, salinity was a focal point, with a generally pessimistic outlook for the long-term arability of land if salt continues to accumulate. Some are switching to more salt-tolerant, higher-value crops (see **AG-1-6** for more detail).
- Some growers noted distrust in the government and the need for more support and value for agriculture in general.

Needs and recommendations identified by Delta growers for agricultural adaptation:

- More regulatory support to reduce costs on farmers.
- Quality, unbiased information on crop alternatives, such as rice, from organizations in extension roles.
- Continued incentive programs (e.g., State Water Efficiency and Enhancement Program, Healthy Soils Program) (see **AG-3** for more detail).
- Incorporation of local knowledge into modeling (see **WSR-5-8** for more detail).
- Improved water year forecasting that would allow farmers to plan when they must make planting decisions
- Changes in policy on water transferability.
- Funds for local reclamation districts to acquire easements landside of the levee to control adjacent agricultural practices for levee system maintenance (see **FL-2-11** for more detail).
- Continued state support to fund levee maintenance, but levee management should be done locally (see **FL-2-4** for more detail).
- Programs to reduce risks for small family farms to adopt climate-smart practices (see **AG-2-3** for more detail).
- Agritourism and farm stands to bring in more income and raise awareness about farming among younger generations (see **AG-3-1** for more detail).

## 2.3 Socially Vulnerable Communities

Climate change affects everyone, but it does not affect everyone equally. For example, without actions to address these disparities, unhoused populations and outdoor workers will face the worst impacts of poor air quality; children and the elderly will be more sensitive to heat illness; people with disabilities will have a harder time evacuating in a climate-related emergency; and Native Americans will be more likely to live in areas exposed to sea level rise and high heat days (DSC 2025a). These populations, and low-income communities of color, are less able to cope with, and recover from, climate impacts (DSC 2025a). These are but a few of the ways that socially vulnerable communities will be disproportionately and variably affected by climate change.

Centering equity in adaptation begins with identifying Delta communities that are the most vulnerable to climate hazards and developing adaptation strategies to address these vulnerabilities. To identify vulnerable communities, the project team evaluated existing vulnerability indices and studies, including approaches taken by local Delta jurisdictions, to determine appropriate methodologies. The project team developed a custom social vulnerability index (SVI) for the Delta, using available data and input from interested parties. For the list of indicators used in the SVI, see **Table 2-1**. For more details on developing the SVI, please see the Equity Technical Memorandum (DSC 2021b; included as a supporting attachment to the CCVA).

The custom SVI analysis revealed that six areas (census block groups) in Stockton, Antioch, and Pittsburg scored the maximum possible score in the SVI, meaning that they have the highest social vulnerability among all evaluated communities. These results informed outreach to understand community priorities and concerns in these areas (see **Section 2.2** and **Appendix B** for more information). However, other socially vulnerable communities and populations are located throughout the Delta in other cities and small towns, including legacy communities. Staff expanded its outreach to many other vulnerable communities from 2023 to 2025, and community feedback from that outreach informed the final Adaptation Plan (see **Appendix B** for more information).

### Farmworker Voices

In 2024, Yolo County partnered with the De Colores Resource Center to interview Yolo County farmworkers about how climate change affects their work. Interviewees shared that they "...work in bad weather, dust, smoke, rain, and high temperatures. We work fewer hours and we don't earn enough to support our families, and we stress a lot. All this makes us work in unsafe conditions" (Yolo County 2024). They also shared fears of retaliation when reporting health concerns to management (Yolo County 2024). These interviews highlight some of the ways in which farmworkers who work in and near the Delta are affected by climate change.

**Table 2-1** Indicators Used in the Custom Climate Change SVI

| Indicator | Metric |
|---|---|
| Children | % population under 5 |
| Ability | % households with 1 or more persons with a disability |
| Educational attainment | % adults over 25 without a high school diploma or GED |
| Linguistic isolation | % households that are limited English speaking households |
| Older adults living alone | % households that have 1 member, age 65 years and over |
| Poverty | % of households with income less than 200% of the federal poverty level |
| Race and ethnicity | % households with 1 or more persons that are Hispanic and/or non-white |
| Renters | % of housing units that are renter-occupied |
| Vehicle access | % households without a vehicle |
| Health insurance | % of individuals without health insurance coverage |
| Asthma | Age-adjusted rate of emergency department visits for asthma per 10,000 |
| Cardiovascular disease | Age-adjusted rate of emergency department visits for heart attack per 10,000 |
| Birth weight | Percent low birth weight |
| Food access | At least 100 households are more than ½ mile from the nearest supermarket and have no access to a vehicle; or at least 500 people or 33 percent of the population live more than 20 miles from the nearest supermarket |

### 2.3.1 Antioch

Antioch does not have the highest exposure to climate hazards when compared to other Delta jurisdictions but ranks highly on the SVI because some of its neighborhoods have high concentrations of residents with socioeconomic, health, and demographic characteristics that increase their vulnerability to climate change impacts. One of the Delta's census block groups with the highest SVI score is in Antioch, encompassing the neighborhoods Prosserville Park, Bridgemont, and Del Rio Homes. These communities experience high rates of poverty and low rates of homeownership. Many households have limited English, are older adults living alone, or have at least one member with a disability. These factors can all make it more difficult for residents to receive information about climate hazards and natural disasters and respond or evacuate quickly.

**Delta Residents Survey**

*Key Takeaway*

"Adaptive capacity" refers to the level of resources that households have access to that facilitate resilience in the face of environmental and climate impacts. Adaptive capacity was found to be generally lower among younger, non-white, and low-income residents. Communities in portions of South Stockton, Pittsburg, Oakley, Tracy, and Knightsen were identified as having the lowest adaptive capacity. Delta Adapts prioritizes adaptation actions in socially vulnerable communities to ensure equitable outcomes for all Delta residents.

While Antioch does not have the highest flood risk in the Delta, by 2085 at least 1,180 people will live at elevations projected to be exposed to flooding (as identified by the CCVA). Similarly, social vulnerabilities are likely to exacerbate the effects of heat for many residents, especially older adults living alone, people with pre-existing health conditions, and low-income people, who tend to have higher sensitivity and lower adaptive capacity to heat hazards. To increase resilience, adaptation actions should focus on understanding and addressing the specific needs of vulnerable populations. In implementing strategies **FL-4** and **FL-6,** agencies should consider people who may face challenges evacuating and provide information in multiple languages and media formats.

### 2.3.2 Pittsburg

The Pittsburg communities with the highest social vulnerability score are located within the East Leland, East Central, and Loveridge districts, along Railroad Avenue and State Highway 4. Many households in these areas lack vehicle access and experience linguistic isolation, and nearly half of all households have at least one person with a disability. A high number of adults do not have high school diplomas or GEDs, which can reduce economic opportunities and limit resilience.

As identified in the CCVA, Pittsburg currently experiences little flood risk, but that is likely to increase significantly. By 2085, at least 2,000 people are likely to live in areas exposed to flooding (including sea level rise). Residents are also projected to face increasing exposure to extreme heat. Some 20 percent of people in the Loveridge neighborhood lack health insurance, further increasing their vulnerability to extreme heat.

## Adaptation Priorities: Antioch and Pittsburg

Both Antioch and Pittsburg have included climate vulnerability and adaptation strategies in their Climate Action and Resilience Plan and Sustainability Plan, respectively. Both cities also recently updated their general plans to include adaptation goals and policies. Adaptation priorities for these cities identified through the Delta Adapts community outreach include:

- Coordinate with other agencies on adaptation efforts.
- Prioritize adaptation for vulnerable communities.
- Protect shoreline infrastructure from sea level rise and climate hazards.
- Maximize public shoreline access and increase park resilience (see **ECO-4** for more detail on nature-based solutions for developed areas).
- Address drinking water issues, trash in waterways, and food insecurity.
- Educate youth on climate impacts and adaptation (for example, the need for improved flood risk communication; see **FL-6** for more detail).


8th Street in the City of Pittsburg, California

### 2.3.3 Stockton

Stockton's communities with maximum scores in the SVI correspond closely to historic redlining maps, suggesting that past city planning and investment decisions are still profoundly affecting residents today. Nearly all of South Stockton experiences high social vulnerability, including the historic communities of Little Manila, Chinatown, and Japantown. Today, these communities continue to have high rates of poverty and limited economic opportunities. Many households lack car access, have limited English, and consist of an older adult living alone and/or at least one person with a disability.

Stockton neighborhoods are highly vulnerable to flooding. As identified in the CCVA, the number of people exposed to flooding due to levee overtopping during a 100-year storm event is projected to increase from close to zero today to nearly 30,000 by 2050 and 55,000 by 2085 – the highest number for any Delta city. Yet many of the factors described above will make it more difficult for residents to respond to and recover from flood events. Older adults living alone, households without cars, and people with disabilities will face challenges in evacuating. For lower-income households, a climate disaster is likely to come as a financial shock eroding any savings or economic gains.

Stockton also faces high vulnerability to extreme heat. In the Delta, the urban heat island (UHI) effect is greatest in South Stockton and Tracy and along the Highway 4 corridor. The UHI effect is particularly severe for lower-income neighborhoods that lack tree canopy or are located near industrial land uses. By mid-century, Stockton neighborhoods are projected to experience approximately 25 extreme heat days per year, compared to five days per year currently. Critically, Stockton's socially vulnerable communities experience multiple factors correlated with greater vulnerability to extreme heat.

#### Adaptation Priorities: Stockton

Stockton residents, CBOs, and agencies identified the following priorities, aligning with key themes of regional coordination, flood risk reduction, and environmental justice and equity:

- Implement multi-benefit projects, e.g. Mormon Slough (see **ECO-1-4** for more detail).
- Use collaborative thinking and systemwide investments to prepare for future flood risks.
- Protect vulnerable infrastructure: Highway 99, Stockton Airport, Highway 4.
- Raise awareness about the need for more funding for flood risk reduction.
- Make outreach information accessible in communities with language and technology barriers and get residents more involved in adaptation (see **FL-6** for more detail).
- Coordinate across agency adaptation plans to avoid community participation fatigue.

Port of Stockton

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# Chapter 3 Navigating the Strategies

This chapter provides a guide to the adaptation strategies in the Adaptation Plan. It includes a discussion of tradeoffs among adaptation strategies (**Section 3.1**), describes a range of co-benefits that can be potentially achieved by the strategies (**Section 3.2**), and provides a guide (**Section 3.3**) describing the layout for each strategy profile in **Chapters 4** through **7**.

## 3.1 Evaluating Adaptation Tradeoffs

The Adaptation Plan identifies adaptation strategies to reduce climate vulnerabilities for Delta communities, infrastructure, ecosystems, and agriculture. Although adaptation strategies are designed to achieve multiple resilience goals, implementation of certain strategies may come at the expense of other goals. This is particularly inherent in the Delta, where a multitude of land uses and interested parties converge, and the socio-ecological system is largely influenced by actions that occur outside of the legal Delta, such as upstream water management practices and downstream land use and water demand. These external factors make regional adaptation planning efforts uniquely complex and call for a holistic, science-based approach.

This section summarizes tradeoffs that may arise if one outcome – flood risk, water supply, ecosystems, or agriculture – is prioritized over others. These tradeoffs should be considered when choosing between adaptation actions and fine-tuning strategies to minimize negative outcomes. Through planning and collaboration across interested parties, adverse tradeoffs can be minimized or eliminated. However, in some situations, a perfect solution will not emerge and/or tradeoffs cannot be avoided. The role of the Council is, in part, to provide relevant science and overarching perspective to help mediate, facilitate, and inform the necessary decisions between difficult tradeoffs.

## Agriculture

Actions focused on preserving agriculture will maintain a key driver of the Delta's economy and jobs. The agricultural economy also supports a portion of the funding for levee improvements, which protect communities from flooding.

However, where intensive agriculture is maintained, less land is available for restoration and for improving habitat connectivity. Agricultural land has higher rates of subsidence and GHG emissions than natural or restored land. In addition, preservation of agriculture land use affects communities in and around the Delta, who would not enjoy the ecosystem benefits of restoration, such as improved air and water quality, flood attenuation, easier access to recreational opportunities, thriving native fisheries, and improved natural aesthetics. Reducing agricultural land will require supporting a regional economic transition to provide new jobs to agricultural communities. Alternative land uses like restoration will require maintenance, which can provide jobs. However, funding sources will be needed to support habitat restoration and maintenance and training opportunities for individuals switching from agricultural jobs to restoration and levee improvement jobs.

Potential solutions to the tradeoffs between agriculture and restoration are wildlife-friendly climate-smart farming practices [**AG-1**] that include switching to crops that provide many of the same ecosystem functions as a wetland, such as rice. Multi-benefit land use projects that rotate functional uses between productive cropland and seasonal habitats (e.g., the Yolo Bypass) can provide ecological benefits and reduce flood risk while preserving agricultural interests.

## Ecosystems

Adaptation strategies focused on restoring ecosystems and improving habitat have many benefits, including habitat creation, water supply protection, flood risk reduction, subsidence reversal, water supply and water quality improvements, GHG emissions reduction, and improved habitat connectivity [**ECO-1**]. Communities benefit from restoration activities through improved air and water quality, access to recreational and cultural resources, and other ecosystem services.

On the other hand, strategies that shift the agricultural Delta economy toward restoration will likely lead to broader shifts in local economies and communities currently employed in the agricultural sector. While new jobs are created from restoration and levee improvements to counter the loss of agricultural jobs, these opportunities may be realized by other community members, leaving agricultural workers to bear the costs. When agricultural land is taken out of production or alternative land ownership or management is pursued, there remains the need for sustainable funding for levee improvements, as the reduction in economic activity may no longer be sufficient to support the local cost share required to operate and maintain Delta levees. In addition, habitat restoration costs can be high.

Delta ecosystems need adequate and appropriate flows to function. However, restoring these flows can result in tradeoffs between different species needs as well as human uses such as water exports. For example, releasing large flows from reservoirs in dry years to cue salmonid migration will reduce water availability for cold water pool retention and water exports.

Effectively protecting the Delta's ecosystems also requires holistic management approaches such as ecosystem-based management or multi-species assessments/ management [**ECO-1**]. As Stella and Lee (2025) note, "Multi-species assessments identify critical areas for protection, optimize the distribution of conservation efforts, and seek to preserve or enhance ecological connectivity across landscapes.…This strategy allows for the evaluation of trade-offs among species and highlights the importance of shared threats—such as habitat loss, climate change, and invasive species—that affect multiple species within a given ecosystem.… Prioritizing these shared threats can enhance management strategies by grouping species with similar vulnerabilities and developing targeted restoration plans. Multi-species management differs fundamentally from single-species strategies by considering the interactions among various organisms within an ecosystem, while also prioritizing the needs of individual species. This approach allows managers to promote sustainable practices that support both the health of ecosystems and the well-being of the species they encompass."

## Flood Risk and Water Supply

Reducing flood risk will largely occur through updating levee systems and restoring wetlands to mitigate flooding. In a similar vein, water supply reliability will be achieved by expanding local storage and improving conveyance systems and reservoir operations. Tradeoffs for both focus areas are generally similar.

Many flood risk and water supply reliability strategies also support agricultural and ecosystem goals. For instance, farming practices that minimize flood risks [**FL-5**] maintain agriculture and restoring ecosystems for flood mitigation [**FL-3**] promotes restoration. However, these strategies will have the same tradeoffs between agriculture and ecosystems discussed above.

Maintaining water supply reliability makes it possible for agriculture, ecosystems, and people to thrive. However, if water is scarce, it will be difficult to achieve agricultural and restoration goals. Improving water quality may require additional releases from upstream reservoirs, impacting water supply in future years, while maintaining reservoir levels will lead to less instream flows. Water shortages also impact socially vulnerable communities. Reducing the risk of water supply shortages can be achieved by improving storage [**WSR-2**] and promoting natural flows [**WSR-5**].

Levee investments must be made strategically [**FL-2, ECO-2**]. If levee improvements are not adequately funded, some people, including those in socially vulnerable communities, and infrastructure will be more exposed to flooding. In addition to damaging properties and infrastructure, flooding leads to more invasive species and reduced water quality. There are also economic downsides to not investing adequately in levees, namely, fewer jobs created from levee improvements, crop damage due to flooding, and economic damages associated with flooding that may occur in unprotected areas. The cost to repair levee breaches, and subsequent emergency response, is also significantly more than the cost to improve and maintain existing levees. In fact, a benefit-cost analysis completed for Delta Adapts demonstrates the economic value of investing in levee improvements for most Delta islands, underscoring the economic and environmental advantages of all levee improvements for community protection and economic benefit (DSC 2023).

## 3.2 Strategy Co-Benefits

Each adaptation strategy brings unique co-benefits, defined as any **additional benefits that result from a strategy outside its original or primary intent.** For example, a strategy that restores wetlands for flood risk mitigation also boosts ecosystem resilience, enhances biodiversity, reduces greenhouse emissions, improves water supply and water quality, grows the local economy, reverses subsidence, and improves equity. The degree to which a strategy creates co-benefits depends on how it is designed, planned, and carried out. A collaborative and coordinated effort that brings together multiple interested parties and experts early in the planning process can lead to more thoughtfully designed, holistic, multi-benefit outcomes.

The co-benefits listed below are highlighted throughout the adaptation strategies presented within the four focus areas of flood risk reduction, ecosystem, agriculture, and water supply reliability in **Chapters 4** through **7**. A community's priorities, goals, and vulnerabilities should guide the consideration of co-benefits and the choice of strategies or adaptation paths.

**Improve Human Health and Well-Being:** Strategies that promote human well-being include strategies that reduce safety risks from flooding, heat, and drought and strategies that support the preservation and enhancement of cultural resources and practices, recreation access, and human connections to the environment.

**Increase Community Cohesion:** Strategies that facilitate connections and engagement among community members and groups improve the adaptive capacity of the community.

**Increase Public Access and Recreation Opportunities:** Strategies that increase public access, recreation, and urban greening, including for communities that historically have lacked access to such amenities.

**Improve Food Security:** Strategies that support more sustainable farming practices and smart agriculture, local agriculture, and farmers.

**Diversify Economic Development:** Strategies that support local economic development, create job and workforce development opportunities, and increase income opportunities for underserved and vulnerable communities. Actions that contribute to more resilient infrastructure are included here.


**Reduce GHG Emissions and Sequester Carbon:** Strategies that support carbon storage, carbon sequestration, and emission reductions.

**Reduce Flood Risk:** Strategies that support floodwater absorption, improved levee management, improved flood resilience (preparedness, response and recovery), and reduce exposure of people, assets, economic activity, and critical facilities to flooding.

**Enhance Biodiversity:** Strategies that support biodiversity and ecosystem health through restoration, conservation, and habitat creation and connectivity.

**Maintain and Improve Water Quality and Supply:** Strategies that reduce water demand, increase water supply, recharge groundwater, support use of recycled water, and improve water quality.

**Reverse or Halt Subsidence:** Strategies that incentivize subsidence reversal and/or halting activities.

## 3.3 Strategy Layout

The strategies and actions recommended in this Adaptation Plan are presented as *strategy profiles.* Each strategy profile consists of the following key components.

**Strategy Overview:** Each strategy profile begins with a strategy number and an overview of its overall focus, objectives, and adaptation approach.

**Recommended Implementation Lead:** Each strategy identifies an entity as the preliminary implementation lead, as well as potential partners. Agencies identified as the implementation lead do not necessarily have regulatory authority or legal jurisdiction to fully carry out a particular strategy; rather, the designation indicates that the agency is best positioned to convene, coordinate, and demonstrate leadership on a strategy. Identified implementation leads are preliminary, subject to change based on further discussions among agencies, and intended to facilitate further discussion as strategies move towards implementation. As many agencies are active in planning for and managing flood risk, water supply, ecosystem health, and agriculture, authorities can often be both complex and overlapping, and simultaneously limited in reach. Successful implementation often necessitates collaboration between a number of partners on strategies across all levels of government and sectors with varying authorities and powers under unified leadership.

**Recommended Partners:** Identifies entities with a role in collaborative implementation of the strategy and its corresponding implementing actions. Partners often have direct legal or permitting authority over parts of the strategy and implementing actions. Partners can include federal, state, and local agencies, Delta cities and counties, metropolitan planning organizations, tribes and tribal communities, community organizations, water agencies and reclamation districts, the private sector, and other entities.

The level of engagement and roles of partners may vary from strategy to strategy.[1]

**Hazards Addressed:** Identifies the hazards from the CCVA that are addressed by each strategy.

**Co-Benefits:** Positive effects that result from achieving the strategy's primary goal. Each strategy has a primary benefit – the main objective of the strategy – and secondary co-benefits that may result.

## State Adaptation Priorities

Each strategy profile identifies the California Climate Adaptation Strategy adaptation priorities that the strategy is most closely aligned with, which are:

1. Strengthen protections for climate vulnerable communities
2. Bolster public health and safety to protect against increasing climate risks
3. Build a climate resilient economy
4. Accelerate nature-based climate solutions and strengthen climate resilience of natural systems
5. Make decisions based on the best available climate science
6. Partner and collaborate to leverage resources

**Equity Considerations:** All strategies are designed to support representational justice, inclusive community and tribal participation in public processes, and more equitable outcomes for socially vulnerable communities. The profiles consider how each strategy can advance equity and environmental justice, with recommendations for how to strengthen equity outcomes and benefit socially vulnerable communities. Where applicable, each profile also considers potential negative impacts for equity and socially vulnerable communities, and potential approaches to avoid or reduce those impacts.

**Implementing Actions:** This section outlines actions to be taken to advance each strategy. Each strategy will be led by varying combinations of the identified lead and partners. Implementing actions provide greater specificity than strategies and range from planning, coordination, research, project deployment, developing or accessing funding, and monitoring and evaluation.

1 Tribal governments and communities should be consulted for any adaptation projects in the Delta and therefore could be partners across all strategies; however, in the strategy profiles they are identified as partners for strategies where there is a clear connection to tribal needs, interests, concerns, or Traditional Knowledge.

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# Chapter 4 Flood Risk Reduction Strategies

## 4.1 Adaptation Approach

Located at the confluence of the Sacramento and San Joaquin Rivers and San Francisco Bay, the Delta is a complex system whose water levels are influenced by riverine inflows, tides, storm surge, and in some locations, flood hazard management and water supply infrastructure. Climate change will affect many of these factors, increasing the risk of flooding. Riverine flows are the primary driver of high-water levels in the north and south Delta, where more frequent and stronger watershed precipitation events and a shift in winter precipitation from snow to rain will drive flood vulnerabilities. In contrast, higher sea levels will increase the likelihood of flooding in Suisun Marsh and the western and central Delta. Climate change is expected to increase the frequency of large runoff events across the Delta watershed. Most of the Delta's flood management infrastructure, including 1,100 miles of levees and upstream reservoirs, were designed to operate under historical conditions that did not consider climate change. Climate change will place greater stress on the flood management system, and Delta levees will become increasingly vulnerable to breaches, overtopping, or other types of failure if no action is taken (DSC 2021a).

### Delta Residents Survey

*Key Takeaway*

Less than 20 percent of Delta residents have flood insurance – increasing the consequence of flooding and limiting the ability to recover from flood impacts.

A core part of adapting to flood risk is understanding the complex flood dynamics in the Delta, including the interactions of climate change, floodplain management practices, land use planning, and community vulnerability. This understanding provides a foundation for potential adaptation strategies, including systematically strengthening and upgrading the Delta levee system to be resilient to climate change [**FL-1**] and [**FL-2**]. Investing in levee improvements now is a cost-effective adaptation approach that brings several co-benefits. Restoring riparian, marshland, subtidal, and intertidal habitats would naturally manage floodwaters while also supporting biodiversity and ecosystem health [**FL-3**]. Similarly, climate-smart agricultural practices to recharge aquifers and manage floodwaters can be applied both within the Delta and upstream

in the watershed to reduce and manage peak flows [**FL-5**]. Other upstream watershed adaptation strategies build on existing initiatives, including forecast-informed reservoir operations (FIRO), flood-managed aquifer recharge (Flood-MAR), mountain meadow restoration, and floodplain restoration [**FL-9**]. Land use planning is another important component of flood adaptation. Avoiding development in flood-prone lands and developing alternative uses for high-risk lands, including as restoration sites, can both reduce flood risks and improve ecosystem health [**FL-7**] and [**FL-8**]. Flood adaptation strategies also consider emergency preparedness and recovery and flood risk communication, with priority given to engaging socially vulnerable and historically under-resourced communities who bear the brunt of the impacts of inadequate preparedness, response, and recovery [**FL-6**].

**Table 4-1** provides a summary list of the flood risk reduction adaptation strategies recommended by Delta Adapts. Detailed strategy profiles are presented in **Section 4.2.**

**Table 4-1** Summary of Flood Risk Reduction Strategies

| Strategy ID | Strategy Description |
|---|---|
| **FL-1** | **FL-1: Develop a Comprehensive, Climate-Informed Understanding of Flood Dynamics in the Delta** |
| **FL-2** | **FL-2: Improve and Modernize Levees Based on Asset Importance and Vulnerability** |
| **FL-3** | **FL-3: Restore Climate-Resilient Ecosystems to Act as Nature-Based Solutions for Natural Flood Mitigation and Support Biodiversity** |
| **FL-4** | **FL-4: Improve Flood Emergency Preparedness and Response** |
| **FL-5** | **FL-5: Promote Innovative Technologies and Farming Practices that Minimize Flood Risks** |
| **FL-6** | **FL-6: Effectively Communicate Flood Risks, Warnings, and Mitigation Strategies to All At-Risk Communities** |
| **FL-7** | **FL-7: Incorporate Land Use and Urban Planning to Reduce Flood Risk** |
| **FL-8** | **FL-8: Use Adaptive Resilience Planning in High-Risk Flood Areas with Consideration for Existing Land Uses** |
| **FL-9** | **FL-9: Manage and Expand Upstream Water Storage Capability** |

# 4.2 Strategy Profiles

## FL-1: Develop a Comprehensive, Climate-Informed Understanding of Flood Dynamics in the Delta

**Recommended Implementation Lead:** Council

**Recommended Partners:** USACE, tribes and tribal communities, DWR, CDFA, LCI, CVFPB, BCDC, CalOES, local governments, local flood management agencies

**Hazards Addressed:** Flooding, Extreme Heat, Drought, Wildfire

**Co-Benefits:** Water, Community

**State Adaptation Priorities:** (1) Strengthen protections for climate vulnerable communities, (5) Make decisions based on the best available climate science, (6) Partner and collaborate to leverage resources

**Equity Considerations:** Actively involve and incorporate voices that have not historically been represented in decision-making, including tribes, tribal communities, and socially vulnerable communities, in the planning, decision-making, and implementation of flood risk reduction strategies. Consult with communities and tribes early on key considerations for incorporating vulnerability metrics into flood risk modeling [**FL-1-1**]. When linking land use and water use plans [**FL-1-4**], make sure that outcomes do not place vulnerable communities at greater harm or negatively impact their water supply. Ensure strategies are aligned with the actual needs and preferences of communities through ongoing dialogue, community meetings, feedback sessions, and partnerships with local organizations.

The Rio Vista Bridge is in a critical channel that could address drought conditions through temporary barriers.

### Strategy Description

Develop a comprehensive understanding of flood dynamics in the Delta, and include climate change considerations in risk assessments, floodplain management, levee standards, and design. A comprehensive understanding of flood dynamics can aid in more efficient water management practices, reduce flood risk, and guide more resilient agricultural and land use practices.

### Implementing Actions

- **FL-1-1:** Integrate climate change considerations and socio-economic factors (e.g., community income levels, access to resources) into **risk assessment models,** floodplain management, levee design and standards, and operations and maintenance (O&M) to ensure that flood risk management strategies align with future climate scenarios and consider the specific vulnerabilities and adaptive capacities of different communities.

- **FL-1-2: Strengthen collaboration and dialogue on flood risk reduction** among water agencies, flood management agencies, agricultural interests, environmental groups, and other interested parties within the Delta. Promote transparent communication and shared objectives.
- **FL-1-3:** Apply **integrated flood risk and emergency preparedness models** to simulate and predict the impacts of single and multiple levee failures across the Delta, including assessing scenarios of levee overtopping and flood dynamics under various climate conditions. Form a multidisciplinary team of experts in hydrology, ecology, climate science, engineering, and emergency management to integrate scientific data, academic research, and empirical observations from local agencies. This approach considers phenomena such as the cascading effect of levee failures (i.e., the 1995 Liberty Island levee failure) to make model predictions as accurate as possible.
- **FL-1-4:** Consider and advance approaches to better **link local comprehensive land use plans and water use plans** to balance agricultural and housing needs with flood risk management. Facilitate the alignment of policies and strategies across sectors and regions.

# FL-2: Improve and Modernize Levees Based on Asset Importance and Vulnerability

**Recommended Implementation Lead:** DWR

**Recommended Partners:** USACE, tribes and tribal communities, Council, CVFPB, reclamation districts or other local flood agencies

**Hazards Addressed:**


**Co-Benefits:**


**State Adaptation Priorities:** (1) Strengthen protections for climate vulnerable communities, (5) Make decisions based on the best available climate science, (6) Partner and collaborate to leverage resources

**Equity Considerations:** Prioritize socially vulnerable communities in all stages of levee investment, including monitoring, maintenance, and funding. Listen to tribes and CBOs to identify and protect resources and assets important to them. Create and implement tailored flood risk reduction strategies, such as home elevation, financial assistance for floodproofing, and improved access to flood insurance. When integrating equity into the Delta Levee Investment Strategy (DLIS) [**FL-2-2**], build in sufficient resources to allow for transparent decision-making and engagement as part of the process.

Yolo Bypass with the Lower Elkhorn Basin Levee Setback Project

## Strategy Description

This strategy focuses on enhancing the resilience of the existing Delta levee system to the challenges of climate change and rising water levels. The strategy tailors protection levels to the importance of the assets at risk, including vital water supply islands and critical infrastructure like highways, while prioritizing community safety and well-being. It ensures the protection of people's lives and properties, recognizing their paramount importance in the Delta. This strategy leverages modern, climate-adaptive engineering solutions to future-proof levees. Underpinned by a robust funding strategy, it integrates both climate risk and social equity into investment decisions, creating a data-driven, cost-effective, and equitable pathway to long-term flood resilience. Adaptive levee designs that include environmental features such as fish passages or floodplain restoration areas can also benefit local ecosystems.

**Asset level flood protection** describes the process of assessing and applying flood protection measures tailored to specific assets, considering importance, value, and associated risk. This approach recognizes that different assets may require varying levels of protection based on their unique characteristics and roles within the Delta. For instance, agricultural lands in the Delta are provided a different level of flood protection compared to urban areas, reflecting differing needs and vulnerabilities.

## Implementing Actions

- **FL-2-1:** Assess current vulnerabilities, consider climate risks, and **evaluate tradeoffs of future land and water use scenarios.** Include consultation with tribal governments and organizations when evaluating land and water use changes, especially for public lands with tribal cultural or historical significance.
- **FL-2-2: Integrate climate risks into DLIS.** This approach aligns investment decisions with emerging climate challenges.
- **FL-2-3:** Carry out **ongoing inspections and maintenance,** considering increased requirements under future climate conditions such as higher water levels and increased erosion/scour of levees. Develop robust operational and maintenance protocols.
- **FL-2-4: Secure sustainable state and federal funding** for levee operation, maintenance and improvements, habitat restoration, and flood resilience projects (multi-benefit projects). Specifically, consider establishing permanent funding mechanisms (e.g., the Delta Levees Maintenance Subventions Program) to support ongoing levee upkeep and repair. Apply for grants and other funding sources dedicated to climate adaptation and flood risk reduction to modernize data gathering infrastructure.
- **FL-2-5: Protect islands considered vital for water supply at a 200-year level of protection.** The remaining islands or tracts responsible for safeguarding highways, legacy communities and other small communities, and other critical infrastructure should be provided with a 100-year level of protection. Align state protection standards with updated vulnerability assessments and climate risks on an ongoing basis.
- **FL-2-6: Prioritize levee improvements in socially vulnerable communities by incorporating an equity-weighted benefits evaluation into DLIS.** Use tools such as the social vulnerability index developed for Delta Adapts and updated flood risk models that consider climate change to identify socially vulnerable communities with high flood risk and prioritize them for levee improvements. Listen to community needs and priorities through listening sessions, surveys, community meetings, and partnerships with local organizations.

- **FL-2-7:** Develop **specific design/ engineering guidance for adaptive levees.** Upgrade Project and Non-Project levees to withstand sea level rise and more intense storms and adopt modern engineering solutions and adaptive levee designs that anticipate future raises.
- **FL-2-8: Support local maintaining agencies and reclamation districts** to upgrade levees, considering long-term sustainability and resilience.
- **FL-2-9:** Implement **advanced monitoring technologies for inspections and maintenance,** including remote sensing and in-ground integrated monitoring technology. Use motion-detection remote devices to provide real-time data on levee conditions, enhancing predictive maintenance and rapid response capabilities.
- **FL-2-10:** Develop or expand strategies to **secure suitable and cost-effective fill material** (such as SediMatch) for the extensive levee improvements required in the coming decades. Explore innovative and sustainable sourcing methods.
- **FL-2-11:** Develop a pilot program, funding mechanism, and implementation strategy for **purchasing flood easements** from willing sellers, thereby creating additional space for flood management and mitigation.

## Delta Plan Connection

Risk Reduction Policy 1 (**RR P1**) focuses on guiding investment toward prioritized levee improvements and aligns with **Strategy FL-2's** emphasis on enhancing the resilience of the levee system in the face of climate change and rising water levels.

Ecosystem Restoration Policy 4's (**ER P4**) directive for levee projects to "evaluate and where feasible incorporate alternatives, including the use of setback levees, to increase floodplains and riparian habitats" supports creating additional flood management areas, resonating with the strategic use of easements in **Action FL-2-11.**

# FL-3: Restore Climate-Resilient Ecosystems to Act as Nature-Based Solutions for Natural Flood Mitigation and Support Biodiversity

**Recommended Implementation Lead:** CNRA Office of the Secretary (coordination and alignment role), DWR, Council
**Recommended Partners:** USFWS, NOAA, CVFPB, CNRA (includes 26 departments, conservancies, and commissions), CDFW, tribes, universities, local governments

**Hazards Addressed:**


**Co-Benefits:**


**State Adaptation Priorities:** (4) Accelerate nature-based climate solutions and strengthen climate resilience of natural systems, (5) Make decisions based on the best available climate science

**Equity Considerations:** Prioritize ecosystem restoration for socially vulnerable communities with high flood risk. Use data-driven assessments to identify these high-risk areas and work toward equitably distributing flood management and restoration project benefits. Partner with tribes and Traditional Knowledge holders to identify how restoration can increase access to sacred places or benefit traditional practices; avoid disrupting sacred or significant habitats and cultural resources; and explore opportunities to interweave Traditional Knowledge. Regularly monitor and evaluate strategy impacts on socially vulnerable communities, using clear metrics, with the goal of delivering equitable benefits for all communities.

## Strategy Description

This strategy leverages nature-based solutions by restoring riparian and marshland habitats to mitigate flood risks. The approach prioritizes projects through data-driven assessments, continuously monitors impacts, and focuses on equitably benefiting socially vulnerable communities and partnering with tribes. By doing so, it creates a cohesive adaptive framework that aligns ecosystem health with effective flood management. Restoring habitats like riparian zones and wetlands not only provides natural flood protection, restoration makes these lands more resilient, aids in carbon sequestration, creates habitat, and provides other ecosystem services. These measures collectively contribute to a more robust and adaptable ecosystem better equipped to face climate change impacts.

## Implementing Actions

- **FL-3-1:** Conduct an assessment to determine the **types of restoration** (intertidal, subtidal, riparian, etc.) that would provide the greatest flood reduction benefits in specific parts of the Delta. Use this assessment to prioritize multi-benefit projects that restore riparian, marshland, subtidal, and intertidal habitats that serve as natural flood defenses and are resilient to climate change impacts.

- **FL-3-2:** Establish **ongoing monitoring and evaluation processes** to assess the effectiveness of multi-benefit ecosystem and flood management projects, adapting strategies as needed. Extend these processes to regularly assess the impacts on socially vulnerable communities, using clear metrics and periodic evaluations to ensure that communities are equitably benefiting from flood risk reduction investments.
- **FL-3-3: Prioritize research regarding the effectiveness of nature-based solutions** to better understand how restored wetlands absorb floodwaters, and the comparative benefits of nature-based solutions to gray infrastructure, interweaving Traditional Knowledge in consultation with tribes and knowledge holders as applicable. Use this data to advocate for land use changes when warranted.
- **FL-3-4:** Explore and prepare a **comprehensive nature-based solution funding strategy** to attract potential partners from the private, non-profit, and other sectors interested in contributing to habitat restoration.
- **FL-3-5: Streamline permitting processes for habitat restoration that provides flood management co-benefits** by building upon and expanding California state agencies' Cutting the Green Tape initiative to expedite and simplify permitting for nature-based projects that also provide flood protection benefits. The objective is to distinguish these projects from industrial activities like gravel mining by making the process less time-consuming and costly.

The habitat surrounding the Lookout Slough Tidal Restoration Project

## Case Study: Dos Rios Ranch Restoration

**Partners:** River Partners, Tuolumne River Trust, California Department of Fish and Wildlife (CDFW), Bureau of Reclamation

Dos Rios State Park, a 2,100- acre floodplain restoration initiative near Modesto and California's newest State Park, stands as the state's largest public- private floodplain restoration project. Before its transformation, the ranch was a dairy and cattle operation vulnerable to frequent flooding, experiencing six flood events between 1983 and 2007. After the project was acquired as a gift from the Lyons family in 2002, River Partners removed levees and other flood hazard management structures in 2012, allowing the Tuolumne River to reconnect with its historic floodplain.

The subsequent restoration involved creating wetlands, planting native vegetation, and developing new wildlife habitats. These efforts have significantly reduced flood risks by allowing floodwaters to disperse and slow down, thus reducing erosion and safeguarding infrastructure. The restored floodplain also filters pollutants, enhancing water quality and providing critical habitats for endangered species like the Central Valley Chinook salmon, steelhead trout, and riparian brush rabbit.

Beyond its environmental impact, the Park serves as a recreational hub, open to the public for activities like hiking, biking, fishing, and birdwatching, and offers educational programs. Economically, the project has been a boon for the local community, creating over 250 jobs and generating more than $40 million in economic activity, according to a study by River Partners. It has also increased property values in the surrounding areas.

While this project is outside of the Delta, upland Delta practitioners have much to learn from the successes at Dos Rios. The project serves as a multifaceted model for floodplain restoration, showcasing how such projects can improve environmental health, offer recreational and economic benefits, and potentially mitigate flood risks, improve environmental health, and offer both recreational and economic benefits for the areas of the Delta where floodplain expansion is possible (as called for in [**FL-3-4**]).

Read more about the **Dos Rios Restoration** and its status as a **new State Park**.

# FL-4: Improve Flood Emergency Preparedness and Response

**Recommended Implementation Lead:** DWR

**Recommended Partners:** USACE, Council, county offices of emergency services, nonprofit organizations

**Hazards Addressed:**

Flooding

**Co-Benefits:**

Community

Water

**State Adaptation Priorities:** (1) Strengthen protections for climate vulnerable communities, (2) Bolster public health and safety to protect against increasing climate risks, (5) Make decisions based on best available climate science, (6) Partner and collaborate to leverage resources

**Equity Considerations:** Emergency response plan updates should consider the needs and potential challenges faced by socially vulnerable communities; for example, emergency warning systems should be designed using the best ways to reach people who are socially or linguistically isolated, and evacuation plans should include procedures and programs to help people with mobility challenges or other access and functional needs. Ensure equitable emergency preparedness in socially vulnerable communities through targeted education, training, and awareness programs. Involve community representatives in emergency planning to tailor strategies to their community's specific needs, thereby equipping them with the knowledge and resources to effectively respond to flood events. Special attention should be given to unhoused individuals who may reside near rivers and are vulnerable to floods. Collaborate with non-profit organizations and volunteers that work directly with unhoused populations to develop and implement programs to notify individuals of flood risks and safety procedures without criminalization. Ensure low-income and other socially vulnerable households – who are often the least able to recover from the impacts of flooding - have the resources they need to recover after flood events. Without adequate resources for recovery, families often become entrenched in cycles of poverty.

## Strategy Description

This strategy elevates emergency preparedness for flooding by updating local response plans through gap analyses and accounting for climate change impacts. By integrating advanced hydrologic models for more accurate flood forecasting and developing specialized flood-fighting training programs, the strategy seeks to support rapid, effective responses to flooding. Effective emergency response minimizes flood damage to agricultural lands and ensures quicker recovery, which is critical for sustaining agriculture in the Delta.

## Implementing Actions

- **FL-4-1: Identify emergency planning gaps and update response plans for underserved Delta communities.** Conduct a comprehensive gap analysis of existing emergency response plans across Delta communities to identify areas lacking adequate coverage or where plans are outdated. Special attention should be given to underserved populations, functional needs populations, and climate change vulnerabilities. Based on these findings, collaborate with county emergency offices to develop or update localized plans that reflect current risks, including climate-driven flood scenarios. These revised plans should include evacuation protocols, shelter-in-place strategies, and resource allocation for emergency events. Where possible, align efforts with existing general plan safety elements and local hazard mitigation plans.
- **FL-4-2:** Work with local county offices of emergency services to **develop robust flood-fighting training programs,** ensure personnel readiness, and increase material stockpiles for emergency levee repairs. Collaborate with first responders, such as police, fire, and transportation agencies, to ensure efficient response to flood emergencies.
- **FL-4-3: Acquire and implement cutting-edge hydrologic modeling and forecasting technology in emergency response planning.** These tools can provide more accurate and timely flood predictions and early warnings for flood events. Incorporate climate projections to better understand future flood scenarios and to inform emergency planning. Advances in modeling and forecasting are critical for both anticipating and mitigating the impact of increasingly severe flood events exacerbated by climate change.
- **FL-4-4: Strengthen and coordinate existing emergency response plans with local partners.** Leverage existing flood preparedness efforts by counties, reclamation districts, and other local entities to enhance current emergency response plans. Focus on increasing interagency coordination, addressing logistical challenges related to large-scale evacuations, and incorporating lessons learned from recent disasters like the Paradise Fire and Oroville Dam incident. Emphasize cross-jurisdictional planning and consistent response protocols that consider real-world limitations and operational readiness under future flood conditions.
- **FL-4-5: Support funding for advanced flood forecasting and monitoring technologies.** Partner with local agencies well-versed in hydrologic modeling and flood forecasting to integrate their expertise into regional emergency planning.
- **FL-4-6: Raise awareness about the availability and importance of flood insurance:** Educate communities, particularly those vulnerable to flooding, about how flood insurance can complement their emergency preparedness plans.

### Delta Plan Connection

Delta Plan Risk Reduction Policy 1 (R**R P1**) prioritizes State investments in Delta levees and risk reduction, calling for the State to fund levee operation and maintenance. This action is supported by **Strategy FL-4**, which aims to improve emergency preparedness for flooding.

# FL-5: Promote Innovative Technologies and Farming Practices that Minimize Flood Risks

**Recommended Implementation Lead:** DWR

**Recommended Partners:** Council, Delta Conservancy, CDFW, CDFA, University of California (UC) Cooperative Extension

**Hazards Addressed:** Flooding, Water Supply

**Co-Benefits:** Food, Subsidence, Water

**State Adaptation Priorities:** (5) Make decisions based on the best available climate science, (6) Partner and collaborate to leverage resources

**Equity Considerations:** Innovative flood monitoring and prediction technologies should address and be accessible to all communities, regardless of their economic status. Programs to inform and train farmers should be accessible in multiple languages and to all educational backgrounds. Crop diversification strategies should consider the cultural importance of various crops to communities. Collaboration with research institutions should prioritize the inclusion of studies that consider the social dimensions of flood risk management, including those that focus on socially vulnerable populations. Use equity-weighted cost-benefit assessments or other analyses that consider social factors to prioritize levee improvements in areas where they will have the most equitable impact, balancing both flood risk and social vulnerability.

Flooded rice fields north of Sacramento County

## Strategy Description

Centered on innovation, this approach integrates advanced technologies into farming practices to minimize flood risk and improve flood risk management. Projects to manage aquifer recharge and reverse subsidence can enhance land resilience and levee protection. Additionally, interdisciplinary partnerships can propel advancements in flood prediction while filling knowledge gaps. Multi-cropping and other farming practices that reduce flood risks also make agricultural lands more resilient to flood risks, potentially reducing crop losses and promoting soil health. Subsidence reversal projects could improve the structural integrity of lands used for farming. Real-time and continuous monitoring of levee conditions and river flows can aid in more accurate flood predictions, allowing for better water resource management, which in turn could improve the reliability of water supplies.

## Implementing Actions

- **FL-5-1:** Prioritize research to **develop and apply innovative flood prediction and prevention technologies.** Identify knowledge gaps and key research needs, encouraging collaboration across various fields and expertise, to guide future investments in flood risk management research and development. Facilitate knowledge-sharing platforms, including workshops and conferences, to foster innovation and integration of the latest scientific advancements in flood risk management.
- **FL-5-2:** Support and incentivize the **implementation of farming practices that minimize flood risks.** Use practices like upstream managed aquifer recharge and multi-cropping to increase the land's water-holding capacity and reduce flood risk. Initiate subsidence reversal pilot projects, with special attention to halting subsidence within 500 feet of levee toes, a critical measure for flood protection (CALFED Bay-Delta Program, 2000, Section 2.3.2). Collaborate with UC Cooperative Extension to create improved informational materials and training on farming practices that reduce flood risk.
- **FL-5-3:** Use **innovative technologies** to establish real-time and continuous monitoring systems for key flood risk factors like levee conditions and river flows. Incorporate climate change impact assessments to enhance preparedness and response.

Yolo Causeway crossing the Yolo Bypass and the Vic Fazio Wildlife Area

# FL-6: Effectively Communicate Flood Risks, Warnings, and Mitigation Strategies to All At-Risk Communities

**Recommended Implementation Lead:** DWR

**Recommended Partners:** National Weather Service, Council, DPC, Delta Conservancy, and local governments

**Hazards Addressed:** Flooding

**Co-Benefits:** Community

**State Adaptation Priorities:** (1) Strengthen protections for climate vulnerable communities, (2) Bolster public health and safety to protect against increasing climate risks, (6) Partner and collaborate to leverage resources

**Equity Considerations:** Work with community leaders and CBOs to develop and execute targeted outreach, information, and communication strategies and programs that can reach all demographic groups, including people from different cultural and ethnic backgrounds and age groups. Adapt messaging to be culturally relevant and sensitive and translate communications into multiple languages. Use a variety of platforms including online, print, landline phones, and community meetings to reach people who are not online or with disabilities. Provide educational programs and resources at no or low cost, targeting economically diverse engagement so that lower-income families can benefit from flood risk education. Develop specialized communication channels or programs that provide information to socially vulnerable populations such as the elderly or those in flood-prone areas.


Press conference at the State-Federal Flood Operations Center in Sacramento

## Strategy Description

This strategy disseminates flood risks and warnings to diverse parties using clear protocols, local partnerships, and a multilingual online portal focused on transparent and inclusive communication. Collaboration with local media and community leaders can raise awareness about flood risk and the importance of preserving natural habitats, such as wetlands, that can act as natural flood barriers. Targeted programs can provide critical information to socially vulnerable populations, while promoting sustainable practices and community resilience. A centralized portal for climate and weather information can also serve as a resource for farmers to make climate-informed decisions about planting and harvesting.

## Implementing Actions

- **FL-6-1:** Develop clear communication channels and protocols for the timely dissemination of **flood warnings and advisories.** Create and maintain a multilingual, accessible central online portal

for up-to-date flood warnings and advisories. Coordinate with existing social media channels and phone/mobile alert systems to provide flood warnings, enabling real-time updates. Collaborate with local media to ensure that flood warnings reach the widest audience, including those without internet access.

- **FL-6-2:** Improve **flood risk communication** (overall risk, prediction updates, preparedness strategies) and information dissemination to diverse parties, including farmers, residents, and business owners, in both SPFC and non-SPFC levee-protected areas. Communications should emphasize risk mitigation actions, the anticipated effects of climate change on flood risk, the need for levee improvements, and the processes required to obtain flood insurance.

DWR conducts emergency repairs on the Victoria Island levee in San Joaquin County in December 2024

# FL-7: Incorporate Land Use and Urban Planning to Reduce Flood Risk

**Recommended Implementation Lead:** Council

**Recommended Partners:** U.S. EPA, DPC, Delta Conservancy, LCI, DWR, CalEPA, Department of Insurance, city and county governments, councils of governments/metropolitan planning organizations (COGs/MPOs/FCAs)

**Hazards Addressed:**


**Co-Benefits:**


**State Adaptation Priorities:** (4) Accelerate nature-based climate solutions and strengthen climate resilience of natural systems, (5) Make decisions based on the best available climate science, (6) Partner and collaborate to leverage resources

**Equity Considerations:** Actively incorporate flood risk assessments into land-use planning decisions, especially those affecting low-income and socially vulnerable communities. Recognize that many formerly redlined communities are in areas with higher flood risk and work to reduce that risk or to plan affordable housing developments in areas with low flood risk. Work with urban planners, environmental experts, and community leaders to ensure that flood vulnerabilities are considered in all zoning changes and discretionary land use proposals, including consideration of industrial sites and zoning that may lead to hazardous flood contaminants. Advocate for the inclusion of flood-resistant features in new housing projects, particularly those serving or located in socially vulnerable communities. Smaller or under-resourced communities often face greater challenges meeting National Flood Insurance Program (NFIP) Community Rating System (CRS) requirements—resulting in fewer flood insurance discounts and potentially higher premiums.

Lookout Slough Tidal Habitat Restoration and Flood Improvement Project in Solano County

## Strategy Description

This strategy integrates land use and urban planning to mitigate flood risks. By curbing development in flood-prone areas and incentivizing resilient practices like wetland restoration, it aims to protect both ecosystems and communities. Wetlands act as natural sponges, absorbing floodwaters and reducing risk to communities. Customizable building codes and focused equity considerations can guide local zoning and housing decisions.

## Implementing Actions

- **FL-7-1:** Incentivize land use practices that **enhance the resilience of Delta ecosystems,** such as restoring wetlands and conserving agriculture.
- **FL-7-2:** Develop Delta-specific climate-informed **model floodplain management ordinances and building codes** for local customization and adoption. Host workshops for local planning departments on incorporating climate science into floodplain management and provide standardized templates for adapting ordinances.
- **FL-7-3:** Apply for **grants and other funding sources** supporting scientific analysis, flood mapping, and resilient land use practices.
- **FL-7-4:** Work with local governments to continue **limiting development in flood-prone areas** as adaptively defined through periodic scientific analysis and mapping. Use FEMA flood maps and the CRS to update local general plans and zoning and the Regional Transportation Plan/Sustainable Community Strategy to direct development away from areas with high- flood risk. The CRS framework can also help cities and counties to incorporate best practices for floodplain management into local ordinances, master plans, and building codes.
- **FL-7-5: Explore and pilot innovative flood insurance approaches that complement traditional FEMA coverage,** including community-based and parametric insurance options tailored to the Delta's needs. Pilot new strategies that expand flood insurance availability and affordability, especially in small and underserved communities. Explore innovative approaches—such as community-based group insurance, index-triggered parametric policies, or pooled-risk programs—that offer more flexible, locally responsive alternatives to conventional insurance.

### Delta Plan Connection

**FL-7** is in line with Delta Plan Policies **DP P1** and **DP P2,** which collectively emphasize the importance of aligning new urban development and infrastructure projects with local land use plans and minimizing conflicts with existing uses, including in flood-prone areas.

Land use policies can limit growth in flood-prone areas

# FL-8: Use Adaptive Resilience Planning in High-Risk Flood Areas with Consideration for Existing Land Uses

**Recommended Implementation Lead:** Council

**Recommended Partners:** FEMA, DWR, CDFA, CDFW, local governments

**Hazards Addressed:**

Flooding

**Co-Benefits:**

Subsidence Biodiversity Recreation

**State Adaptation Priorities:** (1) Strengthen protections for climate vulnerable communities, (6) Partner and collaborate to leverage resources

**Equity Considerations:** Any comprehensive relocation plan or voluntary buyout program should prioritize community input to ensure that impacted residents are involved in the planning process. Plans and programs should address the concerns and needs of socially vulnerable communities, including but not limited to: affordable housing, employment, access to community services, and displacement and gentrification. A voluntary buyout program should establish eligibility criteria to prioritize socially vulnerable communities and provide equitable pricing, recognizing that homes in vulnerable communities often have lower market values.

## Strategy Description

This strategy explores the relocation of properties threatened by continual flooding away from high-risk flood areas, which can also preserve ecosystems and maintain the viability of agricultural lands and cultural resources. Retreating from high-risk flood areas provides an opportunity to restore land back into natural habitats, wetlands, or buffer zones that enhance biodiversity and ecological resilience. While the near-term focus is on relocating utilities and critical infrastructure, this strategy outlines processes for identification of areas that are "too wet to farm" (areas that are not economical or physically possible to farm due to water seepage under levees (Deverel et al. 2015)), as well as considerations for potential community relocation (given projections of significant increases in flood losses).

## Implementing Actions

- **FL-8-1: Assess vulnerable communities and infrastructure** by reviewing existing assessments of repetitive loss properties, considering climate change impacts on future high-risk areas. Collaborate with agricultural agencies to identify overlap with "too wet to farm" areas and explore opportunities for flood-informed land use changes, such as wetland restoration or levee setbacks where feasible.
- **FL-8-2:** Explore **voluntary buyout programs.** Establish criteria for eligibility based on flood risk, property value, and community input. Consider opportunities for multiple benefit criteria in areas of repetitive loss, such as ecological restoration or agricultural land use change.

- **FL-8-3:** Explore and engage in a **comprehensive funding strategy,** like a Delta Flood Insurance Program or localized funding mechanisms like Geologic Hazard Abatement Districts (GHADs), to support adaptive resilience planning.
- **FL-8-4:** Prioritize research regarding the effectiveness of **a transferable development rights model** to permanently protect and restore areas most appropriate for restoration while directing development to other areas.
- **FL-8-5:** Develop **comprehensive relocation plans** that include considerations for housing, employment, community services, and cultural preservation. Identify synergies with ecosystem restoration potential by considering how areas of retreat could lend themselves to restoration or other beneficial land use changes. Evaluate how high-risk areas align with agricultural challenges, such as "too wet to farm" areas, and consider managed wetlands/subsidence reversal as potential solutions.
- **FL-8-6: Monitor and evaluate relocation success:** Set clear objectives and performance metrics, including ecological and agricultural benefits. Consider environmental restoration of vacated flood-prone areas, turning them into natural flood buffers, recreational spaces, or areas for managed wetlands/subsidence reversal.
- **FL-8-7: Support funding** for the development of comprehensive relocation plans and voluntary buyout programs.

Farmland and waterways in the Sacramento-San Joaquin Delta

## Case Study: The Role of Geologic Hazard Abatement Districts (GHAD) in Mitigating Flood Risks

**Partners:** USACE, City of Isleton

The persistent risk of levee failure looms large in Isleton, located in Sacramento County on Andrus Island in the Central Delta. With average annual flood insurance premiums exceeding $1,200 in 2020 (compared to a median household income of less than $45,000), residents found insurance costs under the NFIP unbearable and the protection insufficient. For a community with limited resources, it is challenging to benefit from programs such as FEMA's CRS that can help reduce premiums. Additionally, Isleton's levees do not meet the 200-year urban level of protection standards, which affects property eligibility for more favorable NFIP rates. Lastly, the NFIP approach to flood risk management is based on broad flood zone classifications that do not account for specific, localized characteristics and may not adequately capture the real level of flood risk. To proactively manage these challenges, Isleton turned to a specialized solution: the formation of a GHAD, a unique government entity in California designed to mitigate large-scale hazards like floods and landslides. In contrast to the NFIP model which provides individual protection, the GHAD model covers communities and can be spent on a wider array of risk reduction strategies.

Created with the endorsement of the city manager and the city council and aligned with state-level directives such as the Governor's 2020 Water Resilience Portfolio, the Delta Region GHAD emerged as an autonomous political subdivision of the state. Unlike traditional local agencies, the GHAD can operate independently to advocate for more robust levee maintenance, build essential flood-fighting infrastructure, and negotiate with insurance providers for better rates. GHADs also allow non-contiguous areas to collectively manage and mitigate risks, enabling communities to share resources for recovery efforts and reduce costs through a larger risk pool.

The GHAD aims to achieve three primary goals. First, it works to secure funding and support for infrastructure upgrades like levees and flood-fighting roads, thereby reducing both the community's flood risk and their insurance premiums. Second, by leveraging funds approved through local taxes, the GHAD can attract significant federal grants for flood mitigation. Finally, the GHAD aims to lower the cost of flood insurance by working directly with major insurance and reinsurance firms. Although some residents have reported securing flood insurance premiums as low as $400 through private providers, these rates are not universally accessible due to varying home elevations, construction types, and insurer risk assessments.

## Case Study (continued)

Community engagement and support is vital for the success of the GHAD (as called for in [FL-4-6]). However, results from the recent Delta Residents Survey show that only 17% of Delta residents would support a GHAD (Rudnick et al. 2023). Thus, public outreach to explain the GHAD model and its benefits may be necessary to gain wider acceptance. Additionally, the Isleton GHAD should be monitored so its long-term results and efficacy can be communicated.

Residents can influence GHAD efforts by participating in board meetings and supporting propositions to fund local contributions to flood risk reduction efforts. By doing so, the community stands a better chance of lowering insurance premiums while making a collective stride toward long-term resilience.

Read more on **Isleton's GHAD.**

# FL-9: Manage and Expand Upstream Water Storage Capability

**Recommended Implementation Lead:** DWR

**Recommended Partners:** USACE, USGS, tribes and tribal communities, CVFPB, SWRCB, Council, CDFW, and local water agencies

**Hazards Addressed:** Flooding, Drought

**Co-Benefits:** Water, Biodiversity

**State Adaptation Priorities:** (4) Accelerate nature-based climate solutions and strengthen climate resilience of natural systems, (5) Make decisions based on the best available climate science

**Equity Considerations:** Assess whether existing upstream storage and water management efforts are disproportionately benefiting certain communities over others, particularly in terms of water supply reliability. Involve local communities, especially marginalized or vulnerable groups, and tribes in decision-making processes related to reservoir management, floodplain restoration, and aquifer recharge programs. Ensure that any water pricing or taxation resulting from structural improvements or operational changes does not disproportionately burden low-income communities. Be sensitive to how water bodies and land areas selected for storage or recharge may have cultural or social significance, especially for Indigenous or local communities. When implementing new projects or structural improvements, consider job creation in socially vulnerable communities. Ensure that all communities, including non-English speaking ones, are informed about changes in water storage and management plans.

Cottonwood Creek upstream of San Luis Reservoir in Merced County

## Strategy Description

This strategy focuses on managing and potentially expanding upstream storage capabilities while also integrating natural systems like floodplains, aquifers, and croplands for optimal water management. Despite the broader benefits to water supply reliability, the foremost goals remain flood risk reduction and public safety. By strategically capturing, storing, and releasing water in upstream areas, this strategy mitigates immediate downstream flooding risks. Managing and expanding upstream storage is integral to a comprehensive Delta flood risk reduction plan, and also improves water supply reliability and enhances biodiversity.

## Implementing Actions:

- **FL-9-1: Optimize reservoir management and assess current upstream storage capacities:** Improve reservoir operations to optimize the capture and release of water, considering seasonal weather patterns and long-term climate trends (e.g., forecast-informed reservoir operations [FIRO]). Assess upstream storage capacities and determine if there is room for improvement and/or expansion, and integrate these strategies with broader watershed management plans.
- **FL-9-2: Use excess floodwater to recharge underground aquifers,** aligning with Flood Managed Aquifer Recharge (Flood-MAR) principles. This provides long-term water storage and helps to maintain groundwater levels. Regular monitoring should be conducted to avoid adverse impacts on groundwater quality. Not all sites are suitable for aquifer recharge, so selection should be based on criteria such as soil permeability, aquifer capacity, and environmental impact.
- **FL-9-3: Cropland flooding:** Work with farmers to develop strategies for **intentional flooding of croplands** during high water events to attenuate peak flows and reduce downstream flood risk. Offer financial incentives or support for farmers who voluntarily participate in planned cropland flooding.
- **FL-9-4: Divert and absorb floodwaters via floodplains and bypass systems:** Implement bypass channels to divert excess floodwaters to designated areas, reducing pressure on main waterways and potential flood damage to populated areas.

Engineers inspect the outer wall of a spillway

## Case Study: Forecast-Informed Reservoir Operations (FIRO) in Lake Mendocino

**Lead:** Center for Western Weather and Water Extremes, USACE

**Partners:** DWR, Sonoma Water, Yuba County Water Agency, UC San Diego, Scripps Institution of Oceanography

FIRO is a reservoir operations strategy that uses enhanced monitoring and improved weather and water forecasts to inform decision makers to selectively retain or release water from reservoirs. FIRO uses the latest science and modeling tools to predict the landfall location and intensity of atmospheric rivers, leading to improved water supply reliability, reduced flood risk, and enhanced habitat. FIRO represents a shift from traditional water management techniques based on "water on the ground" towards using forecasting methods to better understand and predict future precipitation.

A pilot study at Lake Mendocino in the Russian River basin conducted by a multi-agency steering committee led by USACE demonstrates how FIRO can be used to increase water supply reliability without reducing existing flood protection capacity and damaging fish habitat. Lake Mendocino is a prime candidate for a FIRO pilot because flooding and water supply in the water basin are driven almost entirely by atmospheric rivers. Because of this, researchers were able to focus on understanding how improved forecasting of atmospheric rivers can improve water storage and supply practices. Four different FIRO management options (called Ensemble Forecast Operations, or EFOs) were compared to an existing baseline operation representing the seasonal guide curve and release selection rules from the 1986 USACE water control manual. The options were evaluated based on 16 different metrics.

The analysis showed that all four FIRO options would improve water supply reliability by increasing water storage. The Modified Hybrid EFO was identified as the best option for near-term implementation because it led to the greatest increase in reservoir storage over baseline operations. It also led to benefits for dam operations, fisheries, and recreation. In 2020, use of FIRO enabled a 19 percent increase in water storage by the end of winter, equivalent to annual water use of 20,000 households.

Read more about the **Lake Mendocino FIRO Final Viability Assessment.**

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# Chapter 5 Ecosystem Strategies

## 5.1 Adaptation Approach

The Delta provides important habitat, refugia, and migratory pathways for a range of fish, birds, and other wildlife species. Delta ecosystems have experienced significant degradation due to habitat loss and fragmentation. Over two centuries of human landscape conversion and pressures on the Delta's natural systems have severely reduced the extent and quality of suitable habitat and consequently species population sizes. This renders species and their habitats vulnerable to additional stresses caused by climate change. Conversion of most natural lands to agriculture and developed areas, as well as insufficient shallow water habitats, leaves little room for aquatic and terrestrial habitats and species to migrate or adapt to climate stressors. Water storage and export – combined with changing inflows and sea level rise – could further degrade aquatic habitats. Warming air temperature and drought could lead to decreased soil moisture content and the drying of seasonal wetlands. Temperature rise beyond the range for which species are adapted could also lead to migration or mass mortality events, including for aquatic species. Greater variation in precipitation extremes, flooding, and sea level rise will impact ecosystem health and could lead to habitat transitions. The projected changes to inter-annual precipitation variability favor less diverse species assemblages and could increase the presence of non-native species (DSC 2021a). Without adaptation, Delta ecosystems will face further loss of native biodiversity, increased vulnerability to invasive species, disappearance of critical habitats such as wetlands, and loss of ecosystem function.

To date, most restoration in the Delta has been completed to mitigate for past and ongoing impacts from human modification of the physical environment, not climate change. In this plan, ecosystem restoration is seen as both a way to help ecosystems adapt and thrive under future conditions but also provide benefits that address impacts from areas beyond climate change. However, this approach highlights adaptation to climate change. The strategies in this section strengthen the adaptation potential of Delta ecosystems through a multi-pronged approach, starting by restoring and connecting habitats to meet Delta Plan goals, implementing functional flows, and halting or reversing land subsidence [**ECO-1**] and [**ECO-2**]. Strategies focus on managing ecosystems to protect native species and biodiversity, limit invasive species, and enhance

the health of ecosystems in developed areas. Ecosystem strategies have a broad range of co-benefits that can reduce flood risk while increasing community resilience. For example, restored wetlands and riparian floodplains improve water quality and provide storage and attenuation of floodwaters.

Restored sites also provide a range of multi- benefit uses that can increase public access to green space, especially for socially vulnerable communities who tend to have less access, as well as increase tribal access to cultural resources [**ECO-4**]. Halting or reversing subsidence by incentivizing wetland restoration can help to reduce flood risk, increase landscape resilience, and provide habitat for migratory birds and other species. Under appropriate conditions, wetland restoration can also help avoid GHG emissions and sequester carbon. At the same time, the tradeoffs associated with these strategies must be considered. For example, projects that re-wet or intermittently wet soil provide ecosystem benefits, but can also result in the production of methylmercury, a bioavailable form of toxic mercury, as well as the production of methane, a potent GHG. In this example, special consideration must be given to how restored tidal and non-tidal wetlands are designed and managed. Similarly, rice cultivation can produce methylmercury and methane. Experiments at agricultural and managed wetlands indicate that controls to manage soil, vegetation, and rice straw can help limit methylmercury production and export (Heim et al., 2023; McCord & Heim, 2015; Windham- Myers et al., 2010, 2014).

Finally, these adaptation strategies also address governance challenges by increasing coordination and partnerships between agencies and developing effective financing and incentive programs to support restoration [**ECO-3**].

## Delta Plan Connection

Achieving a restored Delta ecosystem is one of the two coequal goals identified in the Delta Reform Act. To help achieve this, **Chapter 4** of the Delta Plan focuses on ecosystem restoration and includes regulatory policies, recommendations, and performance measures. The chapter was amended in June 2022 to reflect new science and understanding (including climate change) and add five core strategies and a new policy focused on disclosing contributions from restoration projects. These updates further the coequal goals.

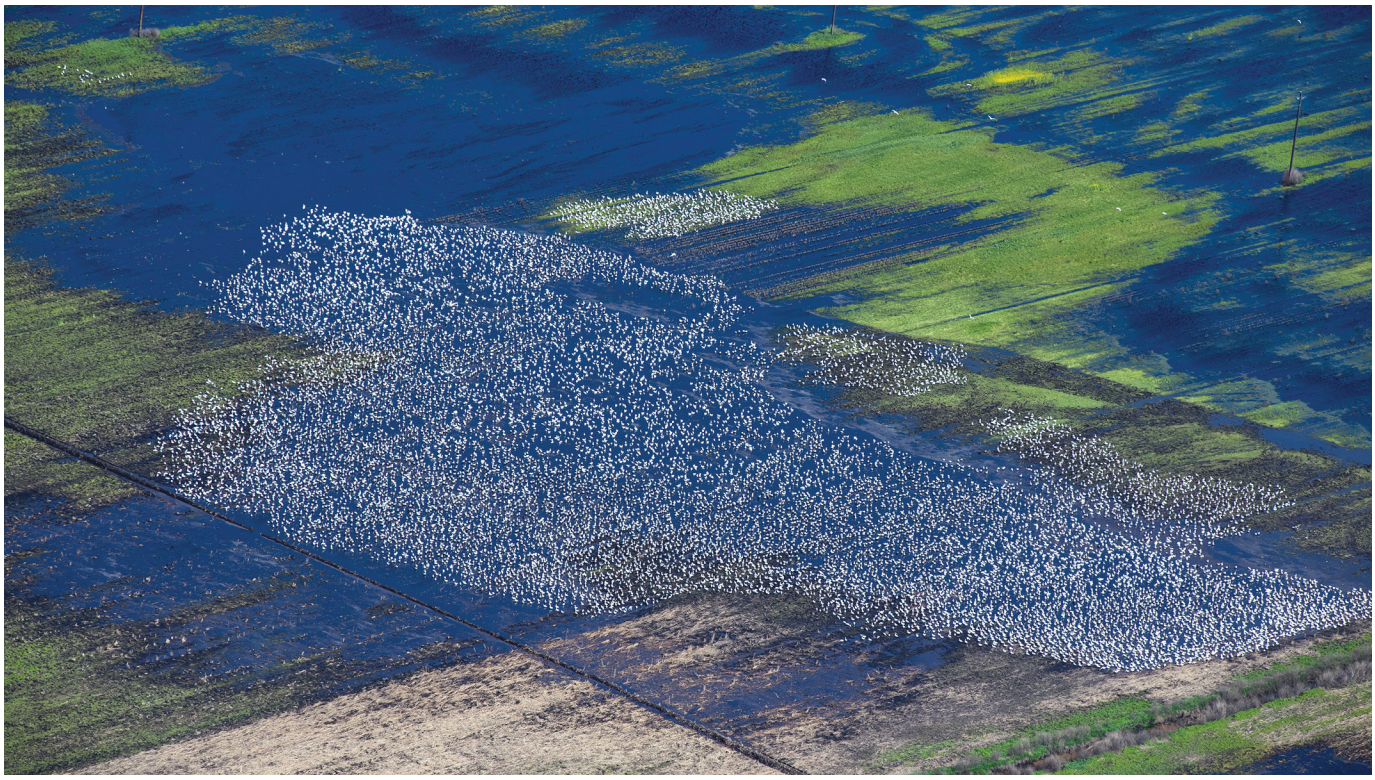
The Delta Plan ecosystem chapter's core strategies, six regulatory policies, fifteen recommendations, and four performance measures most pertinent to ecosystem restoration inform and support the strategies identified under Delta Adapts. For example, the core strategies include a focus on (1) more natural, functional flows, (2) restoring ecosystem functions, (3) protecting land for restoration, (4) protecting native species and addressing non-native invasive species, and (5) improving institutional coordination.

Delta Adapts includes four ecosystem strategies that align with Delta Plan **Chapter 4**, and further highlights the need to adapt to future climate conditions, address subsidence, build capacity and equity, and benefit people in and near the Delta.

**Table 5-1** provides a summary list of the ecosystem climate change adaptation strategies recommended by Delta Adapts. Detailed strategy profiles are presented in **Section 5.2.**

**Table 5-1** Summary of Ecosystem Strategies

| Strategy ID | Strategy Description |
|---|---|
| ECO-1 | ECO-1: Restore Ecosystems and Improve Their Capacity to Adapt to, Thrive, and Support Native Species Under Future Conditions |
| ECO-2 | ECO-2: Protect At-Risk Ecosystems by Halting and Reversing Subsidence |
| ECO-3 | ECO-3: Build Capacity and Coordination to Improve Ecosystem Function and Resilience |
| ECO-4 | ECO-4: Use Nature-Based Solutions to Increase Climate Resilience of Developed Areas In and Near the Delta and Suisun Marsh |



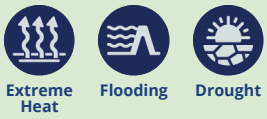
Waterfowl fly over a flooded field in the Sacramento-San Joaquin River Delta

## 5.2 Strategy Profiles

# ECO-1: Restore Ecosystems and Improve Their Capacity to Adapt to, Thrive, and Support Native Species Under Future Conditions

**Recommended Implementation Lead:** CNRA (includes 26 departments, conservancies, and commissions)
**Recommended Partners:** NOAA, USBR, tribes and tribal communities, Delta Conservancy, DPC, DWR, State Lands Commission, BCDC, CDFW, SWRCB, State Parks Division of Boating and Waterways, Council

**Hazards Addressed:**




**Co-Benefits:**


**State Adaptation Priorities:**
(4) Accelerate nature-based climate solutions and strengthen climate resilience of natural systems, (5) Make decisions based on the best available climate science, (6) Partner and collaborate to leverage resources

**Equity Considerations:** Restoration projects should be planned and designed in partnership with tribes to identify opportunities to interweave traditional knowledge and intentionally increase tribal access to restored habitat areas for traditional uses, cultural resources, and ancestral lands. Similarly, project proponents should work with CBOs and community leaders in the design and siting of restoration projects to increase access to recreation, habitats, and green space for communities with the lowest access to such places (e.g., the South Delta). Multi-benefit restoration projects should be prioritized and designed to address climate hazards for the most vulnerable communities; for example, prioritize restoration projects to halt or reverse subsidence, decrease pressure on levees, and attenuate floodwaters for communities with the highest flood risk. Careful attention should be paid to how changes to flow management could, if water quality objectives also changed, result in impacts to water quality that disproportionately affect socially vulnerable communities. For example, decreased Delta outflow requirements could affect communities and agricultural operations in the Delta, while increased Delta outflows could affect export areas, potentially resulting in fewer agricultural jobs in downstream socially vulnerable communities.

## Strategy Description

As called for in the Delta Reform Act, the Delta Plan provides a long-term vision for restoring habitats within the Delta and its watershed by 2100 (California Water Code section 85302[e][1]). To achieve this goal of a functioning Delta ecosystem, the Delta Plan sets a target of restoring an additional 60,000-80,000 acres of functional, diverse, and interconnected habitat across the Delta and Suisun Marsh by 2050 and sets target acreages by ecosystem type (based on information in Delta Plan Appendix Q4 (DSC

2022d), and specified in Delta Plan Performance Measure 4.16). These targets broadly align with the CARB target of restoring 60,000 acres of Delta wetlands by 2045 (CARB 2022). The importance of Delta wetland restoration and conservation is similarly highlighted in California's Nature-Based Solutions Climate Targets (CNRA 2024). Restoration should occur at a suitable scale and location, and with appropriate characteristics to adapt to and function under future climate change conditions. **Delta ecosystems need adequate and appropriate flows of high-quality water to function.** These flows are necessary for successful restoration and climate adaptation. However, restoring these flows can result in tradeoffs between different species needs as well as water exports.

## Implementing Actions

- **ECO-1-1:** Work with tribes and tribal communities to identify appropriate ways to **interweave Traditional Knowledge into nature-based restoration planning** and **identify opportunities to return traditional tribal homelands, or restore tribal access** to habitat/restoration areas, for traditional uses and access to cultural resources.
- **ECO-1-2:** Implement a range of **nature-based solutions and conservation strategies** that address both ecosystem function and individual at-risk species (e.g., ecosystem-based management and multi-species management approaches (Stella & Lee 2025). Promote a diversity of habitat types at locations throughout the Delta.
- **ECO-1-3:** Increase **public access opportunities** on restoration areas, open and green space, and habitat areas – in a manner that does not negatively impact their function – especially in and near communities that have the lowest amount of access to such areas.
- **ECO-1-4:** Prioritize **nature-based solutions and multi-benefit projects** that improve and support ecosystem function and connectivity while providing benefits to other sectors (e.g., flood risk reduction, improved water supply reliability, mitigating UHI, supporting healthy soils and sequestering carbon, and reducing GHG emissions).
- **ECO-1-5:** In **Suisun Marsh**, implement enhanced wetland management and protect adjacent upland transition zone habitat on suitable public and private lands while balancing other objectives. Update the Suisun Marsh Habitat Management, Preservation, and Restoration Plan (Suisun Marsh Plan) and Suisun Marsh Protection Plan (SMPP) to incorporate climate change concerns for the Marsh. Proactively plan for and place restoration projects at suitable locations that leverage the ability of natural areas and select native species to better adapt to variable salinity regimes, while reducing salinity intrusion that affects human health and safety and water supply. Prioritize contiguous restored parcels to enhance habitat management and limit impacts to adjacent, unrestored parcels. (Refer to **Section 8.4** for discussion of Suisun Marsh adaptation considerations).

- **ECO-1-6:** Update **upstream water storage management operations** to incorporate functional flow parameters (e.g., fall pulse, wet-season base, peak magnitude, spring recession, and dry-season base flows) or unimpaired flow objectives into state regulations.
- **ECO-1-7:** State and federal agencies should coordinate to develop and implement Delta- wide communications, management, and funding plans for **preventing and managing invasive species and protecting native species**, including avoiding or reducing impacts to sensitive species from invasives and climate change.
- **ECO-1-8:** Conduct an updated assessment of the **Delta sediment budget** to guide sediment management actions.
- **ECO-1-9:** Continue and increase coordination among state and federal agencies and other organizations across the Bay-Delta on dredging and **beneficial reuse of sediment.** Secure funding for addressing sediment supply shortages across the Bay-Delta.
- **ECO-1-10: Restore more natural stream flows and functions,** as called for in the State's *Natural and Working Lands Climate Smart Strategy* (2022): "Where practical, remove barriers, such as obsolete dams and undersized culverts, to allow streams to function naturally and restore species' access to cooler water habitats", and allow for sediment transport, upstream of and within the Delta and Suisun Marsh, where appropriate.
- **ECO-1-11: Protect water quality** by enforcing existing water quality standards, updating flow objectives as necessary, and improving water management (e.g., enforcing regional total maximum daily loads and water quality plans, decreasing agricultural runoff, reducing and treating runoff from developed areas, and managing flows to maintain appropriate salinity and water temperature).

# ECO-2: Protect At-Risk Ecosystems by Halting and Reversing Subsidence

**Recommended Implementation Lead:** Delta Conservancy
**Recommended Partners:** Tribes and tribal communities, DWR, DPC, State Lands Commission, Council

**Hazards Addressed:** Flooding, Drought

**Co-Benefits:** GHG, Flood, Water, Health

**State Adaptation Priority:**
(4) Accelerate nature-based climate solutions and strengthen climate resilience of natural systems

**Equity Considerations:** Investments in subsidence halting or reversal actions should consider who will benefit most and who will be most impacted, including socially vulnerable communities. Projects should be planned, where possible, to benefit tribes and tribal communities with ancestral ties to the Delta and communities who live in high flood risk areas, lack a stable supply of clean drinking water, depend on agriculture for their livelihood, and/or lack access to green and open space.

Tidal channel near the Vogel Cache/Hass Levee in Solano County

## Strategy Description

Subsided lands pose a major threat to the resilience of Delta ecosystems, as well as human life, the Delta's unique culture and geography, the agricultural economy, and statewide water supply. This strategy prioritizes halting and reversing subsidence at scale. Additional acreage dedicated to activities that halt and reverse subsidence is urgently needed to support California's carbon emission reduction goals, but large-scale projects are limited by both economic viability and lack of available incentives.
Near- term action, substantial funding and incentives, sustained partnerships, and buy-in from the wider Delta community are necessary to significantly halt and reverse subsidence. Proactive planning is also important to start adaptation activities now, at the appropriate place, and at sufficient scale to help species adapt in time. In addition, ongoing monitoring, maintenance, and adaptive management will be critical to achieve functional landscapes and avoid as many negative impacts as possible, like methylmercury production.

## Implementing Actions

- **ECO-2-1:** Prioritize and incentivize conversion or maintenance of **land use types that halt or reverse subsidence** (e.g., multi-benefit projects or repurpose lands that are not economical for farming). Additionally, allow and incentivize managed inundation on parts of agricultural fields for peat building (Windham-Myers et al. 2023).
- **ECO-2-2:** Incentivize land conversion to **tidal wetlands** on public and private lands that are at current intertidal elevations in the North Delta or Suisun Marsh, prioritizing locations with adjacent upland migration potential.
- **ECO-2-3:** Direct investments to areas that have the potential to both **reverse subsidence** and **restore intertidal marsh habitat** (Delta Plan Recommendation ER C).[1]
- **ECO-2-4:** Incentivize land conversion to **non-tidal wetlands** on public and private lands that are deeply subsided and/or at locations where tidal connection would have negative impacts to the Delta (e.g., water supply corridors).[2]
- **ECO-2-5:** Implement **mosaics of subsidence-mitigating land uses,** including rice farming and managed wetlands, which can provide continued agricultural income and potential GHG reductions (Deverel et al. 2017).
- **ECO-2-6:** Incentivize subsidence-halting activities such as **rice cultivation or paludiculture** (productive cultivation on wet peatlands) on subsided privately-owned lands.
- **ECO-2-7:** Promote the restoration of **riparian and marshland habitats** that act as natural flood defenses and are resilient to climate change impacts.

1 Delta Plan Recommendation ER C states that "In order to ensure the long-term durability of state investments in restoration, state agencies that fund ecosystem restoration in subsided areas should direct investments to areas that have opportunities to both reverse subsidence and restore intertidal marsh habitat" (DSC 2022b).

2 Areas subject to special benefit assessments may still be subject to assessments regardless of the land use types (Cal. Const., art. XIII D, § 4.). The economic cost of this should be addressed within restoration projects, especially if there is a change from private to public ownership.

# ECO-3: Build Capacity and Coordination to Improve Ecosystem Function and Resilience

**Recommended Implementation Leads:** Council and CNRA Office of the Secretary (coordination and alignment role)
**Recommended Partners:** Tribes and tribal communities; Delta Plan Interagency Implementation Committee (DPIIC) member agencies, including CDFW, CDFA, CalEPA, CVFPB, DWR, BCDC, DWR, Council, DPC, Delta Conservancy, SWRCB, NOAA/NMFS, USFWS, USACE, USBR, U.S. Dept. of the Interior, U.S. EPA, USGS; state/federal coordination bodies such as the Delta Coordination Group.

**Hazards Addressed:**


**Co-Benefits:**


**State Adaptation Priorities :** (4) Accelerate nature-based climate solutions and strengthen climate resilience of natural systems, (6) Partner and collaborate to leverage resources

**Equity Considerations:** Ecosystem restoration can provide access to open space (when permitted) and cooler temperatures to nearby communities.

Regulatory processes, streamlined or otherwise, should incorporate meaningful public input and ensure that restoration projects do not significantly and adversely affect communities or nearby properties. Outreach early in the planning process (pre-California Environmental Quality Act (CEQA) review, if applicable) can enable more meaningful community participation. Tribes and community groups should be included in leadership and decision-making roles to guide project direction.

## Strategy Description

This strategy increases the capacity of and coordination between agencies, communities, and other partners working in areas that support ecosystem restoration, adaptation, and management and monitoring. It also aims to increase the pace and scale of restoration by leveraging new funding sources and reducing "green tape". It includes actions focused on building partnerships, reducing regulatory burdens, and ensuring adequate funding for restoration. A core focus is to incorporate equity and human concerns into activities that support this strategy.

## Implementing Actions

- **ECO-3-1:** Prepare **program-level environmental documentation** for restoration programs when possible. This strategy helps accelerate the pace and scale of restoration by reducing regulatory burdens as well as the time and cost required to complete individual projects.
- **ECO-3-2: Partner with, and fund opportunities for, tribes to identify and implement** shared nature-based solutions and identify opportunities to co-manage restored public areas in the Delta. Prioritize

opportunities that enable and support Indigenous-led ecocultural practices for stewardship, restoration, and revitalization. Projects that include tribal and cultural components should restore and enhance natural and cultural resources, traditional foods, and cultural landscapes; support tribes to use their expertise and Traditional Knowledge; and develop cultural easements.

- **ECO-3-3: Partner with community groups,** including those that serve socially vulnerable communities, to understand community priorities for restoring Delta ecosystems and collaborate in defining desired outcomes for conservation, restoration, and land management.
- **ECO-3-4:** Coordinate actions falling under **multiple agencies' jurisdictions** on parallel, concurrent schedules.
- **ECO-3-5:** Prioritize projects that are **exempt from permitting requirements,** or subject to fewer permits, under current land use or planning requirements (e.g., explore growing tules as a type of agricultural activity) in order to increase the pace and scale of restoration.[3]
- **ECO-3-6:** Prioritize projects on **large parcels** that have few owners to streamline a voluntary land acquisition process.
- **ECO-3-7: Streamline environmental review and permitting for restoration projects** in the Delta and Suisun Marsh, while requiring projects to include procedures for environmental protection as part of project design (for example, continue and increase the use of mechanisms like the CEQA Statutory Exemption for Restoration Projects (SERP) and permit-streamlining initiatives like Cutting the Green Tape). Establish program-level endangered species permitting mechanisms that increase efficiency for Ecosystem Restoration Tier 1 or 2 actions, as defined in **Delta Plan Appendix 3A:** within the Delta and compatible ecosystem restoration projects within the Delta watershed (DSC 2022e).
- **ECO-3-8:** Develop a **regional permitting approach** to facilitate multi-benefit projects, using established permitting mechanisms such as Habitat Conservation Plans (HCPs) and Regional Conservation Investment Strategies (RCIS) to facilitate a coordinated approval process.
- **ECO-3-9: Partner with landowners** and incentivize restoration or wildlife-friendly practices on private lands.
- **ECO-3-10:** Expand **public-private partnerships upstream of the Delta** that can help meet ecosystem functions more effectively than equivalent actions in the Delta (e.g., see Dos Rios Case Study).
- **ECO-3-11: Explore and engage in a comprehensive ecosystem restoration funding strategy** to support implementation, operations, maintenance, and monitoring of restoration projects, including novel or blended funding sources. Funding should support competitive land acquisition from willing sellers and restoration on suitable public lands.

3 Growing tules, which requires wetland habitat, is not currently defined as an agricultural activity. Furthermore, conversion to wetlands could trigger mitigation and other regulatory requirements. This example action would need to be supported by changes to existing law, land use definitions, and regulations.

## Case Study: Yolo Bypass Big Notch Project

**Partners:** DWR, Bureau of Reclamation (USBR)

Located in and to the north of the North Delta, the Yolo Bypass is part of the Sacramento River Flood Control Project approved in 1911. For over a century it has provided important flood hazard management benefits to the City of Sacramento and the surrounding region. Areas within the Yolo Bypass are also farmed and provide valuable habitats and food sources for native species.

To better support habitat values, state and federal agencies are proposing to alter flow dynamics through the Yolo Bypass Salmonid Habitat Restoration and Fish Passage ("Big Notch") Project, which will restore 30,000 acres of floodplain habitat. The project is strategically located adjacent to the Cache Slough Complex, an area where many additional restoration projects are planned or in progress. These include projects like Lookout Slough, Lower Yolo Ranch, Little Egbert Tract, and the Lower Elkhorn Basin Setback Levee Project. Together, these projects will restore and help connect habitats, contribute to the regional food web, as well as enhance floodwater conveyance capacity.

The Big Notch project will expand floodplain- rearing habitat for juvenile salmon and improve fish access through the bypass, which is pivotal to the recovery of threatened and endangered salmon and sturgeon. When completed, during high water conditions in the Sacramento River, the notch will allow water to flow into the Yolo Bypass floodplain, allowing fish to migrate through the area. Juvenile salmon will be able to feed in a food-rich area for a longer time, which will increase their size and improve their survival rates. Additionally, the notch will also improve passage for adult salmon and sturgeon, reducing strandings and migratory delays.

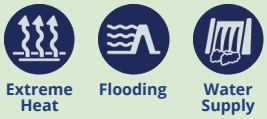
Most floodplain and wetland habitats in the Delta have been converted to agriculture over the last 150+ years. Projects like Big Notch may provide an analogue to historical ecosystem functions and support native species under future climate conditions.

Read more about the **Yolo Bypass project.**

# ECO-4: Use Nature-Based Solutions to Increase Climate Resilience of Developed Areas In and Near the Delta and Suisun Marsh

**Recommended Implementation Leads:** CNRA (includes 26 departments, conservancies, and commissions)
**Recommended Partners:** USACE, tribes and tribal communities, California Department of Parks and Recreation, CDPH, LCI, regional climate collaboratives (Capitol Region and Bay Area), Delta cities and counties

**Hazards Addressed:**




**Co-Benefits:**


**State Adaptation Priorities:**
(1) Strengthen protections for climate vulnerable communities, (2) Bolster public health and safety to protect against increasing climate risks, (4) Accelerate nature-based climate solutions and strengthen climate resilience of natural systems

**Equity Considerations:** Many of the region's most socially vulnerable populations are located in developed areas. Within the rural Delta, most land is privately owned and in agricultural cultivation, with relatively little green space. As a result, residents, including socially vulnerable communities, are less likely to enjoy the physical and mental health benefits of green space access, and face greater exposure to extreme heat, poor air quality, and other negative impacts associated with low tree canopy. These solutions can increase community resilience, but only if designed thoughtfully with participation from communities. Urban greening projects, for example, should include actions to prevent displacement of existing communities and address community concerns regarding the cost of ongoing tree care and maintenance, safety, and preferred species.

The Dutch Slough Tidal Marsh Restoration Project site

## Strategy Description

This strategy increases nature-based solutions within developed areas, with a focus on benefiting both people and ecosystems. The strategy aims to reflect the reality that the largest populations are concentrated in developed areas and can benefit from these strategies, and also that developed areas provide unique opportunities for implementing nature-based solutions. Through actions such as increasing tree canopy area, connecting

habitats, and rewilding waterways, this strategy increases climate resilience through mitigating flood risk and extreme heat and can improve physical and mental health, educational outcomes, and other benefits for residents.

## Implementing Actions

- **ECO-4-1:** Protect, restore, and re-wild **rivers/ streams, riparian areas, floodplains, and seasonal wetlands in and adjacent to developed areas**, prioritizing those where restoration or enhanced protection would provide the most benefits for localized flood risk reduction, water quality improvement, and habitat creation.
- **ECO-4-2:** Increase **tree canopy cover and other green/vegetated spaces** in developed areas with the lowest percentages of tree canopy cover, greatest UHI effects, and poorest air quality. Additionally, plan and budget for ongoing management of the urban forest. As recommended in the state's *Natural and Working Lands Climate Smart Strategy* (2022):
  - "Close the **tree canopy gap** in low-income/socially vulnerable communities, particularly those vulnerable to the impacts of extreme heat, hazardous air quality, and/or with the least access to nature."
  - "Use place-based tree and plant selection and intensity with the principle of **'the right tree for the right place'** to ensure the species selection process considers climate, water, and locally specific circumstances."
  - **"Protect urban trees** from pests, disease, and drought for as long as feasible, and seek the highest and best use for trees and other biomass that must be removed due to pests and disease or for valid management purposes."
  - Use "urban forestry-related efforts such as tree planting and maintenance to help create **high quality local jobs** where they are needed most and provide training and workforce development opportunities for priority communities to enhance the effectiveness of the urban forest economic sector."
- **ECO-4-3:** Increase **habitat and greenway connectivity** and enhance biodiversity and pollinator habitat in developed areas , through actions such as those recommended in San Francisco Estuary Institute's (SFEI) *Making Nature's City: A Science-Based Framework for Building Biodiversity* (Spotswood et al. 2019):
  - **"Prioritize the creation and protection of regional biodiversity hubs** [areas of green space/habitat greater than 130 acres – e.g., regional parks]. Ongoing protection and enhancement of habitat quality in existing regionally significant patches is essential for supporting city-wide biodiversity. Creating large new patches, particularly in cities that have few or no large parks, can also be made a priority during biodiversity planning."
  - **"Prioritize the protection of large remnants of high-quality habitat.** Patches [defined as contiguous areas of green space in a city between 2-10 acres] that already contain high-quality habitat can (and may already) support more biodiversity than similarly sized patches that have been highly modified. Patches with high-quality habitat should require less investment to achieve biodiversity objectives and will require less active restoration to recover ecological functions."

- **"Expand existing patches.** When planning future acquisitions, consider possibilities to expand existing large, high-quality patches. This can be an effective strategy for maximizing biodiversity and can help to create local or regional hubs of biodiversity by building on existing greenspace resources."
- **"Reduce edges.** Square or circular patches have more core habitat and shorter perimeters and are thus more suitable to area-sensitive species than long, skinny patches of similar size."

The State's *Natural and Working Lands Climate Smart Strategy* (2022) also recommends:

- **"Connect communities with greenways/greenbelts**; consider how these landscapes can protect communities (particularly the most vulnerable) from climate impacts such as flooding, fires, heat, etc."
- **ECO-4-4:** Promote and increase use of **green infrastructure and nature-based solutions,** instead of gray infrastructure, in developed areas, where appropriate, to provide multiple benefits. For example, promote the use of constructed wetlands for wastewater treatment; bioswales, rain gardens, and green roofs to collect runoff; and provide or increase incentives for property owners to implement green infrastructure.

Lookout Slough Tidal Habitat Restoration and Flood Improvement Project in Solano County

# Chapter 6 Agricultural Strategies

## 6.1 Adaptation Approach

Agriculture is a significant part of the Delta's history, culture, and economy. Agriculture is the predominant land use in the Delta, providing more than 23,000 jobs statewide and over $4.5 billion in economic output. Crop production is diverse, with key crops including corn, alfalfa, wine grapes, tomatoes, wheat, and asparagus. More than 80% of Delta farmland is classified as Prime Farmland, the richest soil classification in the state. However, climate change poses a range of threats to Delta agriculture, including increased precipitation variability, drought, saltwater intrusion, water quality decline, flooding, warming temperatures, increased temperature variability, and reduced chill hours, all of which can reduce crop yield and quality. Other compounding factors include subsidence, land use change and development, wind erosion of soils, and levee seepage (DSC 2021a).

Delta farmers are experts at handling the unique challenges of farming in the Delta, but they too will need to adjust and adapt to prepare for the compounding effects of climate change. The adaptation strategies outlined in this section take a holistic approach to agricultural resilience. Climate-smart farming practices can support more efficient agricultural water use, healthier soils, and conversion to crops that are better suited for a drier and hotter climate [**AG-1**]. Agricultural adaptation strategies have a broad range of co-benefits, such as reducing flood risk while increasing community and ecosystem resilience. Building an equitable, sustainable local food system can improve community health and food security while also strengthening the local agricultural economy, especially for small family farms [**AG-2**]. Crop conversions that wet the land for prolonged periods of time, such as rice cultivation, can halt land subsidence (thereby mitigating future flood risk), reduce GHG emissions, and contribute to habitat diversity for a diverse range of species. Working agricultural lands can also augment on-farm income through activities such as agritourism [**AG-3**]. Other strategies recognize that some agricultural land may benefit from retirement for restoration, flood protection, renewable energy, and other purposes [**AG-4**].

## Delta Plan Connection

The following Agricultural Strategies align with Delta Plan Policies **DP P1** and **DP P2** which collectively emphasize the importance of aligning new urban development and infrastructure projects with local land use plans and minimizing conflicts with existing uses, including agricultural areas.

These strategies build from the Delta Plan which lays a foundation for agricultural adaptation through various recommendations and performance measures. For example, the Delta Plan includes recommendations to increase subsidence- reversal projects, fund wildlife-friendly farming, and encourage agritourism. Likewise, the Delta Plan also includes a performance measure that targets no conversion of Delta farmland to urban development.

**Table 6-1** provides a summary list of the agricultural climate change adaptation strategies recommended by Delta Adapts. Detailed strategy profiles are presented in **Section 6.2.**

**Table 6-1** Summary of Agricultural Strategies

| Strategy ID | Strategy Description |
|---|---|
| **AG-1** | **AG-1: Expand Adoption and Support Implementation of Climate-Smart Farming Practices Across Delta Agricultural Lands** |
| **AG-2** | **AG-2: Build a Sustainable, Equitable Regional Food System** |
| **AG-3** | **AG-3: Support Diversification of Income/Revenue Opportunities on Operating Agricultural Lands** |
| **AG-4** | **AG-4: Cooperatively Identify Strategic Agricultural Land Retirement Opportunities, Where Other Land Uses Would Be of High Monetary or Non-Monetary Value** |

# 6.2 Strategy Profiles

## AG-1: Expand Adoption and Support Implementation of Climate-Smart Farming Practices Across Delta Agricultural Lands

**Recommended Implementation Lead:** CDFA

**Recommended Partners:** USDA NRCS, Delta Conservancy, DPC, DWR, CARB, UC Cooperative Extension, landowners, farmers, growers, county RCDs, local air districts, non-government organizations

**Hazards Addressed:**


**Co-Benefits:**


**State Adaptation Priorities:** (3) Build a climate resilient economy, (4) Accelerate nature-based climate solutions and strengthen climate resilience of natural systems, (5) Make decisions based on the best available climate science, (6) Partner and collaborate to leverage resources

**Equity Considerations:** These actions will support local farmers. Small, urban, and diversified farms, as well as socially disadvantaged farmers will specifically need additional support to adopt these practices. It is important to listen to farmers and immigrant groups to first understand their concerns, risks, and barriers before proposing solutions and plans of action.

Great egret in a flooded agricultural field on Andrus Island

### Strategy Description

Delta agriculture is the economic engine of the region not only because of the crops grown but also because the industry supports infrastructure of statewide significance. This strategy focuses on building a climate-resilient agricultural sector that maintains high productivity and efficient resource use. Appropriate climate-smart farming practices will vary based on farm attributes (e.g., farm size, crop type), geographic differences (e.g., depth to water table, soil type), and targeted climate vulnerability. For all specific actions within this strategy, supporting programs (e.g., incentive programs, technical assistance programs, farmer-to-farmer learning networks, sustainability certifications, regulatory programs, etc.) that facilitate farmer adoption of these practices will be essential.

## Implementing Actions

- **AG-1-1:** Improve and expand **irrigation efficiency** management practices:
  - Expand data-driven irrigation management (e.g., soil moisture monitoring, evapotranspiration-based irrigation demand estimates) to use water efficiently (CDFA 2021).
  - Modernize irrigation equipment for efficient delivery (e.g., pressurized irrigation systems, check distribution uniformity, energy efficient pumps).
  - Use recirculation pumps to reuse irrigation water on-farm, save water and electricity, and reduce agrochemicals discharged to waterways.
  - During dry years or statewide water shortages, encourage dry farming (e.g., pasture, winter small grains) and deficit irrigation where feasible given the crop type, water table level, soils, geography, and likelihood of minimizing subsidence.
  - Support adoption of micro-irrigation systems (e.g., drip, micro-sprinklers)
  - Manage soil salinization by leaching salts from soil profile through overland flooding.
- **AG-1-2: Consult with immigrant farm workers and related groups** to identify recommendations for agricultural practices best suited for cultural knowledges and practices.
- **AG-1-3:** Build **soil health:**
  - On highly mineral/non-organic soils, enhance soil organic matter through practices such as applying compost, mulch, manure, and planting cover crops.
  - On highly mineral/non-organic soils, employ reduced- or no-tillage systems to support soil health, reduce GHG emissions, and decrease compaction.
  - Support whole orchard/vineyard recycling to put wood chips and organic matter back into soils.
  - Streamline permitting of compost facilities and operations.
  - On organic/high peat soils, plant rice for halting subsidence and reducing GHG emissions through rewetting the land.
  - Support new research and on-farm studies that analyze carbon sequestration and GHG emission reduction potential under different conditions, and the importance of incentives or carbon credits to motivate adoption (CDFA 2021).
  - Explore use of water-management practices that reduce methane emissions.

- **AG-1-4:** Increase **plant diversity:**
  - On non-organic soils, increase on-farm permanent plantings, native plants on farms, and agroforestry (e.g., trees for wind breaks, hedgerows, farm border plantings – riparian and roadside buffers) to increase plant diversity, provide pollinator and native insect habitat, help with soil stabilization, and decrease runoff.
  - Rotate crops to increase crop diversity, increase nutrient cycling, and reduce pest threats.
  - Support crop mosaics or polycultures to increase crop diversity, increase nutrient cycling, and reduce pest threats.
- **AG-1-5:** Implement **integrated pest management,** when appropriate, to reduce reliance on pesticides and their impacts on water quality.
- **AG-1-6: Crop switching:**
  - On organic soils, incentivize planting crops that require continuous flooding (e.g., rice) for subsidence-halting and GHG emission reduction benefits. Further develop regional paludiculture (e.g., wet farming on peatlands), including improving understanding of what crops can grow and what markets are available or needed for economic viability.
  - On non-organic soils, support crop switching to drought-tolerant crops
  - Support crop switching to salinity-tolerant crops
  - Support dry farming
  - Prioritize research on rice varieties that would be more economically viable in the Delta
- **AG-1-7:** In areas that are not subsided, consider practicing **rotational fallowing to conserve water and diversify economic portfolios.**

Water irrigation on a farm

## Case Study: Wildlife-Friendly Farming on Staten Island

**Partners:** The Nature Conservancy, Delta Conservancy, DWR, CNRA

On Staten Island, a 9,200-acre island in the North Delta, The Nature Conservancy has implemented an innovative strategy to preserve economic vitality and habitat for sensitive species while reducing flood risk and GHG emissions. The island is a critical spot for sandhill cranes and other migratory birds, who stop along their winter journeys. Two decades ago, The Nature Conservancy became concerned by the ongoing conversion of wetlands into farmland and the looming threat of development. In 2001, The Nature Conservancy acquired Staten Island to prevent development and protect the cranes and other species. DWR and CNRA funded the purchase of the island through grants with the CALFED Bay-Delta Program and the National Fish and Wildlife Foundation.

The Nature Conservancy wanted to find a solution that would benefit both the farmers and cranes. Analysts compared various combinations of crops and wetlands to determine a grouping with maximum carbon offsets. The ultimate outcome was a carefully crafted mosaic of wetland, rice, and traditional crops such as alfalfa, corn, and potatoes. In addition to modeling, the project was informed by research on cranes and other waterbirds, including studies focused on how birds use the different crops in the Delta. For instance, research revealed the optimum water depths at which cranes roost, so managers now strategically flood the island, creating roost sites and diluting water that is increasingly salty due to sea level rise. The project shows that diverging from traditional agricultural practices can result in benefits to both farmers and wildlife, with additional co-benefits.

Cranes continue to winter on Staten Island, where a diverse assortment of crops provides habitat for foraging and roosting. In addition, by the time the project is fully complete, carbon offsets are expected to be comparable to what farmers earned when cornfields covered the island, but with up to 60% less GHG emissions.

The Delta Conservancy provided funding to The Nature Conservancy to convert 426 acres of existing corn to wetlands to provide habitat, reverse subsidence, reduce GHG emissions, support wildlife-friendly agriculture, and explore the carbon market as a potential revenue stream for wetlands.

Read more about the **Staten Island Restoration Project.**

# AG-2: Build a Sustainable, Equitable Regional Food System

**Recommended Implementation Lead:** CDFA

**Recommended Partners:** USDA Agricultural Marketing Agency, Department of Conservation, DPC, UC Agriculture and Natural Resources, landowners, farmers, growers, RCDs, local food policy councils, Delta counties and cities, farm bureaus, non-government organizations

**Hazards Addressed:** This strategy does not directly address impacts from any specific climate hazard. However, actions that support a sustainable and equitable local and regional food system will help increase social and economic resilience to the overall impacts from a changing climate that will likely disproportionately affect socially vulnerable communities. For example, climate extremes on a global scale may impact crop harvests and increase food prices on the global market, making it more difficult for Delta residents to afford food.

**Co-Benefits:**


**State Adaptation Priorities:** (2) Bolster public health and safety to protect against increasing climate risks, (3) Build a climate resilient economy

**Equity Considerations:** The goal of this strategy is to provide agricultural jobs to sustain the Delta agricultural economy and focus Delta agricultural distribution to local residents that do not have a steady supply of healthy food. Furthermore, this strategy aims to increase the number and diversity of Delta farmers, prioritizing assistance to socially disadvantaged farmers. By strengthening the local agricultural economy with local food growers, processors, and distributors, the strategy helps to connect residents with affordable, locally produced food and keeps money within the Delta, building local health and economic resilience.

## Strategy Description

This strategy focuses on the need to connect the Delta's rich agricultural economy to a regional food system that sustains both local farmers and communities, with a focus on providing healthy, local, sustainably produced food to communities that need it the most. Local food processing, for example, enables small family farms to sell their produce to local grocery stores and larger buyers like schools and food banks, creating local jobs and keeping dollars within the Delta economy. Actions to help connect locally grown foods to the local market also can improve equitable food access and affordability, increasing food security regionally.

## Implementing Actions

- **AG-2-1:** Support and retain **labor and workforce development** and healthy, safe jobs in agriculture by securing additional funding for education and training.
- **AG-2-2:** Create training, employment, and land access programs and **opportunities for the next generation of farmers.** Connect farmers with students to learn about sustainable agricultural practices (Restore the Delta 2023).
- **AG-2-3:** Support and promote **small, family-owned, diversified, and urban farms** – rather than corporate farms – and supply chains that leverage local processing facilities to reduce geographic distance between producer and consumer (SACOG 2016).
- **AG-2-4:** Improve **local food access** – increase the amount of Delta agricultural products in local grocery stores, farmers markets, co-ops, and food banks (Restore the Delta 2023, SACOG 2016).
- **AG-2-5:** Support efforts to enhance access to **local and affordable** foods.

A vineyard near the Delta Farmer's Market near Rio Vista

# AG-3: Support Diversification of Income/Revenue Opportunities on Operating Agricultural Lands

**Recommended Implementation Lead:** Delta Agencies

**Recommended Partners:** USDA, CDFA, Delta Conservancy, DPC, CARB, UC Agriculture and Natural Resources, RCDs, landowners, farmers, growers, non-government organizations, Delta counties and cities

**Hazards Addressed:**


**Co-Benefits:**


**State Adaptation Priority:** (3) Build a climate resilient economy

**Equity Considerations:** Actions that support local farmers will bring additional revenue to farmers in the Delta and offer information and awareness regarding the conditions needed to maintain agriculture in the region. Diversifying economic resilience for local farmers will become increasingly important as climate extremes may increase costs (e.g., for insurance) and eliminate some revenue sources in some years (e.g., failure of high-value crop due to extreme weather event).

Flooding agricultural lands may increase methylmercury concentrations in the water, although farmers can work to limit methyl mercury in flooded fields. Using farm equipment to turn the soil and bury vegetation further underneath the sediment can reduce methylmercury concentrations. Despite these methods, it is important to avoid flooding farmland near or at subsistence fishing areas and locations with high existing concentrations of mercury.

## Strategy Description

This strategy outlines actions that create opportunities for landowners to bring added economic value to their existing crops through additive activities such as tourism and recreation, integration of new systems, and acquiring environmental credits (e.g., carbon credits that have a monetary value) for actions on their land. This also includes building broad awareness of not only the value of agricultural lands—both economic and cultural—but also the climate benefits associated with working lands. Diversifying revenue opportunities may increase resilience to all climate threats in the Delta by increasing long-term economic viability for agriculture in the Delta, enabling farmers to retain more agricultural land and agriculture-adjacent opportunities that reduce risks from drought, flooding, extreme heat, and wildfire.

## Implementing Actions

- **AG-3-1:** Support **agritourism, agricultural recreation, and cultural opportunities** through VisitCADelta, farmers markets, the Delta Farms & Winery Trail, festivals/events highlighting local agricultural production, and permitting for farm stands and on-farm public visitors.
- **AG-3-2:** Integrate **crop-livestock systems:**
  - On mineral soils, facilitate livestock-cropping integration including range-planting, grazing management for positive ecological outcomes, and increasing quality grasses for improved feed, carbon and water storage, and fire resilience (CNRA 2022).
  - Support stubble (crop residue left on soil after harvesting crop) grazing and orchard grazing by livestock, which reduces fire risk, eradicates invasive weeds, and contributes to carbon sequestration (CDFA 2021).
- **AG-3-3: Support environmental credits** (e.g., carbon credits or wildlife-friendly farming incentives):
  - Recognize appropriately designed and sited on-farm habitat, restoration projects, and wildlife-friendly farming practices (e.g., leaving stubble or keeping rice fields flooded to support migratory waterfowl and juvenile fish).
  - Adopt a California wetland carbon sequestration protocol for the California compliance offset market (instead of the voluntary carbon market) to increase carbon credit value and incentivize conversion to wetlands. Integrating carbon credits from wetland projects into the formal compliance market could provide higher prices than the voluntary market and make appropriate wetland restoration more economically attractive.
  - Consider incentives for tule farming to help reverse or halt subsidence and creating biofuel and building materials.
  - Explore actions to streamline process and decrease costs of developing and listing carbon credits (e.g., verification costs (ISB 2023).
  - Develop incentives that stack or bundle multiple environmental benefits or credits together to minimize paperwork burden, maximize environmental benefit, and strengthen financial incentives.
  - Explore incentive programs such as the Fish Friendly Farming Sustainable Certification Program, Delta Conservancy Delta Drought Response Pilot Program, U.S. Department of Agriculture (USDA) Conservation Reserve Program, Conservation Stewardship Program, and Environmental Quality Incentives Program.
- **AG-3-4:** Implement **multiple uses** on agricultural and working lands:
  - Prioritize research evaluating the opportunities, costs, and benefits of on- farm solar (agrivoltaics) and on-farm carbon capture and sequestration to reduce emissions.
  - Implement other technologies such as gasifier technology that can turn biomass into liquid fuel and activated carbon and create revenue by converting organic waste and byproducts into energy and materials.
- **AG-3-5:** Develop partnerships for **multi-benefit agriculture-ecosystem-flood management projects** (e.g., Yolo Bypass Partnership).

## Case Study: Fish and Rice – An Integrated Approach to Rice in the Delta

### *1. Nigiri Project*

**Partners:** Cal Trout, Cal Marsh and Farm, Knaggs Ranch LLC, UC Davis Center for Watershed Sciences, DWR, Northern California Water Association, California Water Foundation, River Partners, CDFW, and others

### *2. Fish Food on Floodplain Farm Fields Project*

**Partners:** River Gardens Farms, UC Davis, Cal Trout, San Luis and Delta Mendota Water Authority, and others

**Status:** Ongoing

These two projects collaborate with farmers to reactivate the Delta's historic floodplain habitats to support healthier fish and waterfowl populations. Historically, the Delta became a seasonal floodplain during winter, creating a habitat that offers a wide variety of food for fish and birds, but extensive levee and water management systems have now disconnected these floodplains from river flows. This prevents fish, particularly salmon, from accessing insects and other food sources found in floodplains. Research shows that juvenile salmon that feed on floodplain insects are able to grow larger and are more likely to survive to adulthood.

A diverse partnership is working to mimic these floodplain benefits through two different models. The Nigiri project works with farmers to flood rice fields dormant outside of the growing season, creating a rich ecosystem of insects and plankton to nourish juvenile salmon, which are conveyed to and from the river via weirs. Rice farmers, in turn, benefit as they no longer need to use stubble burning to remove rice detritus, which degrade naturally in the flooded habitat. Additionally, fish excrement fertilizes the rice, reducing the need for chemical fertilizers, and the presence of fish also reduces disease and pests affecting the rice (Leslie 2015). The project started with just a few acres in Knaggs Ranch in the Yolo Bypass and success has led to expansion into a second phase with thousands more acres. The project has negotiated permitting regulations for large-scale implementation of floodplain management and demonstrates that sustainable agricultural practices can simultaneously support flood management and biodiversity.

## Case Study (continued)

Through the Fish Food on Floodplain Farm Fields project, the fish stay in the river, and the food comes to them. In a different model, River Gardens Farm takes water from the river and floods its rice fields for a few weeks. Then, the water – now rich in bugs and other nutrients – is returned to the river, bringing the food web to the fish.

As a next step, Cal Trout is developing a practice standard that can be used in a payment incentive program by federal and state agencies to support widespread adoption of agricultural practices that reactivate floodplains for fish and wildlife health.

Read more about the **Nigiri Project**, and the **Fish Food on Floodplain Farm Fields Project.**

Juvenile salmon from the Nigiri Project
*Source: Nigiri Project*

# AG-4: Cooperatively Identify Strategic Agricultural Land Retirement Opportunities, Where Other Land Uses Would Be of High Monetary or Non-Monetary Value

**Recommended Implementation Lead:** Delta Conservancy
**Recommended Partners:** USDA, tribes and tribal communities, DWR, CDFA, DPC, Department of Conservation, SAFCA, RCDs, landowners, farmers, growers, non- government organizations, Delta counties and cities
**Hazards Addressed:** This strategy addresses climate and economic resilience for the Delta by diversifying the economy and providing jobs and revenue in a range of sectors.

**Co-Benefits:**


**State Adaptation Priorities:** (3) Build a climate resilient economy, (4) Accelerate nature-based climate solutions and strengthen climate resilience of natural systems

**Equity Considerations:** These actions will support increasing jobs in various sectors, including recreation, energy, and habitat restoration. However, farmworkers may lose jobs due to land retirement; moreover, farmworkers may face a range of barriers to transition to new jobs in the Delta or elsewhere, and thus it is critical to work with service groups or CBOs to provide/ sufficient resources and training to find new jobs.

Asparagus farmers in Victoria Island

## Strategy Description

This strategy recognizes that some land currently in agriculture is only marginally productive and may be most optimally used for other uses than agriculture, potentially adjacent to land that remains productive farmland. Some farmers in the Delta are considering or developing long-term succession plans for their lands to transition into stewardship. The actions below outline steps and opportunities for willing landowners to strategically retire agricultural land in favor of more economically viable alternatives that can also support climate resilience for the region.

## Implementing Actions

- **AG-4-1:** Support projects and coordinate across islands to allow for **flooding, wetting for subsidence-halting or reversal,** or converting to managed wetland on most marginal farmlands.

- **AG-4-2:** Consider **strategic retirement of land** for other uses – including restoration, nature-based solutions, recreation, renewable energy, subsidence reversal through wetland restoration, and carbon capture and storage.
- **AG-4-3:** Promote workforce development and training programs for **alternative economic opportunities and local industries** such as installing solar panels and renewable energy sources.
- **AG-4-4: Support continued resources for land transition.** Funds may come from the Department of Conservation Multibenefit Land Repurposing Program, Community Economic Resilience Funds, federal funding, other state funding, and other sources.
- **AG-4-4:** Work with the Delta Conservancy to identify **access, co-management, and land return opportunities** for tribes and tribal communities with connections to the Delta.

The habitat surrounding the Lookout Slough Tidal Restoration Project

# Chapter 7 Water Supply Reliability Strategies

## 7.1 Adaptation Approach

Some 27 million Californians and more than 3.7 million acres of agricultural lands rely on water conveyed through the Delta. The Delta is an essential part of the SWP and the CVP, serving as a central hub for water deliveries to other parts of the state, and is an area of critical importance for local water use by people, agriculture, and ecosystems. The Delta and its contributing watersheds will be stressed by warming temperatures, decreased snowpack, shifts in the timing and magnitude of runoff, increased interannual precipitation variability, and sea level rise. Climate change in the Delta and its contributing watersheds will reduce water supply, increase demand, and lessen the reliability and performance of California's water supply systems. The Delta's network of water conveyance infrastructure, including aqueducts, canals, diversion points, and pumping plants, is at risk of flooding, which could disrupt water supply across the state. Additionally, extreme weather events and levee-adjacent land subsidence will increasingly stress the Delta levee system, which channels water to intake pumps in the Southern Delta and protects water quality from salinity intrusion.

Finally, drought conditions and salinity intrusion due to sea level rise may degrade water quality, reduce the reliability of in-Delta diversions, threaten human health and safety, and cause economic loss. Even as water supply is likely to face increasing challenges and stresses, water demand could simultaneously increase across the state due to increased irrigation in response to warmer temperatures, as well as the need to increase releases of freshwater from upstream reservoirs to repel salinity due to sea level rise, particularly in dry years (DSC 2021a).

Reducing water supply reliance on the Delta is an existing requirement for certain water suppliers, and it represents a critical step toward climate resilience for everyone. This climate adaptation approach supports the state's policy of reduced reliance on the Delta and the Delta Reform Act's coequal goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. Actions such as increasing conservation, expanding local storage and regional water supplies, using recycled water, or expanding groundwater storage can help diversify water supplies and re-double the Council's efforts to reduce reliance

on the Delta [**WSR-1**]. Other adaptation strategies focus on modernizing Delta conveyance systems [**WSR-3**], improving reservoir operations [**WSR-4**], and updating water quality standards to consider the impacts of climate change [**WSR-5**]. Modifying Delta conveyance infrastructure can reduce salinity intrusion, reduce the impacts of through- Delta conveyance, and enhance ecosystem health, while climate-informed reservoir operations are necessary to adapt to changes in peak runoff patterns and reduce flood risk. Updated water quality standards in the Delta can protect habitats, fish, human health, and safety, and improve water quality for agriculture within the Delta.

However, each strategy has associated tradeoffs. Improving water quality may require additional releases from upstream reservoirs, impacting water supply in future years, while maintaining reservoir levels will lead to less instream flows. Modifying Delta infrastructure may require construction which would directly impact Delta residents. The tradeoffs associated with each action must be carefully considered.

California's complex and fragmented water rights system presents unique challenges to flexible and responsive water resource management under climate change. Additionally, environmental justice groups point out that, as with other systems of property control or ownership in the United States, water rights carry with them a legacy of unequal access that further complicates equitable and effective climate change adaptation. As a result, both drought-induced water shortages and administration of the water rights system result in reduced freshwater flows within the Delta and corresponding water quality issues for Delta communities and ecosystems.

We recognize that as the regulatory body overseeing California water rights, the SWRCB is working within its authorities to address these challenges. Through its water rights data modernization initiative, known as UPWARD (Updating Water Rights Data for California), the SWRCB is digitizing its entire library of water rights information and data and developing a platform that will improve public access to this critical information to support data-driven water management decisions. Additionally, in 2017, the SWRCB established tribal, cultural, and subsistence beneficial uses of water to be considered and incorporated in the nine regional boards' basin plans. In the short-term, potential approaches to improving California's water rights system include increasing awareness of the need for strong water rights enforcement at the SWRCB, developing new policies and augmenting investments in science related to Delta flows and endangered species needs, and supporting the SWRCB's efforts to further define and protect tribal and cultural beneficial uses of water. In the long run, enhanced water rights data and water diversion reporting will ensure that streams are not over appropriated, and enough water remains in the system to support downstream beneficial uses and ecological functions and result in greater equitable use of this shared resource.

**Table 7-1** provides a summary list of the water supply reliability climate change adaptation strategies recommended by Delta Adapts. Strategies are presented in **Section 7.2.**

**Table 7-1** Summary of Water Supply Reliability Strategies

| Strategy ID | Strategy Description |
|---|---|
| WSR-1 | WSR-1: Reduce Reliance on the Delta by Improving Regional Self-Reliance through Conservation and Developing Local Water Supplies |
| WSR-2 | WSR-2: Increase Local Storage of Surface and Groundwater Supplies Outside of the Delta |
| WSR-3 | WSR-3: Improve or Modify Water Infrastructure in the Delta to Minimize the Impacts of Through-Delta Conveyance |
| WSR-4 | WSR-4: Modify Reservoir Operations to Adapt to Changing Climate Conditions |
| WSR-5 | WSR-5: Review and Consider Modifying Water Quality Standards to Develop Climate-Informed Objectives for Agricultural Uses, Fishing, Recreational, tribal, and Other Human Beneficial Uses of Water |

Barker Slough Pumping Plant in Solano County

# 7.2 Strategy Profiles

## WSR-1: Reduce Reliance on the Delta by Improving Regional Self-Reliance through Conservation and Developing Local Water Supplies

**Recommended Implementation Leads:** Water suppliers and utilities
**Recommended Partners:** DWR, SWRCB, Delta cities and counties, water suppliers, and other interested parties
**Hazards Addressed:**

Drought

**Co-Benefits:**

Community

**State Adaptation Priority:** (6) Partner and collaborate to leverage resources

**Equity Considerations:** Vulnerable communities and smaller water systems may not have the resources needed to invest in water projects that will lead to regional self-reliance. Therefore, state programs for water system improvements should prioritize financial and technical assistance for communities served by systems that do not have sufficient resources for such water projects. Current state policies and water conservation goals are designed with larger water systems in mind and may cause an increased financial burden on smaller or socially vulnerable communities, without programs and funding to mitigate financial burdens.

Canada geese fly over the raw water storage ponds on the grounds of the Stockton East Water District

### Strategy Description

Increasing regional self-reliance encompasses multiple aspects, including water suppliers improving their water supply reliability, increasing water-use monitoring capabilities, and implementing methods to control water demand. Core strategies for water supply reliability in the Delta Plan include increasing water conservation and expanding local and regional water supplies. Achieving the coequal goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem requires water suppliers to reduce their reliance on the Delta for water supply, including by improving and developing regional and local water supply resources. Reliability under a changing climate depends on early and effective preparations by local and regional water suppliers. Integrated management of water supplies and demands

has a long history of effectiveness in California (ISB 2022). Water suppliers should focus efforts on the following, where applicable:

- Improved conservation measures to eliminate waste
- Using recycled water to reduce reliance on groundwater and Delta exports
- Improved groundwater management
- Developing local storage projects
- Desalination

## Implementing Actions

- **WSR-1-1:** Engage in community outreach to **promote conservation** and communicate the value of new water projects
- **WSR-1-2:** Support **pilot projects** promoting urban and agricultural water conservation or using recycled water.
- **WSR-1-3:** Improve **water metering** to identify and remove water use inefficiencies and promote water conservation.
- **WSR-1-4:** Coordinate with local and regional agencies to develop an **inter-basin groundwater budget** and implement the Sustainable Groundwater Management Act.
- **WSR-1-5:** Coordinate with local and regional agencies to **develop storage projects** and improve water budgeting.
- **WSR-1-6:** Coordinate with DWR to identify potential **funding** sources for assisting in developing local water supply, storage, and water use efficiency projects.

### Delta Plan Connection

Delta Plan policy WR P1 requires water suppliers to reduce reliance on the Delta through improved regional self-reliance. Some examples of programs or projects contributing to reduced reliance are improvements in water use efficiency, water recycling, stormwater capture, and local and regional storage projects.

## Case Study: North Valley Regional Recycled Water Program

**Partners:** Del Puerto Water District, City of Modesto, City of Turlock, Reclamation

The North Valley Regional Recycled Water Program (NVRRWP) is an infrastructure project developed by Del Puerto Water District (DPWD), the City of Modesto, and the City of Turlock. The project has two objectives: (1) Permanently remove wastewater discharges of the City of Modesto and the City of Turlock from the San Joaquin River, and (2) Provide a regional solution to address water supply shortages within the DPWD service area. The NVRRWP delivers up to 59,000 AFY of recycled water for non-potable use from Modesto and Turlock directly to the Delta-Mendota Canal (DMC). The recycled water is conveyed directly to DPWD customers for agricultural purposes or banked directly with the Central Valley Project. The NVRRWP can provide a reliable recycled water supply that is sufficient to meet at least one-quarter of the annual supply requirement of DPWD's customers. The water can be used for food production on thousands of acres of farmland, reducing reliance on Delta exports and groundwater supplies. The program provides an estimated annual economic benefit of approximately $30 million, contributing nearly $70 million per year to the region's economy.

Increasing use of recycled water is an effective strategy for improving local water conservation as it reduces demand for other sources of water. Treated wastewater can be used for agricultural purposes in lieu of potable water or groundwater. This would allow local agencies to reduce reliance on the Delta and provide opportunities for groundwater recharge. The ecosystem also benefits from the reduction of treated wastewater discharge in the river.

Read more about the **North Valley Regional Recycled Water Program.**

# WSR-2: Increase Local Storage of Surface and Groundwater Supplies Outside of the Delta

**Recommended Implementation Leads:** Water suppliers
**Recommended Partners:** Tribes and tribal communities, DWR, SWRCB, interested parties, Groundwater Sustainability Agencies

**Hazards Addressed:**


**Co-Benefits:**



**State Adaptation Priorities:** (5) Make decisions based on the best available climate science, (6) Partner and collaborate to leverage resources

**Equity Considerations:** Socially vulnerable communities and smaller water systems may not have the resources needed to invest in water storage projects, and therefore investments should prioritize the needs of these communities. Water supply development projects should be designed in partnership with the surrounding community, with close attention to the potential impacts to existing land uses at the proposed storage project locations.

## Strategy Description

Warmer temperatures are resulting in earlier melting snowpacks and altered runoff patterns. Runoff that shifts into the winter months is less likely to be stored and captured in rim reservoirs, leading to increased flood risk and reduced water supplies later in the year. To adapt to changing climate conditions and promote drought resilience, water suppliers should invest in additional local surface water and groundwater storage. Developing this necessary infrastructure will allow water suppliers to take advantage of opportunities to capture additional water during peak flows. Opportunities for storage should be explored both upstream and downstream of the Delta.

## Implementing Actions

- **WSR-2-1:** Streamline processes to allow private landowners to use their fields for **groundwater recharge.**
- **WSR-2-2:** Engage in **outreach** to interested parties to promote and gather support for storage projects.
- **WSR-2-3:** Invest in **improving** monitoring capabilities to support operational decision-making.
- **WSR-2-4:** Invest in planning activities for **flood-managed aquifer recharge** (Flood-MAR) projects.
- **WSR-2-5:** Coordinate with water suppliers to improve **aquifer modeling capabilities.**

## Case Study: Mountain Meadow Restoration

**Lead:** The Sierra Meadows Partnership

Meadow restoration has the potential to enhance water supply reliability and improve water quality. Mountain meadow restoration projects in California have shown immense potential to improve groundwater storage while simultaneously improving habitat for wildlife.

Mountain meadows are especially valuable for water supply management because they function as reservoirs with a controlled release mechanism. The meadows store excess water during wet periods and gradually release the water into streams, rivers, and aquifers during dry seasons. The slow release of water provides a consistent source of water over an extended period. Mountain meadows also improve groundwater quality. As water infiltrates through the meadow's vegetation and soil, pollutants and sediments are trapped and removed, resulting in improved groundwater quality.

A 2018 study investigated the hydrologic impacts of a mountain meadow restoration project that reconnected a small section of meadow floodplain within the Sierra Nevada Mountains. Prior to restoration, outflow in the summer slightly exceeded inflow. However, following meadow restoration in 2012, the study found that total summer outflow was greater than summer inflow by 35 to 95 percent, up from 5 percent the year before. During the 2012 to 2015 drought, summer baseflow was at least five times greater than before the restoration. Additionally, groundwater levels rose at four out of five monitoring sites near the stream channel, showing that mountain meadow restoration has the potential to amplify water availability and streamflow even during drought conditions.

Read more about mountain meadow restoration in the **Sierra Meadows Strategy** and the **Sierra Nevada Meadow Restoration Business Plan** (executive summary).

# WSR-3: Improve or Modify Water Infrastructure in the Delta to Minimize the Impacts of Through-Delta Conveyance

**Recommended Implementation Lead:** DWR

**Recommended Partners:** NMFS, USBR, tribes and tribal communities, SWRCB, CDFW, local agencies, and other interested parties

**Hazards Addressed:**


**Co-Benefits:**


**State Adaptation Priority:** (6) Partner and collaborate to leverage resources

**Equity Considerations:** Poor water quality disproportionately impacts socially vulnerable communities, in-Delta water users, and smaller agricultural communities. Additionally, alterations to existing infrastructure and building new infrastructure in the Delta may have localized impacts on surrounding communities. Impacted communities should be included throughout the planning process, including the design phase and the determination of how negative impacts to local communities would be avoided or mitigated.

California Aqueduct in San Joaquin County

## Strategy Description

As discussed in the Delta Plan, improvements to through-Delta conveyance systems alone are insufficient to achieve a more reliable water supply and protect the Delta ecosystem with anticipated water shortages and salinity impacts in the face of climate change. Developing new isolated conveyance facilities in conjunction with improvements to Delta levees can increase resilience to future hazards and promote ecosystem restoration. This strategy is often referred to as "dual conveyance". **DWR should focus on enhancing existing facilities, developing an isolated conveyance facility, modifying in-Delta operations to minimize impacts on the environment and other beneficial uses of water, and protecting the freshwater pathway to improve through-Delta conveyance and water quality.** Dual conveyance alternatives should be evaluated consistently with the criteria specified in Delta Plan Recommendation **WR R12** to reduce impacts to the Delta ecosystem and protect water quality.

## Delta Plan Connection

Delta Plan Recommendation **WR R12a** recommends new water conveyance infrastructure be developed through a combination of improvements to through-Delta conveyance and developing an isolated conveyance facility to allow for operational flexibility. All alternatives for an isolated conveyance facility should be evaluated in a manner that is consistent with **WR R12b** and applicable Delta Plan regulations.

Improvements or modifications to through-Delta conveyance should be made to lessen or avoid impacts to riparian habitat, lessen or avoid impacts to anadromous fish migration, and lessen or avoid impacts to public safety (**WR 12c**). Potential modifications include improving levees and/or dredging in a manner that provides multiple benefits such as improved flow and water quality.

Emergency drought salinity barrier on the West False River near Oakley

## Implementing Actions

- **WSR-3-1:** Improve Delta levees to support **through-Delta conveyance** and reduce the probability of levee failure
- **WSR-3-2:** Implement **salinity barriers** or sills to improve water quality and help prevent saltwater intrusion.
- **WSR-3-3:** Protect and maintain a **freshwater pathway** through the central Delta.
- **WSR-3-4:** Engage with water suppliers and interested parties in the Delta to explore opportunities for **new conveyance projects** and address concerns.
- **WSR-3-5:** Develop an **integrated modeling framework** to support the feasibility and environmental assessments of new projects (e.g., barriers, conveyance, freshwater pathway, levee improvements).

**COEQWAL, the Collaboratory for Equity in Water Allocations,** is a pioneering initiative aiming to enhance sustainable and equitable water distribution in California. It leverages sophisticated water and climate modeling, engaging with a diverse array of academics, regulators, and water users to develop state-of-the-art planning tools. Specifically focusing on the Delta through a substantial project funded by the University of California's Climate Action Grant Program, COEQWAL employs the CalSim3 model to address critical issues like salinity management, drinking water accessibility for vulnerable communities, and Chinook salmon recovery, promoting transparent and transformative discussions on water management amidst climate change. For more detailed information, visit the **COEQWAL website.**

# WSR-4: Modify Reservoir Operations to Adapt to Changing Climate Conditions

**Recommended Implementation Leads:** Reservoir operators
**Recommended Partners:** USACE, NOAA/NMFS, USFWS, SWRCB, CDFW, Council

**Hazards Addressed:**


**Co-Benefits:**


**State Adaptation Priorities:** (5) Make decisions based on the best available climate science, (6) Partner and collaborate to leverage resources

**Equity Considerations:** Revised reservoir operations should prioritize safety and flood risk reduction strategies, considering the needs of socially vulnerable communities. Revisions of reservoir operations should involve inclusive community representation and tribal consultation. Improved water supply reliability and flood hazard management operations can potentially benefit socially vulnerable communities.

## Strategy Description

Reservoir operators should evaluate existing operations to identify and implement adjustments that support adapting to changing climate conditions. Current reservoir operation capabilities should then be modified to adapt to changes in runoff patterns and the timing and intensity of precipitation. New criteria should be developed to inform decision-making on the timing of retaining or releasing water that considers climate variability. Modified reservoir operations should also account for additional water supply for environmental needs due to climate variability. Operating criteria should be developed in coordination with CDFW, NMFS, and the SWRCB to maximize sufficient flows for the ecosystem and maintain the standards in the Delta. Key developments should focus on:

- Improved water supply and demand forecasting models to assist in operational decision-making.
- Revising flood control curves without compromising flood protection.
- Improved information on changing weather patterns to better inform reservoir releases.
- Improved transparency regarding how reservoirs are being operated to consider changing weather patterns and meet Delta standards.

## Implementing Actions

- **WSR-4-1:** Coordinate with USACE to **review and update, as needed, flood space reservation guidelines for upstream reservoirs.**
- **WSR-4-2:** Coordinate with NOAA to **review and improve existing weather and hydrologic forecast models** to inform reservoir operations.
- **WSR-4-3:** Coordinate with USFWS and NMFS to **review temperature modeling** and balance water supply needs with cold-water release requirements.

## Delta Plan Connection

Delta facilities and reservoirs should be operated using adaptive management principles (Recommendation **WR R12h**). Evaluating the applicability of FIRO and updating flood space reservation guidelines with the USACE are examples of how adaptive management can be applied.

Looking northeast toward Oroville Dam, Lake Oroville and the Feather River located in the foothills on the western slope of the Sierra Nevada mountain range.

## Salinity Management Workshop Series

To address gaps identified during the Salinity Management Workshop series, the Delta Science Program funded exploratory modeling efforts using high-resolution hydrodynamic and salinity transport models of the San Francisco Estuary, alongside the CalSim statewide water operations model, to estimate potential water savings under future scenarios. This initiative aimed to refine salinity prediction modeling approaches, focusing on the salinity response to Delta outflow amid diverse conditions, including restoration projects and projected sea-level rise. By integrating advanced models like SCHISM and RMA-2D and employing surrogate models such as Artificial Neural Networks, these efforts showcased the practicality of utilizing hydrodynamic models for salinity management amidst prolonged droughts and changing landscapes. An important product of this effort is the development of a novel method for streamlining the rapid creation of surrogate models, enhancing the efficiency and adaptability of water resource management strategies. This effort offered valuable insights to decision-makers on in-Delta salinity impacts and optimize critical water management during drought periods. The project aimed to create a new modeling methodology and tools that other researchers can use to explore a wider range of management and operational changes under different sea-level rise conditions.

# WSR-5: Review and Consider Modifying Water Quality Standards to Develop Climate-Informed Objectives for Agricultural Uses, Fishing, Recreational, Tribal, and Other Human Beneficial Uses of Water

**Recommended Implementation Lead:** SWRCB
**Recommended Partners:** USBR, NMFS, tribes and tribal communities, DWR, CDFW, local agencies, and other interested parties

**Hazards Addressed:**


**Co-Benefits:**


**State Adaptation Priorities:** (5) Make decisions based on the best available climate science, (6) Partner and collaborate to leverage resources

**Equity Considerations:** Poor water quality disproportionately impacts socially vulnerable communities and in-Delta water users. Other highly impacted communities include tribes, whose members are exposed to contaminated water through cultural practices, and unhoused individuals, who lack access to clean water for drinking, cooking, and sanitation. The presence of harmful algal blooms (HABs) has health impacts for those exposed through contact with contaminated water or aerosolized toxins (DSC 2022a). People who live near water containing HABs may have a higher risk of inhaling toxic aerosols (Plass and Paerl 2021). Discussions on the modification or creation of new standards should include adequate community representation, allowing for meaningful engagement by residents—including socially vulnerable communities and other communities historically excluded from public process.

## Strategy Description

Water quality and flow regulations also need to adapt to changing conditions while also taking into consideration potential impacts to overall water supply. Delta Plan Recommendation ER R1 recommends that the SWRCB maintain a regular schedule of reviews of the Bay-Delta Plan to reflect changing conditions due to climate change and other factors. During extreme drought conditions, water supplies are insufficient to meet system requirements. This is compounded by sea level rise, which could have significant impacts on in-Delta water users and ecological resources in the Delta, including increased costs associated with managing the system to current prescribed standards. Climate change will increase the frequency and severity of system shortages. The SWRCB should review and consider modifying existing Delta standards using the best available science. There are several areas to consider while reviewing and updating Delta standards:

- Provide functional flows in the Delta
- Improve the detection of HABs

- Maintain sufficient water quality for human health and safety
- Maintain sufficient water quality for agricultural needs
- When feasible, preserve upstream water storage during wet and above-normal years so more water is available during extreme drought conditions
- Minimize impacts on the ecosystem and preserving fishery habitat
- Revise temperature standards for anadromous species
- Ensure water quality safety measures that consider Tribal Beneficial Uses

It may be difficult to find a balance between these desirable goals as improvements in water quality, stream flows, or fishery habitat can result in less water supply in future years.

## Implementing Actions

- **WSR-5-1:** Coordinate with DWR to improve current Delta modeling capabilities to evaluate or consider an **alternative regulatory framework.**
- **WSR-5-2:** Coordinate with all partners to **review current Bay-Delta Plan water quality standards** and begin discussion on potential modifications.
- **WSR-5-3:** Coordinate with NMFS and USFWS to review and evaluate the effectiveness of current **X-2 flow requirements** and temperature standards.
- **WSR-5-4:** Continue to implement regular external reviews to evaluate the effectiveness of existing water quality standards in protecting **anadromous species.**
- **WSR-5-5:** Continue supporting efforts to coordinate and develop comprehensive monitoring programs to **detect HABs.**
- **WSR-5-6:** Re-evaluate existing water quality standards or develop new standards with the goal of **preventing HABs.**
- **WSR-5-7:** Develop new methods for **monitoring and reporting water diversions** statewide to ensure diverters are properly reporting their use, and that sufficient flows remain in the system to protect tribal and other beneficial uses.
- **WSR-5-8:** Coordinate with the Integrated Modeling Steering Committee, the California Water and Environmental Modeling Forum, and other technical experts to further develop **modeling tools** needed for science-based decision-making in the Delta. Well-led collaboration and coordination could reduce development costs while improving model utility and coordination across regional operations and management issues (ISB 2022).

### Delta Plan Connection

The Bay-Delta Plan and Delta flow objectives should be updated to protect beneficial uses in the Bay-Delta watershed (Recommendations **WR R12i** and **ER R1**). Water diverters should develop a process and plan for meeting flow and water quality requirements during extended drought conditions and minimize reliance on temporary urgency change petitions or other similar requests.

# Chapter 8 Implementation Roadmap

The Delta and Suisun Marsh share many common challenges, but individual regions (**Figure 1-2**) within the Delta also have unique challenges, considerations, priorities, and appropriate adaptation strategies. To guide decisionmakers in selecting adaptation strategies, this section describes each region's characteristics and key vulnerabilities, along with corresponding strategies that may be the most applicable. To ensure the efficacy of all strategies, best available science should be used to guide implementation, and new research should be undertaken to fill specific knowledge gaps. Strategies should be adaptively managed, with frequent updates to decisionmakers to discuss progress, new advancements, and ways to make changes as needed.

Many strategies are broadly applicable throughout the Delta. For example, all regions of the Delta should explore opportunities to partner with tribes and tribal communities to identify and invest in shared nature-based solutions and improve tribal access and cultural use of important sites [**ECO-3**]. Thus, even if strategies are not noted explicitly below in a particular region, it does not mean they are not applicable there. Relevant strategies are indicated in parentheses and discussed in more detail in the strategy profiles in **Chapter 4** through **Chapter 7**. Additionally, this section also identifies key implementation recommended partners unique to each region; implementation agencies and interested parties applicable to the entire Delta and Suisun Marsh are listed below.

**Delta-wide Key Implementation Recommended Partners:** USACE, USDA Natural Resources Conservation Service, DPC, Delta Conservancy, DWR, SWRCB, CDFW, BCDC, CDFA, tribal governments and communities with cultural ties to and Traditional Knowledge of the Delta watershed, Department of Conservation, CVFPB, reclamation districts.

## 8.1 North Delta

Primarily rural, the North Delta includes parts of Sacramento, Solano, and Yolo County along the Sacramento River. Many people live and work in legacy communities in the North Delta.

**Flood Risk:** The North Delta has relatively lower flood risk than the rest of the Delta, but this could also become a vulnerability. Levees in this region, particularly along the Sacramento River, are riverine, meaning they are not wet year-round. As such, they require periodic stress tests to identify weaknesses that may emerge during times of increased water flow.

Nonetheless projected levee improvement costs to address future climate hazards are the lowest in this part of the Delta due to previous levee improvements and higher land elevations. To protect communities from flooding, installing real-time sensors and an early warning system could provide valuable data on water levels and flow rates. Outreach initiatives are particularly critical in rural communities to improve flood emergency preparedness.

To reduce flood vulnerabilities, key strategies identified for the North Delta focus on improving and modernizing levees [**FL-2**], improving emergency preparedness [**FL-4**], promoting new farming practices that minimize flood risk [**FL-5**], and communicating flood risks to rural communities [**FL-6**]. Restoration projects can also help to reduce flood risks and provide natural flood buffers [**FL-3**].

**Water Supply Reliability:** Water quality is a concern in the North Delta due to high levels of organic carbon and pollutants. Low flows can exacerbate water quality issues, especially as periods of extended drought are likely to increase, with potential risks for public health and agriculture. High levels of organic carbon can increase water treatment costs, interfere with agricultural irrigation systems, and potentially influence soil composition over time. This could affect the economic viability of water treatment facilities, reduce agricultural yields, and affect land availability for specific crops.

Given the North Delta's relative isolation from extreme weather events, water supply reliability strategies should account for these unique conditions to balance water quality with flood risk and agricultural needs. This may be achieved in many ways, including developing local water storage systems and supplies [**WSR-1**], modifying infrastructure [**WSR-3**] and reservoir operations [**WSR-4**], and reviewing water quality standards [**WSR-5**].

The Tide's End Multibenefit Restoration Project in Yolo County

**Agriculture:** The North Delta is particularly well-suited for integrated farming systems that combine livestock with cropping. This synergy can improve soil health, reduce the need for chemical fertilizers, and increase resilience against variable weather conditions. Relative geographical isolation from extreme weather lends a degree of stability to agricultural practices in the North Delta. This can be an advantage for long-term planning and investment in innovative, climate-smart farming techniques. However, current agricultural shifts in this region from annual crops to permanent nut tree and vine crops may have unforeseen consequences (such as hardened water demand, groundwater withdrawals, subsidence) as water availability shifts. To increase agricultural resilience, the North Delta would benefit from strategies to expand climate-smart agricultural practices and support climate-smart crop choices [**AG-1**], diversify activities and complementary income-generating opportunities on working lands [**AG-3**], and explore multi-benefit land uses [**AG-4**]. Implementing these strategies will enhance local food security [**AG-2**] and build a lively, sustainable agricultural economy.

A water distribution outlet at the Tide's End, Yolo County

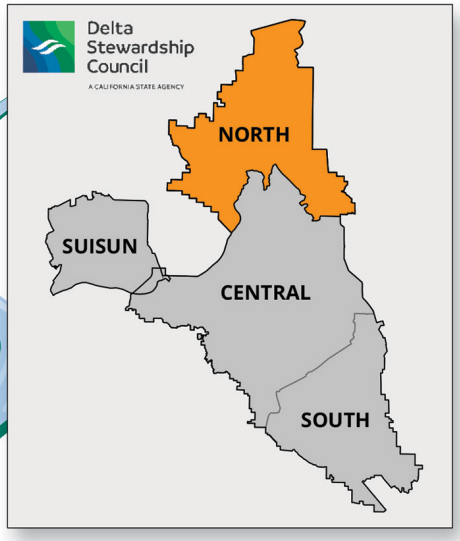
**Ecosystem:** The North Delta has relatively more water and pasture by area, making it attractive for migratory birds. The North Delta also has the highest near-term ecological adaptation potential, including substantial intertidal elevations and upland migration space. Much of the most appropriate elevation land is already in restoration or is slated for restoration and multi-benefit projects. Strategies to support ecosystem resilience in the North Delta include continuing to prioritize strategic, functional locations for restoration, prioritizing multi-function restoration projects, and protecting native species [**ECO-1**, **ECO-3**]. Restoration projects will also need to consider potential impacts on agriculture. Where possible, nature-based solutions should be used to increase the resilience of developed areas and preserve ecosystem services [**ECO-4**]. Levee improvements should be implemented to protect at-risk ecosystems from flooding and reverse subsidence in subsided or subsiding areas [**ECO-2**]. Actions to reduce regulatory burdens for restoration projects and increase coordination and partnerships can help accelerate restoration projects in the Delta where they are most needed [**ECO-3**].

**Key Implementation Partners:** SACOG, Sacramento County, Yolo County, City of West Sacramento, tribal governments and communities with cultural ties to and Traditional Knowledge of the North Delta, North Delta Water Agency, West Sacramento Flood Control Agency (WSAFCA), Sacramento Area Flood Control Agency (SAFCA), Yolo-Solano Air Quality Management District, Sacramento Metropolitan Air Quality Management District, San Joaquin Area Flood Control Agency (SJAFCA).

# North Delta

## IMPLEMENTATION ROADMAP

*Primarily rural and agricultural, with many legacy communities*




### WATER SUPPLY

**Key Adaptation Consideration**

Water quality concerns due to organic carbon and pollutants.

**Key Adaptation Strategies**

- Develop local water storage and supply (WSR-1)
- Improve or modify water infrastructure [WSR-3]
- Install salinity barriers (WSR-3)
- Modify upstream reservoir operations (WSR-4)
- Review water quality standards (WSR-5)

### FLOOD RISK

**Key Adaptation Consideration**

Lower flood risk than other parts of the Delta, but vulnerabilities still exist.

**Key Adaptation Strategies**

- Improve and modernize levees (FL-2)
- Habitat restoration as flood buffers (FL-3)
- Improve emergency preparedness (FL-4)
- Promote new farming practices (FL-5)
- Communicate flood risks (FL-6)

### AGRICULTURE

**Key Adaptation Consideration**

Shifts to permanent crops may increase water demand.

**Key Adaptation Strategies**

- Expand climate-smart agricultural practices (AG-1)
- Enhance local food security (AG-2)
- Diversify income opportunities on working lands (AG-3)
- Explore multi-benefit land uses (AG-4)

### ECOSYSTEM

**Key Adaptation Consideration**

High near-term adaptation potential.

**Key Adaptation Strategies**

- Improve ecosystem capacity to adapt through restoration (ECO-1)
- Halt or reverse subsidence (ECO-2)
- Increase capacity and coordination among interested parties (ECO-3)
- Implement nature-based solutions to protect developed areas (ECO-4)

**Figure 8-1** North Delta Implementation Roadmap

## 8.2 Central Delta

The largest region within the Delta, the Central Delta includes many islands and waterways and is what many people think of when they imagine the Sacramento-San Joaquin River Delta. The Central Delta encompasses parts of Sacramento, Contra Costa, and San Joaquin County and is home to many legacy communities as well as other small towns, many of which have high social vulnerability, and socially vulnerable communities in the urban areas of Contra Costa County (see **Section 2.2** for a deeper discussion of social vulnerability and environmental justice).

**Flood Risk:** Flood risk, primarily driven by sea level rise, is particularly high in the Central Delta due to ongoing land subsidence. Central Delta levees tend to have little freeboard (the distance between the top of the average water surface elevation and the levee crest). These levees are also exposed to constant wetness from ocean currents and tides, making them more prone to failure without regular maintenance. Groundwater rise and drainage issues also add to flood risk within Central Delta islands. Levee improvement costs for the asset level of protection are high in the region. Robust and adaptable drainage systems, with automatic fail-safes to activate pumps or emergency flood gates, can help reduce flood risk [**FL-2**, **FL-5**]. An approach that brings together multiple parties, including farmers, planners, and local agencies can create a well- supported flood risk reduction strategy [**FL-8**].

Emergency preparedness and communications to residents, including to socially vulnerable communities, will be critical to reduce flood risk [**FL-4**, **FL-6**]. Land use strategies will also be key to limit development in high-flood risk areas, and where necessary and possible, to relocate existing land uses [**FL-7**].


Construction crews working on removing an emergency drought salinity barrier in Contra Costa County

**Water Supply Reliability:** Strategies to manage water quality should be integrated with flood risk management, as flooding is likely to reduce water quality by introducing saltwater and other contaminants. Improved island levee management is as important for flood protection as for water quality. Severe subsidence will affect the gravity flow of water and require more active pumping, which can be expensive and less reliable. Strategies to improve or develop new water infrastructure in the Delta can improve water quality [**WSR-3**]. Salinity barriers can reduce saltwater intrusion, while updated dam and reservoir operations can manage flood risk and saltwater intrusion [**WSR-4**].

**Agriculture:** The Central Delta is agriculturally rich, but severe subsidence and groundwater rise create challenges for drainage, soil health, and water quality. Infrastructure costs for adapting to subsidence can be exorbitant, as can ongoing pumping costs to drain Delta islands, creating a financial strain for local farming operations. The agricultural economy, including farmers as well as their suppliers and local markets, could experience a downturn if these issues are not adequately addressed. Exposed peat soils also contribute to GHG emissions. Key adaptation opportunities include strategies to reverse subsidence, such as re-wetting soils through practices like rice planting, which can support healthier soils and reduce emissions [**AG-1**]. Other strategies can include retiring marginal land to allow for wetting for subsidence reversal [**AG-4**].

**Ecosystem:** Similarly, ecosystem challenges in the Central Delta are deeply tied to subsidence and water quality, requiring carefully designed and integrated interventions. Should ecosystems on deeply subsided islands flood, they may transition to open water if not reclaimed. Priority strategies for ecosystem resilience focus on subsidence halting and reversal projects, including mosaic projects, as illustrated by the Delta Islands Adaptation planning process [**ECO-1**, **ECO-2**]. Adaptation strategies for this region include only non-tidal ecosystem types to avoid affecting water quality due to changed tidal exchange patterns and potential salinity intrusion. Meeting water quality standards can help sustain aquatic life, plant species, and the overall ecological balance.

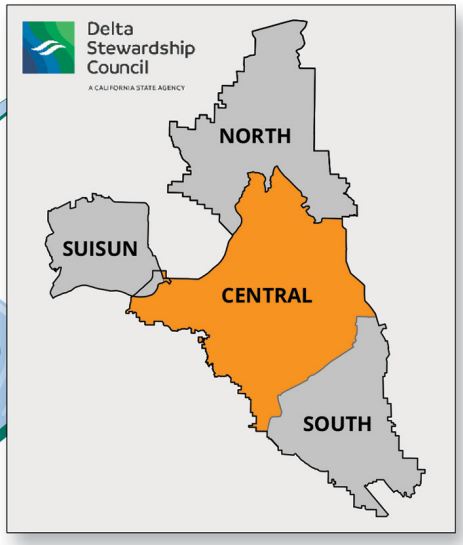
**Key Implementation Partners:** Delta Conservancy, SACOG, SJCOG, Contra Costa County, San Joaquin County, Sacramento County, City of Antioch, City of Pittsburg, tribal governments and communities with cultural ties to and Traditional Knowledge of the Central Delta, Central Delta Water Agency, Sacramento Metropolitan Air Quality Management District, Bay Area Air Quality Management District, San Joaquin Valley Air Pollution Control District, SJAFCA.

An operational vineyard will be preserved at the Dutch Slough Tidal Habitat Restoration Project

# Central Delta

## IMPLEMENTATION ROADMAP

*Severe subsidence is a core challenge for flood risks, farming, and ecosystems*




### WATER SUPPLY

**Key Adaptation Consideration**

Flood management and subsidence reversal practices can benefit water quality.

**Key Adaptation Strategies**

- Improve or develop new water infrastructure (WSR-3)
- Install salinity barriers (WSR-3)
- Modify upstream reservoir operations (WSR-4)

### FLOOD RISK

**Key Adaptation Considerations**

High flood risk due to deep subsidence. Legacy communities have high social vulnerability.

**Key Adaptation Strategies**

- Improve and modernize levees (FL-2)
- Habitat restoration as flood buffers (FL-3)
- Halt or reverse subsidence (ECO-2)
- Improve emergency preparedness (FL-4)
- Communicate flood risks (FL-6)

### AGRICULTURE

**Key Adaptation Consideration**

Subsidence impacts water quality, drainage, and soil quality for farmers, with high pumping costs.

**Key Adaptation Strategies**

- Soil-carbon sequestration and rice planting to reverse subsidence and increase soil health (AG-1)
- Retire marginal land for subsidence reversal (AG-4)

### ECOSYSTEM

**Key Adaptation Consideration**

Carefully designed ecosystem strategies to benefit water quality and subsidence reversal.

**Key Adaptation Strategies**

- Restore habitats in the Delta and its watershed (ECO-1)
- Halt or reverse subsidence (ECO-2)

**Figure 8-2** Central Delta Implementation Roadmap

## 8.3 South Delta

The South Delta is in San Joaquin County and hosts the pumping plants for the SWP and CVP. As such, this area is critical to maintaining water supply for the Bay Area, Central Coast, Central Valley, and Southern California. The San Joaquin River runs through the South Delta, and changes to the volume and timing of its peak flows will have important impacts for ecosystems, communities, and agricultural lands. Compared to the North Delta, the South Delta is home to fewer rural residents and communities. Agricultural operations have changed significantly over the past decades, as high-labor crops have been replaced by more mechanized crops.

**Flood Risk:** The South Delta bears the brunt of the flood risk in the Delta, as a result of various factors such as sea level rise and reduced channel capacity due to sedimentation and invasive aquatic plants. Levees along the San Joaquin River system are riverine, like those in the North Delta, but face higher flood risks. Strategies should fortify and improve levee infrastructure, combined with emergency preparedness measures such as real-time levee monitoring to provide immediate data on structural integrity [**FL-2**]. Levee improvement costs are the highest in this region when compared to the rest of the Delta. However, there is still a key role for nature-based solutions. For example, wetlands can and should be used to provide natural barriers by absorbing floodwaters while offering environmental benefits [**FL-3**].

Looking southeast at a section of the San Joaquin River

**Water Supply Reliability:** Like other Delta regions, water supply reliability and quality are closely tied with flood risk management. Flood protection strategies will likely benefit water quality and supply. Clogged, sedimented channels may necessitate dredging or additional pumping, increasing costs for water supply and delivery. Priority strategies focus on improving or building new water infrastructure and updating water quality standards. [**WSR-3**, **WSR-5**].

**Agriculture:** Notwithstanding flood risk, South Delta growers generally agree that salinity management is the biggest challenge facing the long-term sustainability of farming in the South Delta. Poor water supply reliability can have severe repercussions for agriculture, such as failed crops, increased costs, and economic stress. Invasive hyacinths can also impact irrigation systems. Effective salinity management may require advanced irrigation techniques and soil treatments to repair damaged soils, or even transitioning to salt-tolerant crops [**AG-1**]. Long-term strategies may include repurposing some agricultural lands for other uses, such as solar farms, dry irrigation, water basin recharge, or upland habitat restoration to benefit local ecosystems [**AG-3**, **AG-4**].

**Ecosystems:** Dominated by privately owned agricultural lands, the South Delta has fewer readily available opportunities for large-scale restoration projects. Partnerships with private landowners to incentivize restoration or wildlife-friendly practices will be important [**ECO-3**]. The region also offers opportunities to develop restoration projects for many habitat types, including various terrestrial types, riparian, non-tidal wetlands, and open and recreational multi-use spaces near communities [**ECO-4**]. Paradise Cut is an example of a relatively large- scale project in the South Delta that would benefit the ecosystem while also reducing flood risk. This project has been under consideration for many years, and with support could finalize planning and move to implementation.

**Key Implementation Partners:** SJCOG, San Joaquin County, City of Stockton, tribal governments and communities with cultural ties to and Traditional Knowledge of the South Delta, SJAFCA, San Joaquin Valley Air Pollution Control District.

San Luis Reservoir in Merced County

# South Delta

## IMPLEMENTATION ROADMAP

*Critical to water supply for California*


### WATER SUPPLY

**Key Adaptation Consideration**

Flood protection for the State Water Project and Central Valley Project will benefit water supply and quality.

**Key Adaptation Strategies**

- Dredge or pump clogged, sedimented channels
- Improve or build new water infrastructure (WSR-3)
- Update water quality standards (WSR-5)

### FLOOD RISK

**Key Adaptation Consideration**

High flood risk due to sea level rise and channel sedimentation.

**Key Adaptation Strategies**

- Improve and modernize levees and emergency preparedness measures (FL-2 and FL-4)
  - Nature-based solutions (FL-3)

### AGRICULTURE

**Key Adaptation Consideration**

Salinity management and poor water quality are key challenges.

**Key Adaptation Strategies**

- Expand climate-smart agricultural practices (AG-1)
- Diversify income opportunities on working lands (AG-3)
- Support wetting for subsidence reversal or wetland conversion on marginal farm lands (AG-4)

### ECOSYSTEM

**Key Adaptation Consideration**

Partnerships are key to restoration due to high share of privately owned lands.

**Key Adaptation Strategies**

- Partner with tribes to restore tribal access (ECO-1, ECO-3)
- Incentivize ecosystem-friendly land management practices (ECO-3)
- Implement nature-based solutions to protect developed areas (ECO-4)

**Figure 8-3** South Delta Implementation Roadmap

## 8.4 Suisun Marsh

West of the Delta, the Suisun Marsh primarily consists of managed wetlands and serves as a transition zone from fresh riverine water to saltwater. Hunting and wildlife viewing make up a key part of the recreational economy and culture of the Marsh, and significant portions of the Marsh are owned by private landowners and managed for duck hunting.

**Flooding:** Sea level rise poses the predominant threat for flooding in Suisun Marsh, and persistent flooding of managed wetlands will negatively impact habitat for endangered species. However, to date, flooding has been driven by weather conditions and limited levee maintenance. Soils here can only support relatively shorter levees and corresponding flood protection, and do nothing to protect against groundwater rise. Establishing flows upstream of the Delta to mobilize sediment can support restoration. In addition, the brackish environment accumulates organic matter and increases ground elevation faster than in saline wetlands. Restoring ecosystems, including tidal wetlands, can help to buffer against coastal flooding and provide natural habitats [**FL-3**, **ECO-1**]. Advisory and community working groups for the Suisun Landscapes Project (Vaughn et al. 2024; see **Section 2.1 Outreach and Engagement Summary**) noted that they are interested in better understanding how to prioritize levee maintenance investments to take a more proactive approach, rather than conducting reactive post-flood levee repairs [**FL-2**].

**Water Supply Reliability:** Saltwater intrusion into water supplies is a key concern. Tidal expansion could likely increase salt water in the Marsh, while climate change will also affect salinity concentrations; for example, prolonged droughts could reduce freshwater flows into the Marsh. Water quality in Suisun Marsh is primarily managed through the Suisun Marsh Salinity Control Gates. Gate operations should be coordinated with local communities. Modifying or updating operations of the SWP and other upstream reservoirs to adapt to changes in runoff patterns can support water flows throughout the Delta, including Suisun Marsh [**WSR-4**]. Another key component to this is updating Delta water quality standards to improve flows and maintain water quality [**WSR-5**].

**Agriculture:** While hunting and wildlife viewing have historically been important components of Suisun Marsh, private duck club ownership has declined over the years due to levee failures, lands returning to tidal wetlands, and land purchases by agencies. Invasive species also challenge agriculture in the Marsh, as their removal tactics can be costly and very intensive. As such, strategies to diversify economic and revenue-generating activities on grazing lands and duck clubs can help support landowners while achieving other goals such as restoration, carbon sequestration, and ecosystem services [**AG-3**]. Such strategies could include, for example, increased fee-based recreation, carbon credits, or agrivoltaics (where appropriate).

Grizzly Island wildlife area in Solano County

**Ecosystem:** Suisun Marsh is designated as an Important Bird Area of global importance. The Marsh is also home to many other important species, such as the endangered salt marsh harvest mouse, which are likely to be further affected by sea level rise and flooding. Potential strategies include implementing enhanced wetland management and identifying and protecting upland transition zone habitat on suitable public and private lands, such as creating migration space for future tidal wetlands and marshes [**ECO-1**]. Restoration actions should also balance other objectives in the Suisun Marsh Plan and SMPP, and align with updates to the SMPP to incorporate climate change concerns for the Marsh [**ECO-1**]. Strategies will also need to evaluate potential impacts to the tidal prism and effects on other areas in the Marsh and Delta. Ideally, strategies will restore contiguous parcels to support enhanced habitat management and reduced impacts to adjacent parcels that are not restored. However, climate change will likely make it more challenging to manage tradeoffs between competing Marsh management objectives, for example, for waterfowl, reversing or halting subsidence, fish, and salinity management, increasing dissolved oxygen levels in water, and decreasing methylmercury production.

Suisun Marsh ecosystems are further stressed by Phragmites australis, a highly invasive reed grass whose population in Suisun Marsh has increased by 325 percent between 1999 and 2015 (DWR 2019). Phragmites can degrade habitat quality, increase tidal habitat elevations, and out-compete native plants that support native wildlife, including the salt marsh harvest mouse and waterfowl. Left uncontrolled, Phragmites can reverse the ecological benefits of restoration, but it may also have benefits, such as providing a refuge from extreme heat (California Sea Grant 2022). Thus, its overall impact on the Suisun Marsh should be assessed to determine appropriate management strategies.

**Key Implementation Partners:** Tribal governments and communities with cultural ties to and Traditional Knowledge of Suisun Marsh, BCDC, State Coastal Commission, Solano County, Suisun City, Suisun RCD, San Francisco Estuary Partnership, the Nature Conservancy, SFEI, Ducks Unlimited, Audubon Society, San Francisco State University.

Broadmoor Island in Solano County

# Suisun Marsh

## IMPLEMENTATION ROADMAP

*Estuarine wetlands support wildlife and recreation*


### WATER SUPPLY

**Key Adaptation Consideration**

Saltwater intrusion and drought can increase salinity concentrations, deteriorating water quality.

**Key Adaptation Strategies**

- Coordinate Suisun Marsh Salinity Control gate operations with communities (WSR-3)
- Modify upstream reservoir operations (WSR-4)
- Update water quality standards (WSR-5)

### FLOOD RISK

**Key Adaptation Considerations**

Sea level rise-related flooding can permanently impact habitats.

**Key Adaptation Strategies**

- Establish upstream flows to mobilize sediment and support restoration (ECO-1)
- Restore ecosystems, including tidal wetlands (FL-3, ECO-1)
- Improve and modernize levees (FL-2)

### AGRICULTURE

**Key Adaptation Consideration**

Invasive species, levee failures, and tidal wetland expansion are challenges for agriculture and duck clubs.

**Key Adaptation Strategies**

- Diversify income opportunities on grazing lands and duck clubs to support landowners and achieve ecosystem goals (AG-3)

### ECOSYSTEM

**Key Adaptation Consideration**

Suisun Marsh supports birds of global importance and other endangered species.

**Key Adaptation Strategies**

- Enhance wetland management and protect upland transition zone habitats (ECO-1)
- Incorporate climate change into other Suisun Marsh plans and goals (ECO-1)

**Figure 8-4** Suisun Marsh Implementation Roadmap

## 8.5 Out-of-Delta

Climate change impacts and activities upstream, both within and beyond the Sacramento and San Joaquin River watersheds, directly affect the Delta and Suisun Marsh. For example, reduced Sierra Nevada snowpack, shifts in the timing of snowmelt, and increased winter precipitation falling as rain instead of snow will all affect upstream reservoir management and consequently the amount of flows in the Delta throughout the year.

Critically, the most effective strategies for water supply management and flood risk reduction are those implemented outside of the Delta, both upstream and downstream. Upstream strategies to manage floodwaters, such as through increased surface water storage and groundwater aquifer recharge, can also benefit local water supply by reducing reliance on the Delta's tributary waters [**WSR-2**]. Reservoir management regimes can be updated to incorporate functional flow parameters (e.g., fall pulse, wet-season base, peak magnitude, spring recession, and dry-season base flows). Upstream habitat restoration can also facilitate water storage in natural lands, such as mountain meadows, which can help buffer flood impacts by releasing water more slowly. Other habitat types, including oak woodlands and floodplains, also have more opportunity areas upstream of the Delta than within the Delta or Suisun Marsh.

Downstream of the Delta, agricultural water users that rely on CVP and SWP exports may experience economic loss from reduced agricultural production and groundwater replacement costs. Municipal and industrial water users will likely also be affected. Out-of-Delta water strategies can support greater water supply self-reliance by increasing storage or supporting conservation [**WSR-1**]. For agriculture, expanding the market for Delta-grown rice can help bring additional economic demand to support Delta rice cultivation [**AG-2**].

**Key Implementation Partners:** USBR, USGS, California Native American tribes and tribal communities, Central Valley Joint Venture, upstream water agencies

The Delta's watershed extends into the Sierra Nevada mountains

## 8.6 Cross-cutting Themes

As the strategies were developed for each primary focus area, several common themes surfaced. Recognizing these cross-cutting themes can increase collaboration across topic areas and learning from similar experiences. Cross-cutting themes identified during development of the strategies include:

- **The need to promote multi-benefit projects** appears in flood risk reduction (**FL-3**, **FL-9**), ecosystem (**ECO-1**, **ECO-2**, **ECO-3**, **ECO-4**), agriculture (**AG-3** and **AG-4**), and water supply reliability (**WSR-3**) strategies.
- **Sustainable soil and sediment management** is discussed in the ecosystem (**ECO-1** and **ECO-2**), agriculture (**AG-1** and **AG-4**), and water supply reliability (**WSR-3**) strategies, as this practice promotes resilient agriculture and brings environmental benefits, including increased capacity of soil to hold water.
- **Halting or reversing subsidence** through prioritization of projects, streamlined regulations, and incentives is critical to regional adaptation. Actions supporting subsidence reversal are included in ecosystem (**ECO-2**), agriculture (**AG-3** and **AG-4**), and flood risk reduction (**FL-3**, **FL-5**, and **FL-8**) strategies.
- **Actions that improve flow management and regulation** are discussed in flood risk reduction (**FL-5** and **FL-9**), ecosystem (**ECO-1**), agriculture (**AG-4**), and water supply reliability (**WSR-1**, **WSR-2**, **WSR-3**, **WSR-4**, and **WSR-5**) strategies, as flows can affect storage capacity, water quality, habitat, and overall flood risk.
- **Actions that reimagine land use** support flood risk reduction (**FL-1**, **FL-2**, **FL-7**, and **FL-8**), ecosystem (**ECO-3**), and agriculture (**AG-4**) strategies, as land use planning can have a significant impact on regional resilience.
- **Regulatory burden and the need to streamline approval processes** are components of the flood risk reduction (**FL-3**), ecosystem (**ECO-3**), and water supply reliability (**WSR-2**) strategies. The need for improved governance, collaboration, partnership, and equity in both process and outcome are discussed more in **Chapter 10.**
- **Best available science should be integrated into all strategies.** The broad science needs called for in several strategies should adaptively inform the update of plans, policies, regulations, standards, and guidance related to adaptation actions.

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Chapter 9

# Costs and Benefits of Adaptation

The strategies mapped out in Delta Adapts will require significant investment. This chapter describes the benefits and costs of adaptation and the funding needed, with a focus on proposed levee improvement and ecosystem restoration strategies. The costs of implementing these levee improvement and ecosystem restoration actions are estimated to range from $5.7 billion to $8.5 billion over a 30-year period. **The scale of funding needed over the next 30 years is greater than what has historically been allocated to Delta levee and ecosystem enhancements, indicating that multiple new sources will be needed.**

The social, economic, and environmental benefits of preparing the Delta for climate change are documented throughout this Adaptation Plan and the CCVA (DSC 2021a). When considering the level of funding needed, **it is important to acknowledge that implementing proposed adaptation projects is more cost effective than taking no action and risking the value of the assets – and the communities and ecosystems they protect or serve – to future climate hazards** as well as associated emergency response and recovery costs. For instance, while levee improvements are estimated to cost $3.24 billion to $3.34 billion, these costs are just a fraction of the value of the assets and economic activity at risk: $22 billion in assets and over $5 billion in annual economic activity could be to be exposed to flooding in 2085 if improvements are not made.

# 9.1 Costs and Benefits of Adaptation

## 9.1.1 Costs

The cost analysis in Delta Adapts focuses on levee improvement and ecosystem restoration strategies (**FL-2**, **ECO-1**, **ECO-2**) because they are major sources of capital costs associated with implementing this plan. However, funding will also be needed to implement the water supply, conveyance, and agricultural strategies in this plan. For example, funding is needed to support projects at the local level that promote water supply resilience such as storage, stormwater capture, recycled water use, water use efficiency, and salinity barriers/gates (**FL-5**, **FL-9**, **WSR-1**, **WSR-2**, **WSR-3**). This chapter neither quantitatively outlines those investments, nor does it quantify every major investment in the region related to adaptation.

Council staff evaluated potential funding needs to implement a range of levee improvement and ecosystem restoration actions in the Delta to address climate change vulnerabilities through 2050 (DSC 2023):

- Estimates include the costs associated with planning, designing, permitting, and constructing levee and ecosystem enhancements.
- Levee improvement costs focus on required crest raising to accommodate projected water level increases in the Delta as a result of sea level rise and changes in watershed hydrology (as evaluated in the CCVA). The climate adaptation costs do not include projected costs to bring existing levees up to Bulletin 192-82 standards, but recognize that ongoing investments are required for most levees to meet these standards, and assume that those improvements have already been made by the time climate change adaptation actions are undertaken.
- Council staff also evaluated a number of potential future land use scenarios in the Delta that included restoration, ranging from approximately 60,000 to 80,000 acres (inclusive of restoration completed since 2007) throughout the Delta and Suisun Marsh (DSC 2023).

Levee improvements at the Natomas East Main Drainage Canal in Sacramento County

Based on these evaluations, Council staff estimated adaptation costs by region (**Table 9-1**) for a range of potential levee improvement and ecosystem restoration scenarios, as follows (DSC 2023):

- Levee improvement costs to address future flood risk through 2050: $3.24 to $3.34 billion
- Ecosystem restoration costs to meet Delta Plan targets and increase ecosystem resilience to climate change: $2.51 to $5.19 billion.

Similar adaptation costing analyses have been done for other regions. For example, a similar effort, focused on funding required to protect the San Francisco Bay's shoreline from flooding, was undertaken by BCDC and the Metropolitan Transportation Commission (Metropolitan Transportation Commission et al. 2023).

While the flood risk reduction strategies in Delta Adapts are intended to address flood risk projected through 2050, the timing and severity of climate change impacts and weather extremes are inherently dynamic and subject to change due to uncertainty associated with future GHG emission trajectories and other factors. As such, the scale and timelines for strategy implementation may need to be adjusted to maximize the benefits of adaptation, and associated costs and investments will also shift accordingly. This uncertainty also underscores the importance of continuing to invest in obtaining and applying the best available science to inform adaptation efforts. As the strategies in Delta Adapts are built out in more detail, the implementation approach should be adjusted to match the latest science. Nonetheless, investing in flood risk reductions and ecosystem improvements should have a wide range of ecosystem, social, and economic benefits that extend beyond 2050.

**Table 9-1** Estimated Adaptation Costs by Region for Delta Adapts Levee Improvements and Ecosystem Restoration (from DSC 2023)

| Region | Levee Improvement | Ecosystem Restoration |
|---|---|---|
| North Delta | $34M | $761M to $1.57B |
| Central Delta | $552M to $594M | $1.03B to $2.13B |
| South Delta | $2.56B | $141M to $292M |
| Suisun Marsh | $89M to $144M | $577M to $1.19B |
| **Total** | **$3.24B to $3.34B** | **$2.51B to $5.19B** |
| **Combined Total** | **$5.7B to $8.5B** | |

Note: "M" = million and "B" = billion

### 9.1.2 Benefits of Climate Change Adaptation

**The benefits of adaptation, considering the cost of inaction, will likely far outweigh the cost of implementing proactive adaptation actions.** Research has shown that investing in proactive resilience and preparedness actions reduces the cost of recovery after disasters (U.S. Chamber of Commerce et al. 2024). Climate adaptation strategies can reduce risk and avoid costly damages while simultaneously maximizing co-benefits (Fuldauer et al. 2022). For example, a recent study found that every $1 spent on climate resilience and preparedness in the Sacramento area results in $10.80 in economic savings, including reduced damages, cleanup costs, and economic impacts (U.S. Chamber of Commerce 2024).

Potential benefits of adaptation are likely to accrue to ecosystems, local economies, infrastructure, and communities, including socially vulnerable communities. The CCVA identified the people and assets in the Delta, including monetary value of those assets, that would be exposed to flooding from levee overtopping under future climate scenarios, if no levee improvements are made (DSC 2021a). Implementing no improvements to Delta levees through 2050 would expose approximately 10 percent of the Delta's population (including more than 42,000 residents who live in areas with high social vulnerability), 33 percent of Delta land, and 148,000 acres of agriculture to flooding from levee overtopping during a 100-year event. This represents more than $10 billion in agricultural, residential, commercial, and infrastructure assets and nearly $2 billion in annual economic activity. These figures will double by 2085, when approximately 21 percent of the Delta's population (including 71,200 residents in areas with high social vulnerability), 68 percent of Delta land totaling $22 billion in assets, and over $5 billion in annual economic activity may be exposed to flooding.

Analyses of levee improvements for individual islands conducted as part of Delta Adapts found that most islands showed benefits from protection that far exceed the costs of increased protection, indicating that the economic benefits of levee improvements generally outweigh the costs (DSC 2023). This analysis involved calculating the benefit-cost ratio for each island, considering factors like the monetary benefits of reduced flood risk and asset protection against the estimated improvement costs. The analysis prioritized islands where levee enhancements would be most cost-effective, especially under a hypothetical scenario with limited funding of only $2 billion, which identified those islands with the highest returns on investment for allocation.

While placing a value on maintaining and improving the Delta's ecosystem may appear to be difficult, there are methods for doing so. For example, the California Water Commission provided economic valuation factors to be included for evaluating proposals to the Water Storage Investment Program through Proposition 1 (2014) general obligation bond funds (California Water Commission 2016). Several applicants quantified ecosystem benefits from changes in water conditions from those projects. Another example is a study conducted by the Trust for Public Land (TPL) on behalf of the East Bay Regional Park District (district) that linked "local and regional economies, and parks and open space" (TPL 2017). For example, the study found that open spaces and parks in the district provide about $500 million annually by supporting natural functions, tourism, recreation, habitat, and other services. The study also found that residential properties have more value if they are within 1,500 feet of district lands, and

recreational activities on the district's 120,000 acres of lands provide healthcare cost savings of $20 million annually for nearly 60,000 visitors who would not otherwise engage in physical activity. The study was the twelfth such conducted by TPL. A global review of the cost-effectiveness of nature-based solutions for disaster risk and climate adaptation publications showed that nearly all studies have found nature-based solutions to be cost-effective and more effective than engineering-based solutions at attenuating hazards (Vicarelli et al. 2024).

## 9.2 Additional Costs and Financial Considerations

While the analysis in this chapter is limited in scope and focuses on the costs for implementing two specific types of adaptation strategies – levee improvements and ecosystem restoration – the comprehensive, regional adaptation approach outlined in Delta Adapts will exceed these costs and new sources of revenue will be required.

Federal, state, and local government funding has historically helped build and maintain a range of projects in the Delta involving flood and water management, ecosystem restoration, land reclamation, saltwater intrusion, conservation, planning, research, public education, and more. Looking ahead, federal, state, and local governments and private partners will need to explore a mix of new revenue-generating mechanisms to implement the strategies outlined in this Plan.

By 2050, the in-Delta economic activity at risk from climate change could amount to $2 billion annually, with $10 billion in exposed assets (DSC 2021a). The SWP delivers water to 27 million Californians and the CVP supplies water to the largest agricultural economy in the world. More than half of Delta ecosystems, home to many unique species, could be flooded or otherwise damaged or lost. Delta communities, including socially vulnerable communities, and tribes with cultural ties to the Delta, also risk losing their homes, livelihoods, and heritage to the impacts of climate change. While the expected economic damages are unknowable because of the uncertain effects from climate change, the amount of value to society exposed to those hazards is enormous. However, **the longer climate adaptation is delayed, the higher the price tag will be**, both in terms of what is at risk and the costs of taking action, as many strategies take time to plan, permit, fund, and construct. Nature-based solutions, additionally, take time to reach their full potential.

It will require time, effort, and funding to carry out the actions in this plan. The pace of implementation will depend upon the feasibility and availability of resources and competing priorities across federal, state, and local partners. Implementation may require new and existing funding mechanisms, innovative approaches, and collaborative partnerships.

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# Chapter 10 Governance

## 10.1 Governance in the Delta

Governance has many meanings, but in the context of Delta Adapts, governance refers to the structures, organizations, and policies for managing ecosystems and natural resources. Climate change governance encompasses the decision-making systems occurring across individuals, organizations, and agencies to manage climate mitigation and adaptation (Jänicke 2017). Governance determines the process by which organizations plan, fund, implement, and manage climate adaptation, within existing and evolving legal frameworks and authorities. Understanding the current governance structures in the Delta can help identify the actors and processes critical to advancing adaptation, as well as potential barriers.

Climate change governance in the Delta has historically been distributed across authorities, agencies, non-governmental actors, and policies, and across many resource areas, including flooding, heat, water resources, and human health. With over 230 agencies, institutions, and interested parties involved in water and environmental management in the Delta, differing interests and often conflicting visions can lead to institutional fragmentation and slow decision-making processes (Luoma 2015; Rudnick et al. 2025). The distributed governance system increases the demand for coordination, engagement, and collaboration across many actors, which can be costly in terms of both time and staff resources (Andersson and Ostrom 2008). A complete review of Delta governance, characterizing the key processes and structures operating in the system and how this has evolved over time, can be found in Rudnick et al. 2025.

Collaboration on climate adaptation is occurring in the Delta, albeit in a variety of formats and frequencies. Pozzi et al.'s (2025) adaptation practitioner survey shows some examples of the types of collaboration happening in the Delta (**Figure 10-1**).

To facilitate an effective, more equitable climate adaptation process, governance should: 1) extend beyond government agencies and regulated sectors to include robust, inclusive engagement with the public, including communities that have historically

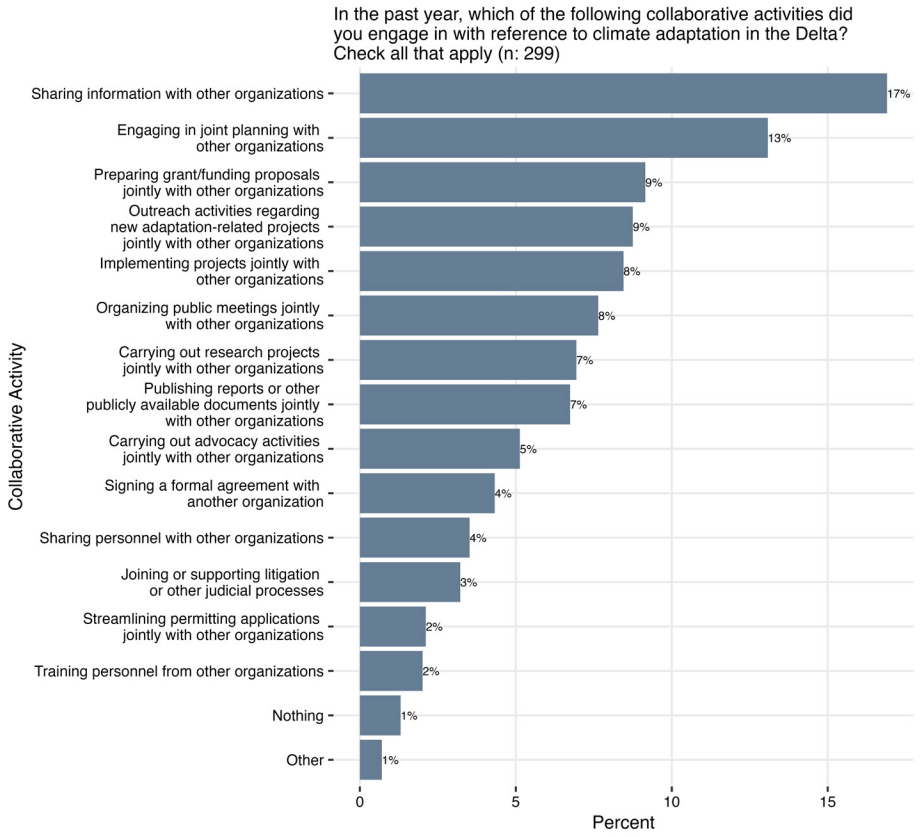


**Figure 10-1** Distribution of Delta adaptation collaborative activities (Pozzi et al. 2025)

been excluded from the public process; 2) incorporate best practices in outreach and education; and 3) adopt an adaptive management framework to monitor, evaluate, and adjust policies and strategies based on environmental changes and evolving understanding. This chapter begins by describing historical governance in the Delta and existing challenges, before describing best practices for participatory governance, outreach and education, and adaptive management.

### 10.1.1 Historical and Existing Factors Affecting Delta Governance

Multiple layers of historical and current intersecting policy processes, programs, and regulations drive governance and decision-making in the Delta (Rudnick et al. 2025). Historically, land development and water rights through the settlement and development of the Delta have altered ecosystems, diverted flows, channelized and leveed rivers, and drained wetlands. These landscape-scale changes are evident today and affect governance, economics, agriculture, land use, and climate hazard exposure. The construction of major water storage and distribution systems, the CVP and SWP, significantly altered water distribution in California and resulted in the present-day statewide water reliance on

the Delta. This has in turn affected water availability and water quality in the Delta itself, which is addressed by water quality regulations that manage salinity and contaminant inflow, with goals of protecting ecosystems (e.g., preventing algal blooms and protect species) and human uses (e.g., drinking water, clean water for fishing and swimming). The Bay-Delta Water Quality Control Plan, last updated in 2018 for the Lower San Joaquin River/Southern Delta system with another update underway by the SWRCB for the Sacramento River/Delta system, establishes water quality control measures and flow requirements to protect the Bay-Delta watershed and its beneficial uses.

Various state and federal regulations and programs also intersect in Delta management and governance, including the federal and state Endangered Species Acts (ESAs) and the Delta Conservancy's restoration work. Formed in 1994, CALFED brought together state and federal agencies to coordinate on the operations of the CVP and SWP, implement the state and federal ESAs, and support ecosystem health. CALFED was the governance structure for the Delta until its dissolution, at which time the State Legislature commissioned the Delta Vision Blue Ribbon Taskforce to develop a better strategy for managing the Delta to support both ecological function and sustainable economic development. These recommendations led the Legislature to pass the Delta Reform Act (2009) which established the Council and the Sacramento-San Joaquin Delta Conservancy to achieve the coequal goals while safeguarding the unique characteristics of the Delta as an evolving place. The Council was created as independent agency with authority, responsibility, accountability, scientific support, and funding to support management of the Delta to advance the state's coequal goals, in part by directing efforts across state agencies (Water Code § 85001(c) and 85020(h)).

Relatively new governance considerations include sea level rise adaptation efforts in the San Francisco Bay, largely coordinated by BCDC under its Bay Adapt initiative. Sea level rise also has implications for salinity management in the Delta, affecting salinity barrier operations, water usage petitions during drought periods, and more permanent regulations. Finally, GHG emission reduction regulations can also incentivize nature-based solutions and carbon sequestration, like the state's Natural and Working Lands Climate Smart Strategy and the Delta Conservancy's Delta Carbon Program. Moreover, a CARB-authorized compliance market for wetland carbon credits could provide higher prices than the voluntary market and make appropriate wetland restoration more economically attractive.

### 10.1.2 Existing Governance Challenges

The distributed governance system in the Delta, with a high number of state, federal, and local agencies active on intersecting policy areas as well as multiple non-governmental actors, requires a correspondingly high level of coordination and collaboration (Heikkila 2018). This can result in **high coordination transaction costs** in time, staff (including loss of staff expertise due to turnover), and resources, and can extend timelines for decision-making (Lubell et al. 2016).

Additional barriers can arise when agencies have **competing interests**, potentially arising from limited public resources. Water agencies, for example, may have different goals than CNRA. Moreover, some agencies may have clear **jurisdiction** over one issue area or strategy type (e.g., flood management agencies and levee improvement projects), but may require partnerships with multiple agencies to fund and permit implementation projects (e.g., the Army

Corps of Engineers, local air districts, cities, and counties). Other issue areas may lack clear ownership or have many potential authorities (e.g., sea level rise, water supply reliability) across jurisdictions, and thus require a high level of coordination to plan, develop, fund, permit, and implement solutions. Pozzi et al. (2025) identified barriers to working collaboratively on climate adaptation using a survey of adaptation practitioners working in the Delta (**Figure 10-2**). Top barriers included insufficient financial resources, competing visions for adaptation pathways, adaptation not being a priority for the respondent's organization, limited capacity to acquire funding, and lack of political leadership.

When successful, coordination can lead to stronger projects that address multiple concerns, are trusted and supported by local communities, and have potential funding pathways. The Council was created in part to facilitate coordination among agencies while advancing the coequal goals. The Council, among other agencies, is making headway in organizing participants, aligning efforts, facilitating adaptation efforts, and avoiding duplication. However, challenges related to the Delta are constantly evolving, requiring new solutions. The accelerating pace of climate impacts means that delays will increase impact costs (e.g., ecosystem degradation, reduced water quality, and flood damage), which are likely to be borne by the wider society, particularly within vulnerable communities. Both extended coordination timelines and higher impact costs lead to higher adaptation costs. Coordinating across multiple actors in a timely manner to avoid the worst climate impacts while simultaneously advancing the best science and piloting adaptation solutions is a governance challenge the Council faces today.

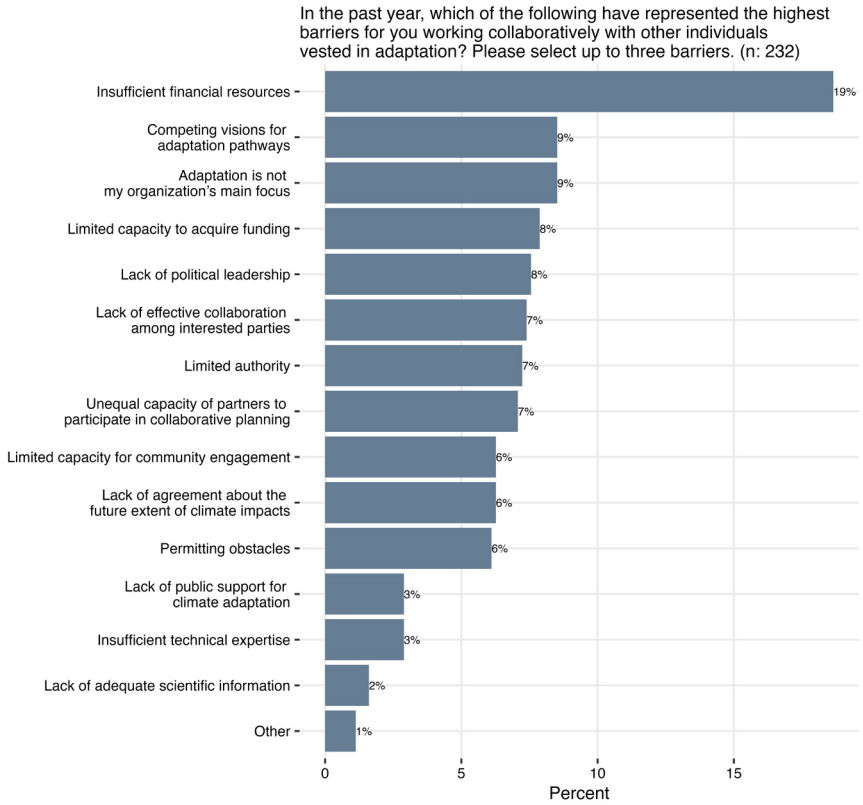


**Figure 10-2** Distribution of barriers to working on collaborative climate adaptation in the Delta, as reported by survey respondents (Pozzi et al. 2025)

## 10.2 Barriers and Challenges for Participatory Governance

A justice-oriented approach to climate adaptation both acknowledges historic unequal resource allocation and exclusionary practices and addresses these deficiencies through programs that prioritize under-invested communities. Critically, a greater emphasis on participatory governance and inclusive engagement can help to avoid re-creating the same inequitable dynamics in power or resource distribution that led to the injustices existing today. In other words, procedural equity – inclusive, accessible, authentic engagement and representation in decision-making processes and planning – is a necessary step to distributional equity – the fair distribution of benefits and burdens across all segments of a community, prioritizing those with the greatest need (USDN 2014).

Historically, socially vulnerable communities and tribes have been excluded from planning and decision-making or have only been engaged through check-the-box exercises that can leave tribes and community members disillusioned or cynical about the governance and outreach process. Increasing equity and participation requires analyzing the governance process and considering questions such as: 1) Who is involved and represented in decision-making – and who is left out?; 2) Who benefits from decision-making – and who bears the cost?; and 3) What are the desired outcomes?

Through a series of interviews conducted with environmental justice groups and tribal interests in the Delta, Council staff identified challenges that limit participation of under-represented communities in public processes and governance in the Delta (for more information about these interviews, see the Council's Tribal and Environmental Justice Issue Paper (DSC 2025a) and the interview summary report (DSC 2022c)). Many CBOs and environmental justice organizations advocating on behalf of socially vulnerable communities report feeling frustrated that agencies do not adequately listen to or respond to their concerns. CBOs and tribes noted that, for example, they are not represented in water management decision-making, and the current water system results in unequal distribution of water and poor-quality water for Delta communities (DSC 2022c).

CBOs also noted various barriers associated with agencies not truly understanding the meaning of environmental justice. For example, some agencies interpreted environmental justice to only include people of color and lacked understanding of the other dimensions in which communities are privileged, disproportionately burdened by the environment, or excluded (e.g., low-income and unhoused communities). Agencies were also observed to lack accurate understanding of tribal sovereignty and applicable laws and do not always adequately train their staff that conduct tribal consultations. Finally, CBOs have also observed systemic racism and resistance to change as key barriers to making progress.

### Delta Residents Survey

*Key Takeaway*

When asked how likely they would be to engage in Delta issues, respondents said while they would vote or sign a petition, the majority would do little beyond that due to insufficient time, not feeling that their input would be affect decision-making, and not knowing how to engage.

## 10.3 Adaptive Management

While climate change is already affecting the Delta and the Suisun Marsh, it is challenging to predict the exact timing, intensity, and geographic extent of climate impacts. Climate change is typically modeled at 30-year timeframes, and the pace of climate change may accelerate or decelerate based on many factors. Other local and regional weather factors, such as the El Niño-Southern Oscillation, will also affect temperature and precipitation in California.

Due to these uncertainties and complexities, climate governance is often reactive – responding to impacts after they occur – rather than proactive (addressing risks and anticipated negative impacts before they occur) or transformative (incorporating broader, historic inequities and addressing processes and procedures) (Muiderman et al 2020, Morrison et al. 2019). However, reactive governance can be more expensive, in terms of damages and repairs as well as higher implementation costs. Reactive governance is also likely to be less equitable and not fully take advantage of opportunities to develop multi-benefit, holistic strategies and solutions (Morrison et al 2022). Thus, to increase both the resilience and equity of adaptation outcomes, as well as to lower overall costs (including both monetary and non-monetary costs such as human life, health, and ecosystem loss), governance approaches should shift from being reactive to proactive, with the goal of eventually adopting a transformative approach that views climate adaptation as an intersectional issue (Rudnick et al. 2025).

Adaptive governance emerges when governance systems facilitate ongoing and regular interactions and learning between vested actors and organizations (Folke et al. 2005; Chaffin et al. 2014). Adaptive management approaches can allow governance components like the structures (e.g., government agencies, non- governmental actors, organizations, forums), processes (e.g., participant interactions, monitoring and evaluation, decision-making), and laws, policies, and rules for managing ecosystems and natural resources to be more flexible and proactive. Structures include not only organizations, but forums and other collaborations that bring organizations together. For example, the Delta science enterprise is a collection of science forums that develop, synthesize, and communicate scientific knowledge for adaptive management across sectorial and organizational boundaries. Other Delta examples include DPIIC, the Interagency Adaptive Management Integration Team, and the Suisun Adaptive Management Advisory Team. Governance for adaptive management should provide a decision-making structure that fosters communication between scientific experts and decisionmakers, and take a balanced approach to involving interested actors (DSC 2013 **Delta Plan Appendix C**). Entities responsible for enacting strategies in this Plan should seek these types of structures to communicate and seek feedback.

## Delta Plan Connection

### *What is Adaptive Management?*

Adaptive management—the process of evaluation, monitoring, coordination, and science-based decision-making—can help to drive the transition to more proactive and eventually transformative governance approaches. Adaptive management is defined in the Delta Reform Act as a framework and flexible decision-making process for ongoing knowledge acquisition, monitoring, and evaluation leading to continuous improvements in management planning (Water Code, § 85052 et seq.). Adaptive management is a pillar of the Council's work. The Delta Plan requires that ecosystem restoration and water management projects include adaptive management components. As required in the Delta Reform Act, the Delta Science Program coordinates and consults with Delta agencies to promote science-based adaptive management. It does this through convening the Interagency Adaptive Management Integration Team, consulting directly with project proponents to provide advice on their adaptive management efforts, and hosting Adaptive Management Forums every two years, among other efforts. Since the Council was created in 2009 and the original Delta Plan adopted in 2013, our understanding of effective adaptive management approaches has increased significantly, but we continue to learn and grow in understanding. Adaptive management provides Delta Adapts an iterative approach to support more effective strategy implementation in three stages: plan, do, and evaluate and respond. Council staff will use this approach by tracking implementation of adaptation strategies and re-evaluating them as needed.


Climate Change Vulnerability and Adaptation Summit at the California Museum (2019)

Pozzi et al.'s (2025) work on adaptation governance in the Delta revealed that the Delta Adapts initiative operates much like a regional climate collaborative (Pozzi et al. 2025). **Figure 10-3** provides an overview of how climate collaboratives are connected in the Delta. Delta Adapts, as shown in the network diagram below, connects a significant portion of the adaptation practitioners working in the Delta region. Pozzi's work consisted of 49 interviews with adaptation practitioners and 299 survey respondents. Interviewees mentioned participation in 94 different collaborative initiatives ranging in focus, formality, and geographic scope. From that list, 15 initiatives were identified as formal collaboratives working on climate change adaptation issues within the Delta specifically. Of those, Delta Adapts ranked the highest in terms of participation. These findings illustrate the opportunity for Delta Adapts to leverage its existing influence to help connect groups working on adaptation in the Delta.

Processes to support adaptative management can take many forms, including coordination and collaboration, data monitoring and technical analysis, information exchange and education, engagement and outreach, networking, and funding. To enhance equity, all these components should be updated to adopt best practices for inclusive participation.

Adaptive management can build capacity within a governance system for learning and change by providing critical sources of information, tools, and resources to support learning and collaboration. Coordination is another key component as it minimizes knowledge and information fragmentation and can facilitate the alignment of diverse perspectives and interests toward a common goal. The Delta Science Program's Adaptive Management Unit builds capacity for adaptive management in the Delta by providing early consultations with project proponents to help develop better adaptive management plans, coordinating several interagency adaptive management working groups, and convening regular Adaptive Management Forums.

Notably, many of the challenges of adaptive management are similar to existing governance challenges. Sufficient funding and staff capacity are required to systemically monitor and evaluate strategy effectiveness over time and facilitate ongoing coordination, information sharing, and outreach. Equitable participation particularly demands thoughtful leadership, resources, time, and funding. Other barriers to adaptive management noted in the Delta Plan include limited buy-in from interested parties and rigid permitting requirements.

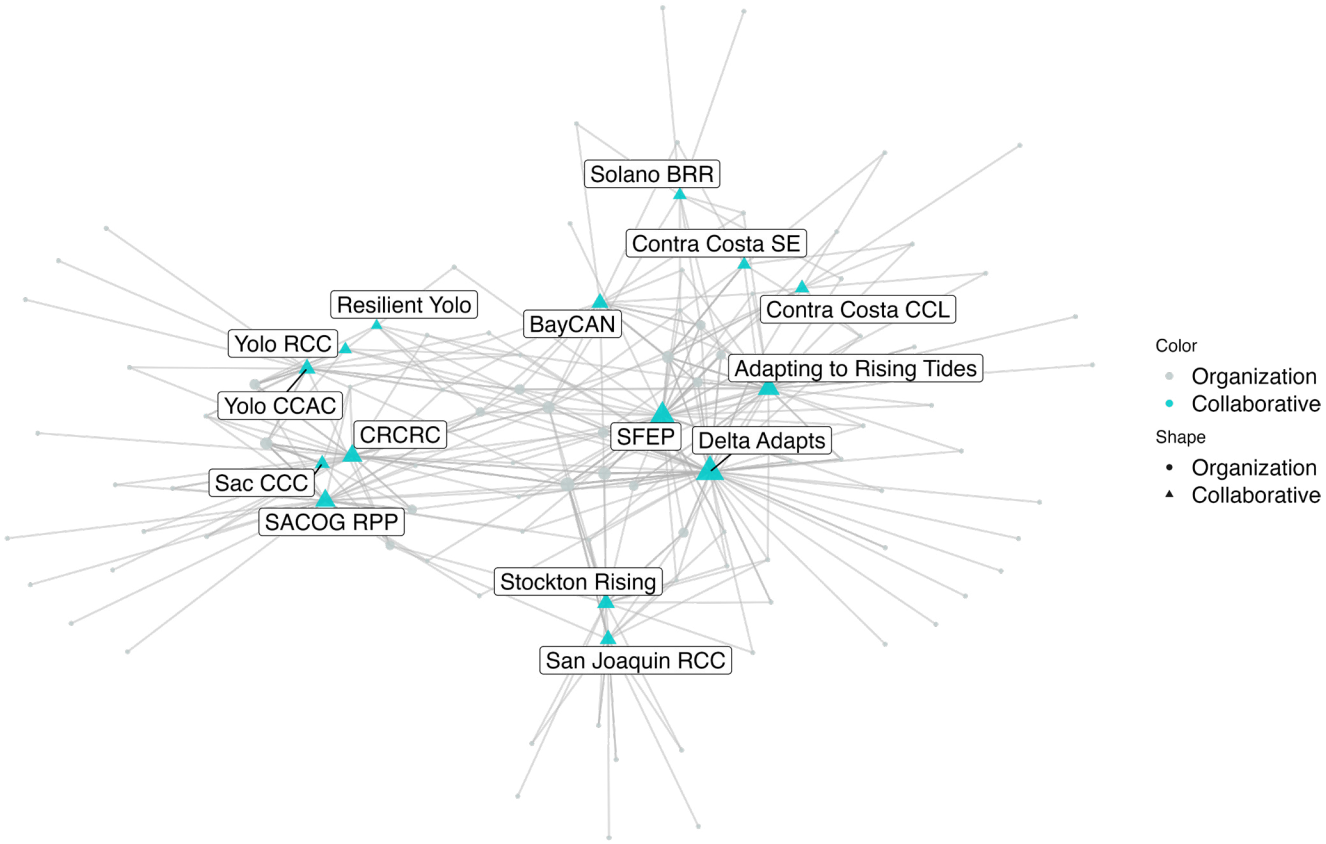


**Figure 10-3** Network plot illustrating climate adaptation collaborative forum participation in the Delta and connections between each collaborative group/initiative, including connections with Delta Adapts (Pozzi et al. 2025).

## 10.4 Best Practices for Successful Representation and Participation in Governance

Best practices for participatory governance, outreach and education, and adaptive management can support greater procedural equity and meaningful participation throughout the governance process. The goal of these best practices is to assist interested parties, especially planning and implementing agencies, to develop governance processes that are equitable and inclusive of all community members. Greater representation can diversify the perspectives included in governance and remove the disconnect between different frameworks of knowledge (e.g., Traditional Knowledge, lived experiences, scientific research, etc.).

The following best practices have been identified through the Delta Science Program's 2023 Adaptive Management Forum (DSC 2025b), the 2023 Delta Residents Survey (Rudnick et al. 2023), and through interviews with environmental justice organizations conducted for the Council's Tribal and Environmental Justice Issue Paper. The best practices below are integrated throughout the adaptation strategies. Adaptation strategies that demonstrate these best practices are noted in text as examples.

### 10.4.1 Increasing Participation from Diverse Perspectives

- **Relationship and trust-building must come first:** During interviews, participants explained that tribes and tribal and environmental justice communities have a long history of being disenfranchised by government, so trust must be rebuilt. Authentic engagement, trust building, and relationship development require time, commitment, and intentionality. Early and repeated interactions and establishing relationships demonstrate commitment and can encourage participation and buy-in to engagement processes. A foundational step is to recognize and respect different modes of knowledge and experiences. For example, the agricultural adaptation strategies will involve trust building with farmers, especially small farms and socially disadvantaged farmers, to implement [**AG-1**, **AG-2**, **AG-3**, **AG-4**].
- **Bring groups in as early as possible:** Bring tribes and tribal and environmental justice communities into decision-making and adaptive management processes as early as possible [**ECO-1**, **ECO-3**]. Build in tribal consultation, community engagement, and equity as part of initial project design and scoping, not as an afterthought, so communities have ample opportunity to provide early and frequent review and feedback over the entire scope.

- **Work with and through trusted community partners that are embedded in the community** [**FL-6**]: Make connections with trusted partners from the communities in which they work. Partnerships with CBOs and community leaders can lead to more successful outreach and education. These trusted individuals understand their audiences and can develop messaging, events, programming, and channels that resonate with the community. CBOs can also help agencies avoid faux pas or unintentionally alienating audience members, such as holding a workshop on a cultural holiday or failing to recognize past traumas. Local governments and public agencies that work at the regional and local scales can also be embedded in the community and take leading roles in engagement. For example, the Delta Conservancy is well suited to support farmers in the Delta who are potentially interested in land retirement [**AG-4**].
- **Meet communities on their terms and actively listen to community concerns:** Agency staff should come out to tribes and communities to meet people in their spaces and experience their events and ways of life. This could include taking tours of communities or significant sites and listening to community concerns, and hosting or attending smaller group meetings to allow for "true dialogue".
- **Pay tribes and CBOs for their time and expertise,** including time spent providing consultation and information to agencies, reviewing documents and plans, participating in committees, and supporting agency outreach and engagement initiatives. Events and meetings should recognize and respect participants' time and availability, take place in accessible locations, and be culturally appropriate. Event organization and facilitation best practices include providing translation and interpretation, subsidizing travel expenses, compensating participants for their time, and providing refreshments and childcare.
- **If incorporating Traditional Knowledge,** follow best practices and fully respect the rights of tribes [**ECO-1**, **ECO-3**]. Agencies interested in working with Indigenous communities on Traditional Knowledge should do so in an equitable, collaborative, and mutually beneficial way that respects the rights of tribes and recognizes Traditional Knowledge holders as experts. Recognize tribal data sovereignty, meaning that Traditional Knowledge belongs to the tribe and the knowledge holder. Obtain "free prior and informed consent" prior to using Traditional Knowledge, where tribes clearly understand how their data and information will be shared and used. Provide training for agency staff working with Indigenous communities so that staff understand the significance of Traditional Knowledge, recognize that information shared with government agencies can be subject to public records release requests, and identify approaches to protect confidential Traditional Knowledge. To learn more about working with Indigenous communities on Traditional Knowledge, please see the *Guidelines for Considering Traditional Knowledges in Climate Change Initiatives* (2014), developed by the Climate and Traditional Knowledges Workgroup, and the *CARE Principles for Indigenous Data Governance from the Global Indigenous Data Alliance* (Caroll, S, et al. 2020).

- **Tailor messaging:** Each tribe and tribal or local community is different, and it is important to tailor outreach content, timing, and format to meet the unique needs and conditions of the community, which local partners can help to do [**FL-6**]. Organizations recommend meeting people where they are and addressing immediate issues first before asking people to care about other topics. Further, agencies should be able to present issues in ways that resonate with the audience, without jargon and technical language.
- **Provide assistance on engagement:** The processes and procedures of government and public engagement can be unfamiliar, rigid, and opaque. Tribes and tribal or local communities may not know which agencies to approach for different issues, or the appropriate channels of communication. Agencies can work with tribal representatives and CBOs to provide training on the best ways to engage on different issues, including identifying relevant agencies, processes, and available opportunities to voice opinions (e.g., commenting on draft public documents, providing oral public comments, participating in a workshop or interview). Additionally, agencies can also simplify their processes, extend timelines, or otherwise support more inclusive access. Foundationally, agencies could consider simplifying documents, plans, forms, and other materials to be understandable to non-technical, diverse audiences (across ages, education level, background knowledge), especially if community feedback is desired.
- **Consider multiple formats for engagement,** recognizing that some will prefer in-person events, while others may prefer or need to participate virtually [**FL-6**]. Multiple formats of online engagement should be considered. Live events allow for dialogue and questions, but short surveys, polls, and social media are likely to reach a wider audience, demand less commitment, and have lower barriers for participation.
- **Follow through:** Many tribes, tribal communities, and environmental justice communities have been invited to one-time engagement events held only to fulfill outreach requirements and never hear back from the organizing agency again, which can lead to disillusionment or cynicism about the public participation process. Engagement must move beyond a "box-checking" exercise. While government planning processes may take time for tribal consultation and public input to be carried through, agencies should be clear, honest, and transparent on how input will be used and on project timelines.

### 10.4.2 Overcoming Delta Agency Governance Challenges

Delta Adapts should continue to connect groups working on adaptation in the Delta, and should consider becoming a more formal regional climate collaborative, focusing on climate action with equity embedded. The DPIIC should be engaged to help advance actions in this Plan.

- **Consider members of tribes and environmental justice groups for government-appointed positions** to place them in positions of authority and decision-making. Amend legislation to require tribal and environmental justice involvement in decision-making processes. Note that tribes should take the lead in determining the best processes to select representation for various decision-making groups. Some tribes lack federal recognition and may face additional barriers to accessing resources.
- **Goals, metrics, objectives, understandings, and areas of concern should reflect the diverse perspectives in the Delta.** When drafting and adopting guiding principles, objectives, definitions, and priorities, agencies should conduct equitable outreach efforts to ensure that draft and final versions incorporate representative perspectives from all Delta communities. This should include the selection of metrics to measure change and track progress, which all interested parties should agree upon. Additionally, agencies should review goals, principles, and other guidance that have been adopted previously without consultation or inclusive participation. When possible, this should be remedied, e.g., at the next scheduled update. For example, [**ECO-3-2**] and [**ECO-3**] emphasize partnering with community groups and tribes to identify and implement shared nature-based solutions, and [**FL-4**] and [**FL-5**] recommend working with local agencies to identify flood risk management solutions consistent with the best available science and emergency response practices.

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# Chapter 11 Conclusions and Next Steps

Historically and to the present day, the Delta has been a meeting point for California waters, peoples, and ecosystems. The Delta is a refuge for critical fish and migrating bird species, a sacred sanctuary for tribes and tribal communities' culture, and the source of clean water for the state's agricultural industry that feeds much of California, the U.S., and the world. As such, protecting the Delta from the impacts of climate change has benefits and consequences for all Californians, including natural and human communities far beyond the Delta. At the same time, protecting the Delta as a unique place, inclusive of its communities, tribal and agricultural heritage, is a foundational consideration for the coequal goals set forth in the Delta Reform Act.

The strategies and actions outlined in Delta Adapts provide a first step toward adapting the Delta to climate change impacts, including elevated flood risks, more variable precipitation, rising seas and salinity, severe droughts, and extreme heat, while recognizing that a significant funding gap remains toward implementing these strategies.

Implementing the strategies recommended by Delta Adapts will require new levels of collaboration and coordination between state, federal, regional, and local agencies, tribes and tribal communities, academia, non-profit organizations, landowners, and residents to align priorities and goals and develop a shared vision for the Delta. As participants have recommended throughout the outreach process, a holistic, systemic approach to adaptation will be the most effective, but this requires conversations and commitments from all interested parties.

As the convener of Delta Adapts, the Council has a core role to play in bringing together partners – both old and new – to coordinate efforts, align visions, and outline pathways to implement the strategies laid out in this plan. Moving forward, we will work collaboratively with partners, and within forums, such as DPIIC and regional climate collaboratives, to accomplish the strategies and actions laid out in this plan. Council staff will convene these parties to memorialize our collective commitment to implementing Delta Adapts and assign specific roles to agency partners. Throughout the implementation phase we will hold periodic meetings to collaborate and track progress.

Council staff also intend to review the Delta Plan to identify opportunities to interweave the strategies and implementing actions identified in this Adaptation Plan, along with considerations of social vulnerability, tribal and environmental justice, justice equity diversity and inclusion, climate change risk communications, and other aspects of recent Council initiatives. Potential amendments to the Delta Plan could include new chapters, policies, recommendations, and performance measures used to guide and track progress related to these efforts.

Critically, these efforts should aim to uplift the perspectives from communities that have historically been excluded from decision-making processes, including tribes and socially vulnerable communities, and enable them to participate in Delta governance and decision-making. By centering equity and prioritizing the needs of the Delta's most vulnerable residents, we can achieve a more resilient, safer Delta for all Californians.

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# Chapter 13 Glossary

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| **10-Year Event** | An event that has a 10 percent chance of occurrence each year. |
| **50-Year Event** | An event that has a 2 percent chance of occurrence each year. |
| **100-Year Event** | An event that has a 1 percent chance of occurrence each year. |
| **200-Year Event** | An event that has a 0.5 percent chance of occurrence each year. |
| **Adaptation, Climate Change** | A change or the process of change to adjust to current or future expected climate change and its effects. |
| **Adaptive Capacity** | The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences to maintain functionality or well-being. |
| **Adaptive Management** | A framework and flexible decision-making process for ongoing knowledge acquisition, monitoring, and evaluation leading to continuous improvement in management planning and implementation of a project to achieve specified objectives (23 CCR Section 5001). |
| **Agricultural** | Cultivated lands, including croplands and orchards. |
| **Aquifer Recharge** | A process where water is conveyed underground to replenish groundwater stored in aquifers. |
| **Atmospheric Rivers** | Relatively narrow regions in the atmosphere that are responsible for most of the transport of water vapor from the tropics. |
| **Best Available Science** | Using the best available scientific data to guide key decisions. The Council has a regulatory policy, G P1(b)(3), with six criteria for this term: relevance, inclusiveness, objectivity, transparency and openness, timeliness, and peer review. Delta Plan Appendix 1A specifically includes Traditional Knowledge as a source of best available science. |
| **Biodiversity** | The variety of living organisms in a particular habitat or ecosystem. |
| **Brackish Water** | Slightly saline water; more salinity than freshwater, but not as much as seawater. |

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| **CalSim Model** | CalSim is a water resources planning model, jointly developed by DWR and the Mid-Pacific Region of the USBR, to simulate operations of the SWP and the CVP and much of the water resources infrastructure in the Central Valley of California and the Sacramento-San Joaquin Delta region. |
| **Central Valley Project (CVP)** | Federal power and water management project in California devised in 1933 that consists of a network of dams, reservoirs, canals, hydroelectric powerplants and other facilities. |
| **Climate Change** | Any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). Climate change may result from (1) natural factors, including changes in the sun's intensity or changes in the Earth's orbit around the sun, (2) natural processes within the climate system (such as changes in ocean circulation), or (3) human activities that change the composition of the atmosphere (for example, through burning fossil fuels) and land surfaces (for example, deforestation, reforestation, urbanization, and desertification). |
| **Climate Hazard** | The potential occurrence of a natural or human-induced physical event that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, and environmental resources. In this report, the term refers to climate-related physical events or their physical impacts. |
| **Climate Stressor** | An event or trend, often not climate-related, that has an important effect on the system exposed and can increase vulnerability to climate-related risk |
| **Climate-Smart Farming Practices** | Approaches and techniques that aim to sustainably increase agricultural productivity, adapt, and build resilience in agricultural and food security systems, and reduce GHG emissions. |
| **Coequal Goals** | Mission of the Delta Stewardship Council: “Coequal goals means the two goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place” (DSC 2025c). |
| **Community-based organization** | Non-profit organizations that organize, advocate for, and/or provide services to specific populations and communities. |
| **Consequence** | Illustrates the extent of potential impacts or losses that could occur for the asset, population, or greater region if exposure to a hazard occurs |

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| **Conveyance** | The movement of water from one place to another. Conveyance infrastructure includes natural water courses as well as canals, pipelines, and control structures including weirs. Examples of natural water courses include streams, rivers, and groundwater aquifers. Conveyance facilities range in size from small, local, end-user distribution systems to large systems that deliver water to or drain areas covering multiple hydrologic regions. Conveyance facilities require associated infrastructure including pumping plants, power supply, diversion structures, fish ladders, and fish screens. |
| **Cultural Resources** | Tangible remains of past human activity that may include buildings, structures, prehistoric sites, historic or prehistoric objects, sites, or landscapes that are important to a culture or community. |
| **Delta Adapts** | The Delta Stewardship Council's comprehensive, regional approach to climate resilience that cuts across regional boundaries and commits to collaboration across state, local, and regional levels through the development of a vulnerability assessment and adaptation strategy. |
| **Delta Plan** | The state of California's comprehensive, long-term, legally enforceable plan to achieve the coequal goals of a reliable stateside water supply and a protected, restored Delta ecosystem in a manner that preserves the values of the Delta as a place. |
| **Delta Reform Act** | 2009 bill, SBX7 1, passed by the California Legislature to create the Delta Stewardship Council and address water supply reliability and ecosystem health in the Sacramento-San Joaquin River Delta. |
| **Disadvantaged Communities** | Areas with higher proportions of people with low income, low levels of homeownership, high unemployment, sensitive populations, or low levels of educational attainment; often disproportionately affected by environmental pollution and other hazards that can lead to negative public health effects. |
| **Drought** | Hydrologic conditions during a defined period, greater than one dry year, when precipitation and runoff are much less than average. |
| **Ecosystem Services** | Ecosystem services are the economic benefits that society derives from ecosystem processes, such as pollination (which supports food production), primary production (which supports fisheries), soil formation (which builds land elevation and sequesters carbon), and water storage and regulation (which can mitigate flood peaks) among other relationships. The Delta's agricultural economy, and cultural and recreational traditions, depend on these processes derived from the continued functioning of the Delta and its connected ecosystems. |

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| **Ecosystem Restoration** | *See "Restoration."* |
| **Ecosystem Enhancement** | Ecosystem enhancement means "improving existing desirable habitat and natural processes" (23 CCR section 5001[o]). For example, enhancement includes flooding the Yolo Bypass more often to support native species or to expand or better connect existing habitat areas. Enhancement also includes many fish and wildlife management practices, such as managing wetlands for waterfowl production or shorebird habitat, installing fish screens to reduce entrainment of fish at water diversions, or removing barriers that block migration of fish to upstream spawning habitats (23 CCR section 5001[o]). |
| **Environmental Justice (EJ)** | The fair treatment and meaningful involvement of all people, regardless of race, culture, national origin, or income, in the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies as well as dedicated outreach and transparent opportunities for all community members to represent their concerns in the decision-making process. |
| **Equity** | Just and fair inclusion, which may acknowledge and make adjustments to address existing inequities or imbalances so that all can participate, prosper, and reach their full potential. |
| **Erosion** | The process of material being removed by water, wind, or other natural processes. |
| **Estuary** | A place where fresh and saltwater mix, such as a bay, salt marsh, or where a river enters an ocean. |
| **Exposure** | The state or process of being exposed or in contact, for example assets, populations, or resources that are within locations most likely to experience climate hazard impacts. |
| **Extreme Heat Day** | Day on which the maximum temperature exceeds the 90th percentile value calculated from a reference period in the same location. |
| **Flood Protection** | The act or technique of managing flood risk, such as from attenuating or containing flow with dams, levees, artificial channels, etc., to minimize the occurrence of flooding in certain areas. |
| **Floodplain** | An area of low-lying ground adjacent to a river, formed mainly of river sediments and subject to flooding. |
| **Greenhouse Gas (GHG)** | Gas that absorbs and admits energy within the thermal infrared range and contributes to climate change. |

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| **Green Infrastructure** | Natural and semi-natural areas that mimic natural processes while providing useful services that would otherwise be provided by constructed or "gray infrastructure." |
| **Habitat Restoration** | The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning the majority of natural functions to the lost or degraded native habitat. |
| **Habitat Transition** | In the context of climate change, habitat transition refers to the alteration of environmental conditions that causes species to shift their habitat range in order to meet their ecological requirements. |
| **Hydrology** | Branch of science concerned with the properties of the water, and especially its movement in relation to land. |
| **Intertidal Habitat** | An ecosystem located on marine shorelines, where an array of organisms inhabits the shore and adapt to fluctuations between high and low tides. |
| **Invasive Species** | Species that establish and reproduce rapidly outside of their native range and may threaten the diversity or abundance of native species through competition for resources, predation, parasitism, hybridization with native populations, introduction of pathogens, or physical or chemical alteration of the invaded habitat. |
| **Isolated Conveyance** | Isolated conveyance involves the movement of water using new points of diversion within the Sacramento-San Joaquin Delta. For example, constructing new intake points in the Delta and transporting water directly from those points to other locations without relying on existing infrastructure. |
| **Land Reclamation** | The process to recover land through channelization and levee construction of what was previously marsh land. |
| **Legacy Community** | Residential, commercial, processing, and retail centers of the Delta that resonate with its history and culture. Legacy communities include Bethel Island, Clarksburg, Courtland, Freeport, Hood, Isleton, Knightsen, Rio Vista, Ryde, Locke, and Walnut Grove (Public Resources Code, § 32301). |
| **Levee** | An embankment built to prevent the overflow of a river. |
| **Levee Seepage** | Levee seepage occurs when water moves away from the river channel, either below or through the levee and surrounding land surface. |
| **Levee Toe** | The edge of a levee where the base meets the natural ground. |

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| **Managed Wetland** | Areas that are intentionally flooded and managed during specific seasonal periods, often for recreational uses such as duck clubs. |
| **Marshland** | Vegetated wetland covered with grasses, sedges, and rushes. |
| **Mitigation** | The action of reducing the severity or compensating for the effect, for example protecting habitat when another area will be affected by a project. |
| **Multi-Cropping** | An agricultural practice where two or more crops are grown simultaneously on the same piece of land during one year, rather than cultivating just a single crop. |
| **Overtopping** | An event when water flows over the top of a levee. |
| **Redlining** | Redlining was the practice of designating certain areas as a financial risk and therefore ineligible for federal mortgages in the US, or otherwise systematically denying services to certain areas based on race or ethnicity. It was an explicitly race-based classification system that enabled systemic discrimination, on the part of the federal government, against Black and other homebuyers of color, and has left lasting negative impacts today. |
| **Refugia** | An area of relatively unaltered climate that is inhabited by plants and animals during a period of climatic change. |
| **Resilience** | The capacity of an entity – an individual, a community, an organization, or a natural system – to recover from shocks and stresses, and to adapt and grow from a disruptive experience. |
| **Restoration** | The application of ecological principles to restore a degraded or fragmented ecosystem and return it to a condition in which its biological and structural components achieve a close approximation of its natural potential, taking into consideration the physical changes that have occurred in the past and the future impact of climate change and sea level rise (CA Water Code § 85066). |
| **Riparian** | Related to or situated along or near the banks of a river. |
| **Runoff** | The flow of water (or substances carried in it) from the surface of an area of land over the surface. |
| **Sacramento-San Joaquin Delta** | An expansive inland river delta and estuary in Northern California, characterized by extensive agricultural cultivation. |
| **Saltwater Intrusion** | The movement of saline water into freshwater aquifers or waterways, which can lead to water quality degradation, including drinking water sources impacts and other consequences. |

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| **Sea Level Rise** | An increase in the level of the world's oceans due to the effects of global climate change (melting ice, thermal expansion, etc.). |
| **Seepage** | Water passing through or under a levee. |
| **Sensitivity** | Describes characteristics that make an asset or population susceptible to harm from climate hazards. |
| **Setback Levee** | A new levee constructed behind an existing levee which allows for removal of a portion of the existing levee and creation of additional floodplain connected to the stream. In the Delta, a "setback levee" may not necessarily result in removal of the existing levee. |
| **Snowpack** | In the context of water supply, snowpack refers to the accumulation of snow within higher elevations of the Delta watershed over the course of a winter season. When the snowpack melts, it releases water into rivers and reservoirs. |
| **Social Vulnerability Index** | Analysis through which the characteristics that affect people's sensitivity and adaptive capacity to climate change are captured quantitatively at the community level. |
| **State Water Project (SWP)** | A water storage and delivery system of reservoirs, aqueducts, power plants and pumping plants managed by DWR, which collects water from rivers in northern California and redistributes to other parts of the state. |
| **Subsidence** | Gradual sinking of an area due to land management practices such as groundwater pumping or agricultural cultivation, which causes oxidation and loss of organic soils material. |
| **Subtidal Habitat** | The area permanently submerged beneath a tidally-varying water surface. |
| **Through-Delta Conveyance** | Through-delta conveyance does not involve new intakes in the Delta. Instead, it focuses on improving or maintaining conveyance capacity through the existing waterways within the Delta. |
| **Traditional Knowledge** | "…a body of observations, oral and written knowledge, innovations, practices, and beliefs that promote sustainability and the responsible stewardship of cultural and natural resources through relationships between humans and their landscapes. [It] cannot be separated from the people inextricably connected to that knowledge. It applies to phenomena across biological, physical, social, cultural, and spiritual systems. Indigenous Peoples have developed their knowledge systems over millennia, and continue to do so based on evidence acquired through direct contact with the environment, long-term experiences, extensive observations, lessons, and skills" (Daniel et al., 2022). These systems of knowledge can improve the understanding of climate change vulnerability and strengthen climate adaptation strategies (CTKW 2014). |

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| **Tree Canopy Gap** | In the context of low-income communities, the tree canopy gap refers to the disproportionate lack of tree cover in these neighborhoods compared to wealthier areas. |
| **Tule** | A sedge native to wetlands and marshes in California. |
| **Urban Area** | A developed area in which there are 10,000 residents or more. Urban areas in California require 200-year flood protection. |
| **Vulnerability** | How easily something or someone can be harmed. In Delta Adapts, vulnerability is specifically defined as the intersection of *exposure* to climate hazards, *sensitivity* to those hazards, and *adaptive capacity* (or the ability to recover from and adapt to climate hazards). |
| **Vulnerability Assessment** | Describes how and why assets, populations, or resources can be expected to be affected by climate hazards. |
| **Vulnerable Populations** | Populations which experience heightened risk and increased sensitivity to climate change and have less capacity and fewer resources to cope with, adapt to, or recover from climate impacts. These disproportionate effects are caused by physical (built and environmental), social, political, and/or economic factor(s), which are exacerbated by climate impacts. These factors include, but are not limited to, race, class, sexual orientation and identification, national origin, and income inequality (LCI 2018a). |
| **Watershed** | An area or ridge of land that separates waters flowing to different rivers, basins, or seas. |
| **Water Quality** | Chemical, physical, biological, bacteriological, radiological, and other properties and characteristics of water which affect its use (Water Code § 13050). |
| **Water Quality Objectives** | The limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area (Water Code § 13050). |
| **Water Quality Standard** | State-adopted and EPA-approved ambient standards for water bodies. The standards prescribe the use of the water body and establish the water quality criteria that must be met to protect designated uses. |
| **Water Supply Infrastructure** | Conveyance or other facilities, such as pipelines and channels, pumps, siphons, gates, and associated infrastructure used to divert, store, and treat freshwater. |

# Appendices

## Appendix A - Agencies with Climate Change-Related Roles in the Delta

**Table A-1** Agencies with Climate Change-Related Roles in the Delta

| Agency Type | List of Agencies |
|---|---|
| Federal Agencies | Federal Emergency Management Agency (FEMA) |
| | Federal Energy Regulatory Commission (FERC) |
| | National Oceanic and Atmospheric Administration (NOAA) |
| | U.S. Army Corps of Engineers (USACE) |
| | U.S. Environmental Protection Agency (EPA) |
| | U.S. Department of the Interior (USDOI) |
| | U.S. Fish and Wildlife Service (USFWS) |
| | U.S. Geological Survey (USGS) |
| | U.S. Bureau of Reclamation (USBR) |
| State Agencies | Department of Fish and Wildlife (CDFW) |
| | Department of Food and Agriculture (CDFA) |
| | Department of Public Health (CDPH) |
| | Department of Transportation (Caltrans) |
| | Department of Water Resources (DWR) |
| | Department of Conservation (DOC) |
| | California Energy Commission (CEC) |
| | California Natural Resources Agency (CNRA) |
| | Public Utilities Commission (CPUC) |
| | Central Valley Flood Protection Board (CVFPB) |
| | California Strategic Growth Council (SGC) |
| | Delta Protection Commission (DPC) |
| | Delta Stewardship Council (Council) |

**Table A-1** Agencies with Climate Change Related Roles in the Delta (continued)

| Agency Type | List of Agencies |
|---|---|
| State Agencies (continued) | Governor's Office of Emergency Services (CalOES) |
| | Governor's Office of Land Use and Climate Innovation (LCI) |
| | Ocean Protection Council (OPC) |
| | Sacramento San Joaquin Delta Conservancy (Delta Conservancy) |
| | San Francisco Bay Conservation and Development Commission (BCDC) |
| | State Water Resources Control Board (SWRCB) |
| Regional Agencies | Sacramento Area Council of Governments (SACOG) |
| | Sacramento Metropolitan Air Quality Management District (SMAQMD) |
| | Yolo–Solano Air Pollution Control District (YSAPCD) |
| | San Joaquin Council of Governments (SJCOG) |
| | San Joaquin Valley Air Pollution Control District (SJVAPCD) |
| | Metropolitan Transportation Commission (MTC) |
| | Association of Bay Area Governments (ABAG) |
| | Bay Area Air Quality Management District (BAAQMD) |
| Local Agencies | West Sacramento Area Flood Control Agency (WSAFCA) |
| | Sacramento Area Flood Control Agency (SAFCA) |
| | San Joaquin Area Flood Control Agency (SJAFCA) |
| | North Delta Water Agency (NDWA) |
| | Central Delta Water Agency (CDWA) |
| | South Delta Water Agency (SDWA) |
| | Local Reclamation Districts |
| | Cities and Counties |

# Appendix B - Community Engagement Summary Fall 2023–2025

From fall 2023 to early 2025, Council staff participated in 36 events and meetings (**Table B-1**). These events were primarily local community events but also included agency/interagency meetings and other events. Staff participation at these events was intended to raise awareness of the Council's Delta Adapts Adaptation Plan and Tribal and Environmental Justice Issue Paper and to receive additional input from community members, CBOs, and other agencies on climate and environmental justice issues that affect them and what they would like to see local and/or state governments prioritize to address those issues. The feedback from these discussions helped inform the development of the final Plan and will also inform implementation.

**Table B-1** Fall 2023–Early 2025 Outreach Events and Presentations

| Event | Month/Year |
|---|---|
| 2023 Delta Heritage Forum | November 2023 |
| Restore the Delta's Holiday Open House | December 2023 |
| Pittsburg Candy Cane Parade | December 2023 |
| Stockton AB 617 Community Steering Committee Meeting & HABs Subcommittee Meeting | February and May 2024 |
| Delta Stewardship Council Meeting | March 2024 |
| U.S. EPA Watershed Academy Webinar | March 2024 |
| Sacramento-San Joaquin Delta Conservancy Board Meeting | March 2024 |
| City of Pittsburg Community & Economic Development Sub-Committee Meeting | April 2024 |
| Conway Homes Resident Council Meeting | April 2024 |
| Contra Costa County Resilient Shoreline Committee Meeting | April 2024 |
| DWR Climate Change Matrix Meeting | April 2024 |
| Delta Independent Science Board Meeting | May 2024 |
| Rise Stockton Coalition Meeting | June 2024 |
| Honored Elders Day | June 2024 |
| Antioch City Council Meeting | June 2024 |

**Table B-1** Fall 2023–Early 2025 Outreach Events and Presentations (continued)

| Event | Month/Year of Event |
|---|---|
| SF Bay Conservation and Development Commission Meeting | June 2024 |
| Science for Communities Workshop | July 2024 |
| Antioch Movie Night | July 2024 |
| National Night Out at Yosemite Street Village | August 2024 |
| Bethel Island Municipal Advisory Council Meeting | September 2024 |
| Hood Community Council Meeting | September 2024 |
| Antioch Big Truck Day | September 2024 |
| Interagency Adaptive Management Integration Team Meeting | September 2024 |
| Native American Day | September 2024 |
| West Sacramento Cinema at Sundown | September 2024 |
| West Sacramento Arts in the Heart | October 2024 |
| Walnut Grove Rotary Club Meeting | October 2024 |
| 2024 Delta Heritage Forum | November 2024 |
| Delta Region Geological Hazard Abatement District Meeting in Isleton | November 2024 |
| Capital Region Climate Readiness Collaborative Meeting | December 2024 |
| California Natural Resources Agency Climate Leaders Meeting | January 2025 |
| Floodplain Management Association Luncheon Presentation | January 2025 |
| Suisun City Climate & Environment Committee Meeting | January 2025 |
| Delta Adapts Drop-In Discussion | January 2025 |
| University of Georgia Resilience Concepts, Methods, and Applications Course | March 2025 |

## Outreach formats

These 36 outreach events spanned a wide range of formats and locations, aiming to connect with diverse audiences, including the public, government agencies, and regional organizations.

- **Presentations:** Staff presented at in-person, virtual, and hybrid meetings such as Board and Council meetings, as invited. These presentations focused on updating interested parties about ongoing initiatives, with a focus on Delta Adapts and the Council's Tribal and Environmental Justice Issue Paper and seeking input regarding community priorities.
- **In-person tabling or "pop-ups":** Tabling at community events provided an opportunity for Council staff to engage with community members in informal settings within their communities. The events were useful in raising awareness about the Council in general, as many community members were not familiar with the Council. Key outreach events included tabling at existing community gatherings like the National Night Out at Yosemite Street Village in Stockton, Pittsburg's Candy Cane Parade, and Antioch's Big Truck Day. At these events, Council staff engaged with attendees on topics such as climate resilience, flood risk, and environmental justice, and provided educational activities for children, such as trivia and hands-on arts and crafts at events. Cultural events, such as the Honored Elders Day and Native American Day, allowed staff to directly engage with tribal members, providing an opportunity to advertise tribal consultation opportunities and discuss issues such as tribal land access and water quality.
- **Virtual courses:** The U.S. EPA Watershed Academy webinar and the University of Georgia engineering course both provided opportunities to share information and foster wider engagement on climate change and adaptation strategies, specifically nature-based solutions. These courses allowed community members, experts, and students to discuss important topics like water quality, nature-based solutions, and flood risks. In particular, the University of Georgia course provided an opportunity for engineering students to analyze specific Delta Adapts strategies of their choosing.
- The **Science for Communities Workshops**, hosted by the Council, facilitated hands-on discussions between CBOs, tribes, and scientists from various sectors on topics including safe consumption of Delta fish, HABs, and flood emergency housing needs of the Delta's legacy communities. These sessions resulted in actionable insights and the development of resources for further outreach and engagement with vulnerable populations.
- Informal drop-in event: The hybrid **Delta Adapts Drop-In Discussion** provided time for interested groups to ask questions about and provide verbal public comment on the draft adaptation plan.

## Key Takeaways:

The outreach events covered a range of critical issues related to climate adaptation. Discussions revealed both concerns and aspirations for implementing effective solutions to address these issues. Several key themes emerged from discussions with community members and other interested parties as described below. Most of the issues identified were consistent with the issues identified in other sources staff reviewed as part of the adaptation plan development.

### Governance and Communication:

- **Need for Localized Information:** Community members, especially those in rural and underserved areas, expressed a desire for more localized and accessible information on climate risks, including flood preparedness, water quality, and emergency response. Many attendees wanted clearer guidance on how this work can directly benefit their communities and specific actions that can be taken to improve resilience.
- **Council Role & Clarity:** At the Hood Community Council and Walnut Grove Rotary Club meetings, participants expressed confusion between the Council and other Delta agencies, emphasizing the importance of clarifying the role of the Council.
- **Funding:** Participants emphasized the need for targeted funding for specific efforts like salinity monitoring and levee maintenance and upgrades. Event participants highlighted the importance of increased funding for programs that support agricultural communities in the face of rising costs due to climate change. Participants also noted the importance of data-driven monitoring to evaluate adaptation effectiveness and progress.
- **Business and Industry Representation:** Some interested parties expressed concerns about the lack of industry involvement. They pointed out that businesses owning significant land in the Delta had not been adequately included in the planning process, underscoring the need for better representation of the private sector in future climate adaptation planning and implementation.
- **Need for More Multi-agency Collaboration and Alignment:** Many discussions advocated for increased agency and landowner involvement in the planning process to foster better coordination on climate adaptation. The importance of including the DPIIC in these efforts was also emphasized, along with the challenges of addressing boundary issues between local and state groups. Drop-in participants noted the need to highlight the role RCDs play in adaptation.
- **Community Awareness and Cultural Competency:** Discussions during the Hood Community Council meeting emphasized the importance of cultural awareness in planning and the need to recognize and address community concerns in planning processes. These conversations reinforced the need for inclusive planning that respects and acknowledges the specific needs of vulnerable communities. Additionally, attendees at the Science for Communities workshops emphasized the need for intersectionality between agency, academic researchers, and CBO staff to better understand how environmental and climate justice issues impact their work. Attendees also expressed the need for required trainings for agency and academic staff on diversity, equity, and inclusion, tribal cultural competency, integrating citizen science, and best practices for community and tribal data sovereignty, as well as more diverse research topics.

Lastly, attendees suggested state agency staff should work more closely with local governments to support local needs and address disconnects between how science is created and used.

### Water Supply and Quality:

- **Water Quality** for drinking water, tribal cultural uses, and recreational water uses in the Delta emerged as a concern, particularly at Honored Elders Day. Discussions at the DWR Climate Change Matrix Meeting, Science for Communities Workshops, and others emphasized water quality issues as well, especially HABs. Workshop participants discussed the need to increase public awareness about HABs, the need for more research on HABs and impacts on people, and the need for better understanding of HAB impacts on air quality. Workshop participants also highlighted mercury contamination and other emerging contaminants of concern (e.g., PFAS and microplastics) that might enter the food chain. Attendees shared other concerns related to water quality, such as salinity intrusion, aquatic invasive species, dissolved oxygen levels, and the negative impacts of poor water quality on drinking water and recreation.
- **Water Management:** Participants emphasized the need for more modernized and efficient water management technologies and policies to reduce reliance on Delta water exports in communities outside the Delta and improve regional water resilience. Multiple people shared concerns about the Delta Conveyance Project and potential impacts to their communities from construction, including to traffic, soils, odors, and flood risk.

### Agriculture:

- **Extreme Heat:** Agricultural groups expressed concerns about the impacts of extreme heat on crops and how climate change could exacerbate water shortages.
- **Land Subsidence:** The BCDC meeting included discussions on the environmental impact of subsidence in agricultural areas, highlighting concerns over the future of Delta farming. At the March 2024 Council meeting, attendees noted the need to better support socially disadvantaged farmers, with a focus on programs such as the Healthy Soils Program, including incentive grants aimed at improving water efficiency and carbon sequestration practices.
- **Representation:** There was a strong interest in ensuring that agricultural lands remain a critical part of the region's climate resilience plans, with agricultural interests well represented throughout the planning process.
- **Regulating Farmers:** Other issues brought up included the importance of farming in the Delta, but that overregulating farmers will make farming untenable.

### Flood Risk Reduction:

- **Flood Modeling:** The Contra Costa County Resilient Shoreline Committee Meeting focused heavily on flood modeling techniques, emphasizing the need for integrated strategies in adaptation planning, particularly around sea level rise and flood mitigation. Attendees at the Floodplain Management Association luncheon presentation acknowledged the importance of developing an open source 2-D model for the Delta.
- **Community-Centered Approaches:** Discussions highlighted the importance of engaging local communities in sea level rise and flood adaptation planning, with suggestions for fostering better communication channels and ensuring that outreach efforts help shape the design and implementation of adaptation initiatives.
- **Emphasis on Riverine Flooding:** Attendees at several meetings raised concerns that riverine flooding, particularly in the San Joaquin and Sacramento River systems, could pose a greater risk than sea level rise alone, prompting discussions around addressing both types of flood risks.
- **Flood Hazard Management:** Some attendees shared the need for better flood management actions, particularly along the San Joaquin River to better protect the cities of Stockton, Manteca, and Lathrop, such as through a Paradise Cut flood bypass. Attendees of the Bethel Island Municipal Advisory Council meeting presentation shared concerns about flood risks to new housing developments and existing roadways on the island, especially from water that can come up from beneath the soil. Delta Adapts Drop-In participants requested more nuanced discussions of the benefits of setback levees and where in the Delta they are or are not appropriate.
- **Emergency Preparedness and Information Dissemination:** At the Council's March 2024 meeting and the Delta Region GHAD meeting, there was a clear focus on improving flood preparedness, with calls for better emergency response systems and more effective communication methods, especially for vulnerable populations. Concerns were raised about the reliability of traditional communication methods, such as telephone landlines, during emergencies. Given concerns about timely flood risk information, developing more agile systems for disseminating real-time updates, particularly in emergencies, should be prioritized. Attendees at the Hood Community Council meeting noted that many residents do not speak English well and some do not have internet. These accessibility considerations are especially important when it comes to ensuring public safety in emergencies. Hood Community Council meeting attendees also shared concerns about roadway congestion and prompt emergency response. In response to past crises, some Council meeting attendees suggested developing flexible, scalable evacuation systems tailored to local community needs, ensuring better preparedness for future flood events. Delta Adapts Drop-In participants expressed the need to be clearer about the catastrophic consequences of inadequate recovery from floods.

### Other issues:

- **Environmental Health:** Many of the previously mentioned topics of extreme heat, water quality, and air quality were brought up as particular concerns during events with communities in rural and underserved areas. At the AB 617 Stockton Community Steering Committee meeting, participants discussed concerns about climate change impacts, noting the importance of educating residents about environmental issues and environmental justice, and meaningfully engaging with environmental justice communities. Hood Community Council meeting attendees noted that illegal dumping is a major pollution issue in Hood.
- **Environmental Literacy:** The call for improving environmental literacy, especially in underserved communities, was a recurring theme across events. Participants emphasized the need for clear, accessible information to help communities prepare for and respond to climate risks. Participants shared that engaging vulnerable populations in these discussions is critical for developing effective, equitable solutions that will protect all residents in the Delta.
- **Unhoused Populations:** Others highlighted how unhoused communities are highly vulnerable to heat waves and flooding from living along waterways.
- **Recreation:** Delta waterways should be made accessible for recreation for the public and specifically those with disabilities. Access to greenspace was raised as an issue at the Bethel Island Municipal Advisory Council meeting, as accessible local open spaces on Bethel Island are limited due to private land ownership.

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# Appendix C - Environmental Justice Expert Group

Council staff formed an Environmental Justice (EJ) Expert Group in June 2021 to inform the Council's EJ work and other Council-led initiatives, including Delta Adapts. This group was comprised of representatives from three CBOs and one tribal-serving organization that specialize in areas including community advocacy, building partnerships, tribal concerns, social and environmental sciences, and other topics related to the Delta. The EJ Expert Group convened periodically between June 2021 and June 2024 to review the Council's work related to outreach, metrics related to equity, and adaptation strategy language and equity considerations. Information on the former EJ Expert Group Members is included below.

EJ Expert Group Members:

**Sara Medina** is the Sustainable Agriculture & Land Manager at Restore the Delta, a nonprofit based in Stockton that works to empower community members to have a direct impact on water management decisions in the Delta through public education and outreach. **Barbara Barrigan-Parrilla**, Restore the Delta's Executive Director, also participated in this group.

**Gloria Alonso** is the Environmental Justice Advocacy Coordinator for Little Manila Rising, a health equity nonprofit in Stockton that works with partners to address the most urgent public health risks in South Stockton while also working to preserve the legacy of marginalized communities in Stockton. **Matt Holmes** served as Little Manila Rising's representative until May 2023. **Jasmine Peterson** is the Environmental Justice Internal Director for Little Manila Rising.

**Bob Erlenbusch** is the Executive Director of the Sacramento Regional Coalition to End Homelessness, a nonprofit in Sacramento that works in the Sacramento region through policy analysis, community education, civic engagement, and advocacy.

**Sherri Norris** is the Executive Director of California Indian Environmental Alliance, a statewide nonprofit that works to empower California Indian communities in environmental health, land advocacy, and youth empowerment.

The California Aqueduct and the O'Neill Forebay

Delta Stewardship Council

A CALIFORNIA STATE AGENCY