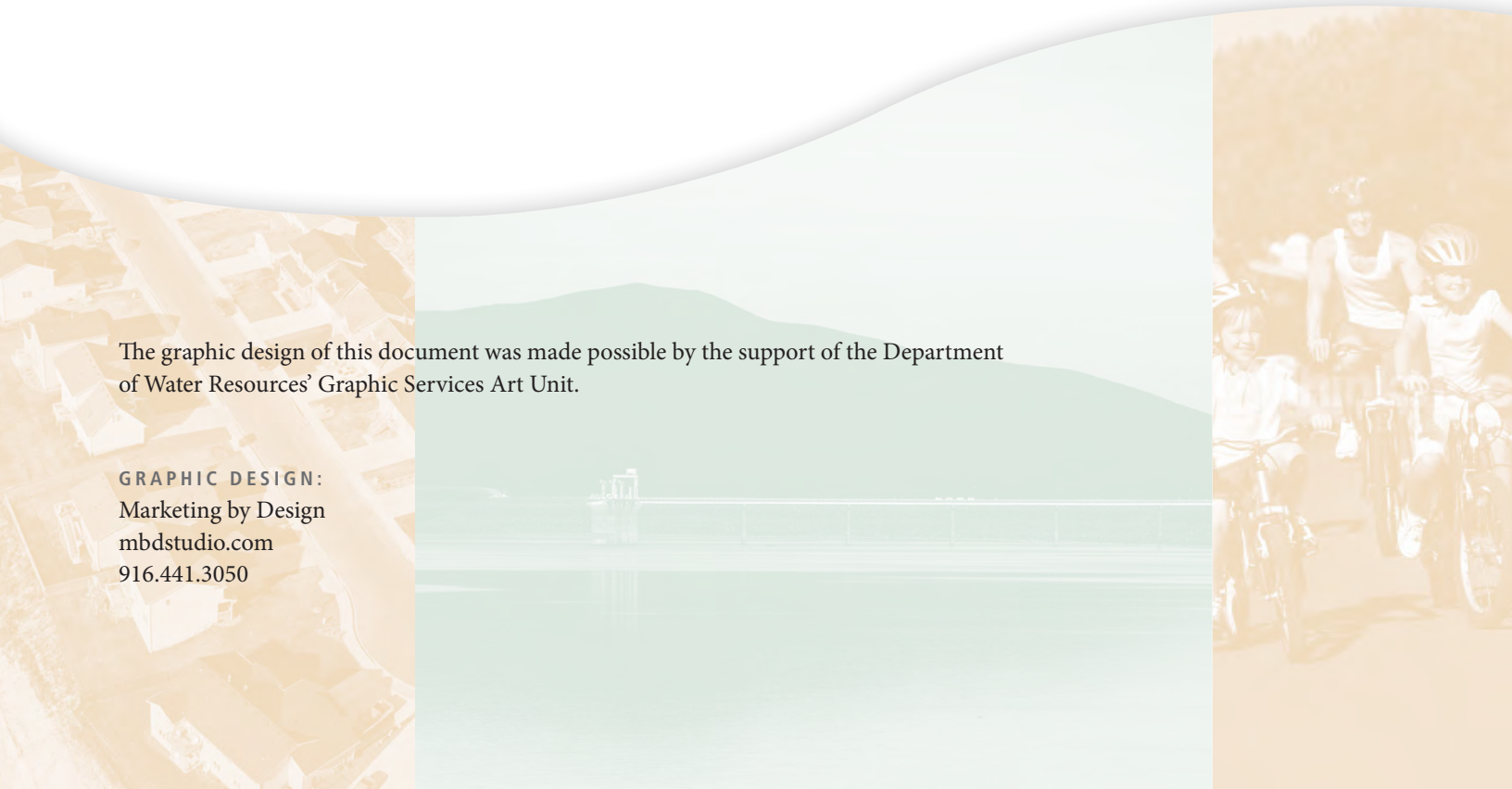
Safeguarding California Plan: 2018 Update

California's Climate Adaptation Strategy | January 2018

CALIFORNIA natural resources AGENCY

"It's time for **courage**, it's time for **creativity** and it's time for **boldness** to tackle climate change . . . The risk is real, the cost is huge and growing, and therefore taking a sequence of **realistic steps** just makes sense, and that's what we're going to do in **California**."

– California Governor Edmund G. Brown Jr.



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The general public, private sector, and government institutions in California have responded to a changing climate by focusing efforts on lowering greenhouse gas emissions. Equally challenging are the growing impacts of that changing climate that will continue even after global emission levels are stabilized. California is a leader in lowering emissions, and we in state government are demonstrating our leadership on climate change resilience as well. This update to the Safeguarding California Plan shows what state government is doing to address the climate impacts we are seeing today and create a more resilient future.

Rising average temperatures, shrinking mountain snowpack, warmer storms, and higher sea levels are already making their mark on our state. This past year, the most severe drought in California's recorded history was interrupted by the wettest season ever experienced. While extremes have always marked California's climate, this dramatic swing highlights what research indicates will become a common trend and underscores the need to bolster California's economy, infrastructure and public services to withstand the effects of such a variable climate.

The permanence and magnitude of these changes requires an aggressive commitment to action based on a sound fiscal foundation, the best available science, and respect for the state's communities. Starting with stabilizing the state budget after the worst economic recession of our time, Governor Edmund G. Brown, Jr. and the California State Legislature have responded resolutely, working across party lines to modernize and strengthen state water, transportation, energy and natural infrastructure and develop a cutting-edge scientific understanding of how climate change will impact our state. We must learn from, work with and proactively invest in our most vulnerable communities so that they are able to respond to climate impacts and thrive under changing future conditions.

This 2018 Update to the Safeguarding California Plan, developed by 38 agencies across state government, is a catalogue of ongoing actions and recommendations that protect infrastructure, communities, services, and the natural environment from climate change. The plan is intended to serve as a durable guide for State government that both makes its efforts transparent to the public and holds agencies accountable for real progress.

It is a privilege to release this plan to the citizens of California so that state government and our partners in cities, communities, California Native American Tribes, non-governmental organizations, and businesses have a tool to safeguard our California for the generations to come. It is not enough to provide this plan – we must take action on the recommendations it provides.

— John Laird, California Natural Resources Secretary

Acknowledgments

The 2018 Update to the Safeguarding California Plan was produced over 13 months through the diligent efforts of hundreds of state agency representatives across 38 agencies. The next page acknowledges the state agency staff who led the development of climate adaptation strategies across eleven policy areas, as well as all of the additional agencies whose staff contributed guidance, expertise, and information to the update. The California Natural Resources Agency extends our sincere appreciation to these dedicated public servants who safeguard California through their work every day.

We also express our deep gratitude to all of the Californians whose thoughtful comments, feedback, and expertise helped improve this plan. Over 300 individuals provided comments on a draft version of the plan through 10 public workshops and 5 tribal workshops across the state. 39 letters representing individuals, groups, and advocacy coalitions provided hundreds of additional notes. The number of people who participated in the public comment process is indicative that California's greatest resources in addressing the ongoing and anticipated impacts of climate change are the knowledge, generosity, and determination of its people.

Climate Resolve, a Los Angeles-based non-profit, assisted with extensive public outreach and engagement across the state to improve the draft version of this update that was released in May 2017. The California Natural Resources Agency extends special thanks to its Executive Director Jonathan Parfrey and Director of Strategic Partnerships Ignacio Fernandez for their efforts to facilitate greater understanding and communication of Safeguarding California, including how it will evolve in the years to come. Their work extends beyond the 2018 Update to the Safeguarding California Plan, showing avenues for growth and improvement for resilience to climate impacts across the state.

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Acknowledgements

This page lists the lead agency, participating agencies, and primary staff that authored, approved, and contributed to each chapter. Lead agencies are identified by italic font.

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What is the 2018 Update to the Safeguarding California Plan?		
USE THE 2017 UPDATE TO THE SAFEGUARDING PLAN AS:	**THIS DOCUMENT IS NOT:**	**RELATED RESOURCES:**
A comprehensive suite of ongoing and needed adaptation actions by state agencies.	**A prescriptive policy document targeting non-state government entities.**	The Governor's Office of Planning and Research convenes the Technical Advisory Council as part of its Integrated Climate Adaptation and Resiliency Program, bringing together local government, practitioners, scientists, and community leaders to help facilitate actions that better prepare California for climate change.
This update is a roadmap of the ongoing actions and next steps being taken by California's state government to make its people, economy, and environment more resilient to the impacts of climate change. It does not detail all actions that need to or should be taken by local and regional governments, the private sector, non-profit organizations, foundations, the public, or others.		
Principles and recommendations to guide and organize adaptation efforts by state agencies.	**Guidelines for local governments and other entities on how to adapt to climate change.**	For the State's guidance on how to prepare climate vulnerability assessments and adaptation strategies, see the Adaptation Planning Guide. The updated General Plan Guidelines provide guidance on incorporating climate considerations into general planning.
This update includes principles and recommendations that provide policy directives and a conceptual framework for the hundreds of adaptation initiatives across state government. Those principles and recommendations do not serve as comprehensive guidance for how to adapt to climate change.		
A way to find out about state programs and policies in areas that relate to your work.	**A clearinghouse of case studies, guidance, and resources for adaptation practitioners.**	The Governor's Office of Planning and Research hosts the Climate Adaptation Clearinghouse as part of its Integrated Climate Adaptation and Resiliency Program. This serves as a centralized source of information that provides the resources necessary to guide decision makers at the state, regional, and local levels.
This update may be useful to practitioners, policymakers, and others who work on climate adaptation and want to find out about state agency initiatives that align with their interests. This update cites many project examples, case studies, grant programs, and other resources, but it is not meant to be a complete clearinghouse for all relevant guidance and resources for practitioners.		
A framework for solutions-oriented initiatives based in climate science.	**A compendium of science on climate impacts and vulnerabilities.**	California's Fourth Climate Change Assessment will be released in August 2018 and provides a great deal of new climate change research. Much of the underlying climate data are being made available on Cal-Adapt.org. California's prior climate change assessments and adaptation strategies (detailed in this update) provide extensive information about climate impacts and vulnerabilities.
This update details hundreds of recommendations and actions based in the best available climate science and refers to many research initiatives. It does not, however, provide a comprehensive overview of existing science in lieu of a large body of forthcoming climate science from California's Fourth Climate Change Assessment.		
A foundation for linking adaptation strategies across policy areas.	**A collection of regional vulnerability assessments and/or adaptation strategies.**	As part of California's Fourth Climate Change Assessment, the State is working with leading climate scientists, practitioners and stakeholders to produce reports for regions and specific topics to synthesize the findings of new research and integrate those with best available regional information. These reports will provide assessments of impacts and vulnerabilities by sector in each region of California.
This update neither revises nor updates climate vulnerability assessments by region or by sector, but provides a framework for future efforts to coordinate on local and regional work that the State is actively building on. The systems and cross-sector linkages in the document will help the State integrate and coordinate actions across policy siloes.		
See page 21 for guidance on how to navigate the Safeguarding California Plan.		

Executive Summary

Globally, California leads in efforts to avoid the worst effects of climate change by reducing greenhouse gas emissions. Still, the impacts of climate change are already being felt in California and are disproportionately impacting the state's most vulnerable populations. The accelerating rate of climate change in this century will likely exceed that experienced by California's native peoples over past millennia. Already these changes have rendered our state's 117 years of weather-related record-keeping unreliable as predictors of future events. We know that California's climate is changing, and responsible institutions must plan for and take action to address current and future climate impacts.

CLIMATE IMPACTS FACING CALIFORNIA:

- Acceleration of warming across the state
- Accelerating sea level rise
- More severe storms and extreme weather events
- More intense and frequent heat waves
- More intense and frequent drought
- Shrinking snowpack and less overall precipitation
- Greater riverine flows
- More severe and frequent wildfires
- Ocean acidification, hypoxia, and warming

The 2018 Update to the Safeguarding California Plan is a roadmap showing how California's state government is taking action to respond to climate change. It clearly lays out the next steps to achieve the State's goals and how those objectives will be achieved. Over 1,000 ongoing actions and next steps, organized by 76 policy recommendations across 11 policy sectors, were developed through the scientific and policy expertise of staff from 38 state agencies. The plan first describes overarching strategies recommended by the California Natural Resources Agency, the State's lead agency on climate change adaptation. The document then outlines ongoing actions and cost-effective and achievable next steps to make California more resilient to climate change. This roadmap serves as a transparent and accountable tool for the public to evaluate the State's progress.

Vision

The Safeguarding California Plan provides a roadmap for state government action to build climate change resiliency. The plan is designed to acieve the following vision and outcomes adopted by the Integrated Climate Adaptation and Resiliency Program's Technical Advisory Council:

ADAPTATION VISION: All Californians thrive in the face of a changing climate. Leading with innovation, California meets the challenge of climate change by taking bold actions to protect our economy, our quality of life, and all people. The state's most vulnerable communities are prioritized in these actions. Working across all levels of government, the state is prepared for both gradual changes and extreme events. Climate change adaptation and mitigation is standard practice in government and business throughout the state. California meets these goals with urgency, while achieving the following long-term outcomes:

All people and communities respond to changing average conditions, shocks, and stresses in a manner that minimizes risks to public health, safety, and economic disruption and maximizes equity and protection of the most vulnerable.

Natural systems adjust and maintain functioning ecosystems in the face of change.

Infrastructure and built systems withstand changing conditions and shocks, including changes in climate, while continuing to provide essential services.

Government managers take climate change adaptation into account in all aspects of their work.*

* This outcome was not in the original vision adopted by the Technical Advisory Council. It was added by the California Natural Resources Agency to reflect the key supportive actions identified throughout the Safeguarding California Plan.

California's Comprehensive Climate Adaptation Strategy

The Safeguarding California Plan provides a holistic overview of California state government's current and planned efforts to address the ongoing and forthcoming impacts of climate change. While the plan's roadmap primarily covers state agencies' programmatic and policy responses in specific policy areas, these detailed ongoing actions and next steps advance resiliency to climate change alongside the State's efforts to coordinate and support climate adaptation at the local and regional level. California is committed to supporting state, regional, and local adaptation action with continued investments in research.

Safeguarding California works to advance its vision of a resilient state in which communities, infrastructure, and the environment can respond to changing conditions, shocks, and stresses related to climate change through comprehensive State policy and programmatic action, coordinated local and regional adaptation initiatives, and an ongoing commitment to investing in and incorporating cutting-edge climate research.

SAFEGUARDING CALIFORNIA FROM CLIMATE IMPACTS

CLIMATE RESEARCH (page 11)

INCLUDES:

California's Fourth Climate Change Assessment

Indicators of Climate Change in California

STATE POLICIES, PLANS, AND PROGRAMS (page 15)

INCLUDES THIS DOCUMENT:

Safeguarding California Plan: 2018 Update

INTEGRATED LOCAL AND REGIONAL ACTION (page 14)

INCLUDES:

Integrated Climate Adaptation and Resiliency Program

Climate Research

California is a global leader in using, investing in, and advancing scientific research to make proactive climate change policy. Efforts to understand and communicate how climate change will affect our expansive and diverse state provide the foundation for state and local actions that make our communities safer from climate threats. The State is investing in the next generation of cutting-edge research that will inform the policies and actions in this plan; as our climate continues to change, California will keep investing and utilizing the best available science to safeguard its people, environment, and economy.

In over a decade of state-sponsored climate research, California has developed critical methods to understand how climate change will impact different places in different ways, and to deliver that information to planners and decision makers. Residents living in Modoc County face very different challenges from climate change than those living in San Diego. Therefore, state government is assessing resources, providing data, and conducting research for climate conditions appropriate for individual communities through its Fourth Climate Change Assessment.

This 2018 Update to the Safeguarding California Plan does not attempt to generalize climate impacts due to their complexity and diversity across the state's different regions. If you are interested in learning about how the state is already experiencing climate change, the Office of Environmental Health Hazard Assessment presents 36 trends in the Indicators of Climate Change in California report. To understand future impacts, the Cal-Adapt.org web portal is at the forefront of resources for specific communities to understand how climate change will raise temperatures and exacerbate extreme heat events, drought, snowpack loss, wildfire, and coastal flooding. In August 2018, the Fourth Climate Change Assessment will be released with several reports detailing the vulnerabilities to climate change across multiple regions and sectors.

California is constantly improving and expanding the body of science that informs policy and action, so it also provides important guidance to local governments, state agencies, and communities on how to best take action on evolving and increasingly sophisticated projections. Operationalizing climate considerations in state government and planning for climate risks in local planning efforts is required by law, so now state and local government can implement adaptation with more clarity and consistency.

California's Fourth Climate Change Assessment will translate the data and findings from 32 State-funded research projects and many external contributions into:

- A statewide report that will cover vulnerabilities and solutions to climate impacts across all the sectors in Safeguarding California.
- 9 regional reports that cover local vulnerabilities.
- Topical reports that synthesize information about important issues like how climate change will affect California's tribal communities, equity and environmental justice, and coastal waters.

CALIFORNIA'S COMPREHENSIVE CLIMATE ADAPTATION STRATEGY

When California's Fourth Climate Change Assessment is published in the third quarter of 2018, it will take the state's cutting-edge accomplishments in climate research to a new level. Its peer-reviewed components will directly inform the hundreds of actions found in this document, as well as summarize new findings and key climate change information for regions around California.

KEY NEXT STEPS TO ADVANCE CLIMATE SCIENCE:

- Continue to evaluate and update the Climate Change Research Plan, engaging a wide range of state agencies to scope and coordinate research that will directly inform adaptation policy advances.
- Institutionalize and prepare for regular California Climate Change Assessments.
- Secure dedicated funding and support for Cal-Adapt.org to keep it updated, comprehensive, and useful for decision-makers and planners.
- Ensure the use of common climate change projections for state and local government planning

Indicators of Climate Change in California

The Office of Environmental Health Hazard Assessment is preparing the third edition of the report *Indicators of Climate Change in California*.[1] These highlights represent summaries of some of the many indicators characterizing the multiple facets of climate change in that report. Taken collectively, the indicators help portray the interrelationships between climate and other physical and biological elements of the environment.

1. Average temperatures have increased by about 1.8 degrees Fahrenheit in California over the past century. Increases in minimum and maximum temperatures were 2.2°F and 1.3°F, respectively.
2. Over the past 120 years, California has become increasingly dry. The most recent drought from 2012 to 2016 was the most extreme since instrumental records began.
3. With increasing temperatures, the energy needed to cool buildings during warm weather—measured by "cooling degree days"—has increased.
4. Extreme heat days and especially nights have become more frequent since 1950. Heat waves have been highly variable each year, but nighttime heat waves have shown a marked increase since the mid-1970s.
5. Glaciers in the Sierra Nevada have decreased in area dramatically. By 2014, several of the largest glaciers were on average about half their size at the beginning of the twentieth century.
6. The amount of water stored in the state's snowpack has been highly variable from year to year, dropping to a record low in 2015, about 5 percent of the historical average. Snowmelt runoff during April through July has declined over the past century.
7. The area burned by wildfires across the state is increasing in tandem with rising temperatures. Large wildfires account for much of the acreage burned each year.
8. Over the past 80 years, California's forests have been changing in response to decreasing water availability, driven by warmer temperatures. Small trees and oaks have increased, while pines have decreased.
9. Sea levels along the California coast have risen overall, except at one location where uplift of the land surface has occurred due to the movement of the Earth's plates.

1 Office of Environmental Health Hazard Assessment, California Environmental Protection Agency (2018). Indicators of Climate Change in California: Report Preview. Sacramento, California.

Integrated Local and Regional Action

While California's state government proudly advances initiatives to mitigate and adapt to the effects of climate change, local and regional government agencies are critical partners implementing and pushing forward climate action. To best serve the people of California on responding to the challenges of climate change, coordination across different levels of government is necessary. Local, regional, and federal agency partners have key jurisdictional responsibilities that must be integrated to achieve resilience to climate change in every area of the state, and California's administration is a committed and engaged partner for those agencies' adaptation efforts.

To best serve the people of California on responding to the challenges of climate change, coordination across different levels of government is necessary. Local, regional, and federal agency partners have key jurisdictional responsibilities that must be integrated to achieve resilience to climate change in every area of the state.

The Governor's Office of Planning and Research (OPR) performs the crucial role of coordinating regional and local adaptation efforts with state initiatives, which complements the role of the Natural Resources Agency to coordinate state government's comprehensive strategy to adapt to climate change. Senate Bill 246 of 2015 established the Integrated Climate Adaptation and Resiliency Program at OPR to help organize a cohesive and coordinated response to the impacts of climate change across California. This program is developing holistic strategies to coordinate climate activities at the state, regional and local levels while advancing social equity. It pursues this mission through two components: the creation and maintenance of the State Adaptation Clearinghouse and the convening of the Technical Advisory Council. The clearinghouse serves as a centralized source of information and resources to assist state, regional, and local decision-makers with planning adaptation projects, while the council supports coordinated adaptation responses through developing guidance and informing state initiatives on how to best address local issues.

California's climate is changing everywhere in different ways, and communities across the state have distinctive priorities and needs to consider in adaptation strategies. State government is committed to working with local and regional entities to make all residents and regions resilient to climate change.

State Policies And Programs

The 2017 Update to the Safeguarding California Plan outlines over 1,000 ongoing actions and next steps that state government is taking to reduce climate risk, but that roadmap is based on a foundation of nine years of climate adaptation policy (see the following pages for a timeline of the highlights of California's climate adaptation policy).

In continuing to implement the policy vision first laid out in Executive Order S-13-08 and the 2009 California Climate Adaptation Strategy, Governor Brown and the Legislature have made climate change central to government planning, investment, and public outreach. Governor Brown's Executive Order B-30-15 directs state agencies to take climate change into account in their planning and investment decisions, and the Legislature reinforced this mandate for all state infrastructure investments, planning, design, construction, operation, and maintenance through Assembly Bill 2800 (Quirk) of 2016. Assembly Bill 1482 (Gordon) of 2015 further prioritizes preparing for impacts from climate change and directs the Natural Resources Agency to update the Safeguarding California Plan every three years. This update to the plan, prepared in accordance with that mandate in Assembly Bill 1482, is designed to capture all of the policies and programs that implement the overarching strategy and vision for making California resilient to climate change.

State government is ensuring that progress on adaptation is coordinated with action to reduce greenhouse gas emissions. California's integrated climate strategy recognizes the need for simultaneously preparing for climate impacts while mitigating emissions to the maximum extent feasible to avoid the worst consequences of climate change. Many of the ongoing actions and next steps found in this plan also reduce emissions, while many of the investments and strategies outlined in the Air Resources Board's Scoping Plan Update support climate adaptation.

California's Climate Action Team directs the State's integrated climate strategy, and supports the overall coordination of policies and programs that support climate adaptation.

The next pages show highlights of California's achievements in climate adaptation over the past nine years.

Examples of State Documents Aligned With Safeguarding California

- Natural and Working Lands chapter of the 2030 Scoping Plan Update
- State Wildlife Action Plan
- Forest Carbon Plan
- Water Action Plan
- Water Plan
- State Hazard Mitigation Plan
- Homeland Security Strategy
- California Transportation Plan
- Integrated Energy Policy Report
- General Plan Guidelines
- Five-Year Infrastructure Plan
- California Water Plan

Highlights of Climate Adaptation Policy in California

California is building on a foundation of policy, research, and legislation to safeguard people, the environment, and the economy from climate change.

NOVEMBER

Executive Order S-13-08: Governor Arnold Schwarzenegger issues the state's first executive order on climate change adaptation, which includes the directive for the Natural Resources Agency to produce a state climate adaptation strategy and for state agencies to address sea-level rise.

OCTOBER

State of California Sea-Level Rise Guidance: The Ocean Protection Council released guidance to help state agencies incorporate sea-level rise impacts; the guidance has evolved over the years to incorporate the best available science.

2008

2009

APRIL

Indicators of Climate Change in California: A recurring report is published that tracks climate trends and how they affect California's people, water resources, oceans, fish and wildlife, forests, and agriculture.

SEPTEMBER

Second Climate Change Assessment: This State-funded research portfolio found that an integrated approach to climate change mitigation and adaptation could substantially reduce economic impacts to California, ultimately informing the California Climate Adaptation Strategy.

DECEMBER

California Climate Adaptation Strategy: The Natural Resources Agency published the state's first adaptation strategy, which used downscaled climate models to assess climate impacts and provide recommendations and strategies to address vulnerabilities. It identified 345 achievable goals across 7 policy sectors for state agencies to improve the state's resilience to climate change

2008

Introduction

HIGHLIGHTS OF CLIMATE ADAPTATION POLICY IN CALIFORNIA

2011

JUNE

Cal-Adapt: The Cal-Adapt.org platform was debuted to the public, providing access to the wealth of data and information that has been, and continues to be, produced by State of California's scientific and research community. The data available can be visualized, downloaded, and shared to offer a view of how climate change is projected to affect California at the local level.

2012

JULY

California Adaptation Planning Guide: The Natural Resources Agency and Emergency Management Agency published guidance that walks local decision-makers through the steps to create climate vulnerability assessments and adaptation strategies.

AUGUST

Third Climate Change Assessment: This collaborative body of research explored local and statewide vulnerabilities to climate change, highlighting opportunities for taking concrete actions to reduce climate-change impacts.

2013

AUGUST

Indicators of Climate Change in California

Introduction

HIGHLIGHTS OF CLIMATE ADAPTATION POLICY IN CALIFORNIA

2014

JULY

Safeguarding California Plan: This update to the 2009 California Adaptation Strategy focused on providing policy guidance for state decision-makers across 9 different sectors, providing updated information on climate vulnerabilities and state agency actions to address them.

2015

MARCH

Climate Change Research Plan

APRIL

Executive Order B-30-15: Governor Brown's major Executive Order integrated directives on climate change mitigation and adaptation, providing a powerful framework for action. This order requires all state agencies to take current and future *climate impacts* into account in all planning and investment. It directed the preparation of implementation plans to ensure coordinated progress on the objectives of the Safeguarding California Plan, and emphasized the State's commitment to protecting vulnerable populations and prioritizing flexible, adaptive, and natural infrastructure solutions.

OCTOBER

Climate Adaptation Legislation: A package of three bills was signed into law by Governor Brown to improve California's resilience to climate change:

SB 246 (Wieckowski): Establishes the Integrated Climate Adaptation and Resiliency Program (ICARP) at the Governor's Office of Planning and Research (OPR) to help coordinate local and regional efforts with state climate adaptation strategies. As part of ICARP, OPR convenes a Technical Advisory Committee of stakeholders and practitioners to provide support for climate adaptation coordination. ICARP also maintains a state Adaptation Clearinghouse that serves as a centralized source of information for resources and guidance.

SB 379 (Jackson): Requires local jurisdictions to include climate adaptation and resiliency strategies in the safety elements of their general plans.

AB 1482 (Gordon): Formalizes a three-year update and reporting process for the Safeguarding California Plan.

2016

MARCH

Safeguarding California: Implementation Action Plans: As called for by Executive Order B-30-15, these plans showed how state agencies were moving forward with ongoing actions and planned next steps to implement the 2014 Safeguarding California Plan. They made the recommendations presented in 2014 more actionable and summarized vulnerabilities to climate impacts across 10 sectors.

OCTOBER

AB 2800 (Quirk): In addition to making the requirement for all state agencies to take the current and future impacts of climate change in all aspects of infrastructure planning, investment, and maintenance, this legislation also directed the Natural Resources Agency to convene the Climate-Safe Infrastructure Working Group. This group will examine how to integrate scientific data concerning projected climate change impacts into state infrastructure engineering.

HIGHLIGHTS OF CLIMATE ADAPTATION POLICY IN CALIFORNIA

JULY

AB 398 (Garcia): As part of the legislation to meet California's 2030 greenhouse gas emissions target through a cap-and-trade system, climate adaptation and resiliency was identified as an ongoing prioritized cap-and-trade auction revenue expenditure category.

AUGUST

General Plan Guidelines Update: The first update to the guidelines since 2003 provides guidance to jurisdictions on how to integrate climate change adaptation and mitigation throughout their general plans.

Cal-Adapt 2.0: In a dramatic expansion of the original 2011 platform, the new Cal-Adapt 2.0 provides new climate projections, more powerful visualizations, improved access to data, a public Applications Programming Interface, and new connections with supporting resources. The website update provides an early look at the new downscaled projections that serve as the foundation to California's Fourth Climate Change Assessment.

NOVEMBER

Planning and Investing for a Resilient California: A Guidebook for State Agencies: This document provides high level guidance on what future climate conditions State agencies should plan for and how State agencies should approach planning differently to adapt to a changing climate.

2017

JANUARY

Indicators of Climate Change Report.

Sea-Level Rise Guidance Document Update: The Ocean Protection Council is releasing a new document based on the best available science to address the needs of state agencies and local governments as they address sea-level rise.

2018

2018 Update to the Safeguarding California Plan:
California's state adaptation strategy is a comprehensive roadmap to over 1000 ongoing actions and next steps that the State is taking to address climate risk and bolster resilience to climate impacts. Its new policy recommendations provide structure and connectivity across 11 sectors, all of which contribute to a holistic climate justice strategy that addresses equity in climate adaptation.

LOOKING FORWARD

2018

AUGUST

Fourth Climate Change Assessment: As the first interagency initiative to implement California's Climate Change Research Plan, this body of research is designed to directly inform adaptation action. Using a common foundation of climate scenarios, 32 State-funded projects and 21 externally-funded projects will provide a wealth of cutting-edge information on the ways state government and others should address climate impacts. To help synthesize the foundational data and bounty of knowledge produced for the assessment, the State is working with leading climate scientists to produce nine regional reports, several topic-specific reports, and a statewide synthesis that will help communicate the new findings and other best available science.

Climate-Safe Infrastructure Recommendations: Leading climate experts and engineers will make recommendations on how to safeguarding California from climate change through integrating climate science in infrastructure design as part of the Natural Resources Agency's Climate-Safe Infrastructure Working Group.

Tracking Progress on Safeguarding California: As required by AB 1482, the Natural Resources Agency will work with its many sister agencies to report on the progress made on the hundreds of next steps identified in the 2018 Update to the Safeguarding California Plan. As part of the effort to communicate the strides made in making California resilient to climate change, the Natural Resources Agency will analyze actions from the 2009, 2014, and 2016 strategies as part of this report.

California Adaptation Forum: The third statewide forum will convene hundreds of local, regional, and state leaders who are committed to addressing California's adaptation needs.

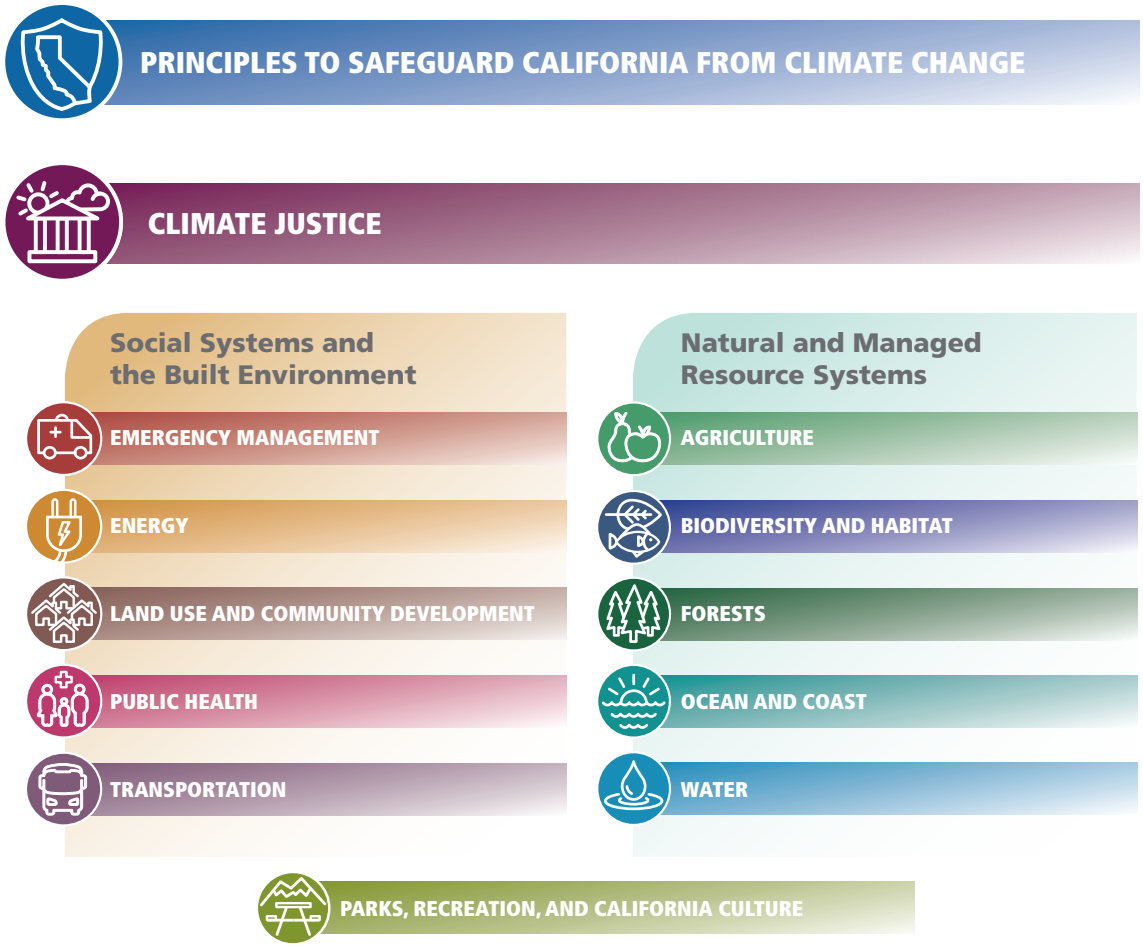
SEPTEMBER

Global Climate Action Summit: Governor Jerry Brown is convening a summit that will demonstrate the groundswell of innovative, ambitious climate action from leaders around the world — and will highlight the economic and environmental transition already underway. In doing so, the Summit will encourage progress at a critical moment that will take place at the 2018 United Nations Climate Change Conference.

Organization

Climate change demands that every aspect of state government adapt to address its growing impacts, so the challenge for the Safeguarding California Plan is how to organize thousands of initiatives in a flexible but durable framework. This 2018 Update builds on the elements of the past three adaptation strategies and incorporates extensive public comment to provide a conceptual structure for state government's policy recommendations, ongoing actions, and next steps to adapt to climate change.

This chart shows the framework used to organize the rest of the 2018 Update to the Safeguarding California Plan, and it is followed by an overview of each component.



Policy Chapters

The substantive policy components of California's adaptation strategy start with two chapters that summarize overarching themes and principles in the following 11 policy-specific chapters. The **Principles to Safeguard California from Climate Change** chapter covers seven comprehensive strategies that must underpin the State's adaptation actions across all policy areas.

The subsequent **Climate Justice** chapter compiles hundreds of next steps that state agencies will take to partner with vulnerable communities to bolster their resilience to climate change and work towards an equitable California. The commitments cited in the Climate Justice chapter are pulled from the 11 chapters on sector-specific policy areas.

Parks, Recreation, and California Culture, the last and newest chapter, is categorized under both systems as it deals with social systems, the built environment, and natural resources. The 2018 Update is the first time this sector has appeared; along with the Climate Justice chapter, it bookends the 10 sector chapters from the 2016 Safeguarding California: Implementation Action Plans. This chapter addresses a common concern heard at workshops around the state: how can state government prepare for and respond to climate impacts on parks, recreation, and areas of important cultural significance as a means of enhancing access for all Californians. Although climate change adds to the challenge of managing these resources, coordinated actions by state agencies and their diverse partners can help ensure that parks, recreation, and cultural resources can be enjoyed by future generations despite climate impacts.

Three common components of recommendations, next steps, and ongoing actions represent the policy framework, future commitments, and present achievements across California's climate adaptation strategy. By coding the recommendations and next steps in this update, state government will have a formal system for reporting on progress for the first time.

Each of the 11 sector chapters follows the same format. They present four to 10 key recommendations that broadly categorize goals to guide action within each sector. Each recommendation is coded with an initial or initials to indicate its sector as well as a number (see the next table). "Next Steps" are identified under each recommendation to lay out the strategies and actions that state agencies will take to work towards the recommended policy goal. After the next steps, each recommendation has a list of "Ongoing Actions" that state agencies are taking or have recently completed to adapt to climate change.

GUIDE TO READING SAFEGUARDING RECOMMENDATIONS

EM-	4.	1
CHAPTER ABBREVIATION	RECOMMENDATION NUMBER	NEXT STEP NUMBER

Emergency Mangement Chapter, Recommendation #4, Next Step #1

Each sector represents a distinct institutional and policy environment; the jurisdictions, capacities, policy context, and priorities vary widely, and the way that sectors organize their recommendations and actions differ accordingly. Nonetheless, three common components of recommendations, next steps, and ongoing actions represent the policy framework, future commitments, and present achievements across California's climate adaptation strategy. By coding the recommendations and next steps in this update, state government will have a formal system for reporting on progress for the first time.[1]

This update to the Safeguarding California Plan also adds a conceptual overlay to the sector chapters. As shown in the organizational chart, the sectors are sorted into "Social Systems and the Built Environment" or "Natural and Managed Resource Systems." These two "policy umbrellas" help draw further connections within Safeguarding California, and can serve as the basis for potentially integrating sectors in future updates.

CONCLUSION AND TRACKING PROGRESS

The 2018 Update to the Safeguarding California Plan closes with an explanation of how adaptation progress will be tracked and reported on, as well as a look ahead to important adaptation initiatives. Its appendices cover a series of proposed metrics to evaluate climate impacts and state government adaptation responses, an overview of how research in California's Fourth Climate Change Assessment will inform Safeguarding California's policy recommendations, a glossary of terms, and a guide to the acronyms used in the document.

1 see the "Tracking Progress" section on page 226 for more information about how state government will report on implementation of the hundreds of next steps in this update for greater transparency and accountability for adaptation progress.

Safeguarding Connections Between Chapters

With 11 sector-specific chapters and two chapters summarizing overarching themes, it was very important to identify and build off of the connections and synergies between different strategies in the Safeguarding California Plan. The 13 sector icons help create a visual system that shows how state government agencies' adaptation actions in distinct sectors are woven together as part of a holistic roadmap for resilience to climate change.

Substantive connections between strategies and steps in different sectors are identified with appropriate sector icons. Specific sector recommendations are occasionally also cited to indicate the chapter's most relevant policy connection.

This guide shows the icon and recommendation identifiers for the 13 policy chapters of the 2018 Update to the Safeguarding California Plan:

Sector icons are clickable in the online version of this document!

Click on the icons listed after next steps to visit the relevant recommendations in those other sectors.

Guide to Safeguarding California Chapter Identifiers

ICON AND ABBREVIATION	CHAPTER
	Principles to Safeguard California
CJ	Climate Justice
EM	Emergency Management
E	Energy
L	Land Use and Community Development
P	Public Health
T	Transportation

ICON AND ABBREVIATION	CHAPTER
A	Agriculture
B	Biodiversity and Habitat
F	Forests
O	Oceans and Coasts
W	Water
PC	Parks, Recreation, and California Culture

Principles to Safeguard California from Climate Change

These seven overarching principles represent foundational objectives for California's approach to climate change adaptation. Based on the lessons learned from nine years of policy achievements, as well as multiple executive orders and laws, this version of the Safeguarding California Plan updates the comprehensive, cross-sector strategies found in the 2009 and 2014 iterations with these fundamental prescriptions for state government agencies.

PRINCIPLE 1:

Consider climate change in all functions of government.

Incorporating climate impacts into all core functions of government ensures we protect people, infrastructure, the economy, and nature from climate impacts and disrupting events. The Governor and Legislature have mandated that all state government agencies consider climate change in planning and investment, and this principle reinforces this key common-sense step for climate adaptation. The Governor's Office of Planning and Research has developed guidance for state agencies on how to consider climate change, and the Government Operations Agency is working with agencies on roadmaps to address climate impacts at State-owned and -operated facilities. The California Natural Resources Agency has convened a Climate-Safe Infrastructure Working Group with leading engineers and climate scientists to address how to integrate climate data into state infrastructure engineering per Assembly Bill 2800 (Quirk). These efforts support dozens of next steps found throughout this document. While almost all the recommendations in this update relate to this overarching principle, several explicitly lay out next steps for an integrated sector-wide approach to considering climate impacts.

Related Recommendations

EM-3 E-3 L-3 T-3 B-5 PC-5

PRINCIPLE 2:

Partner with California's most vulnerable populations to increase equity and resilience through investments, planning, research, and education.

This update prioritizes climate justice, which entails ensuring that the people and communities who are least culpable in the warming of the planet, and most vulnerable to the impacts of climate change, do not suffer disproportionately as a result of historical injustice and disinvestment.[2] The new Climate Justice chapter organizes the next steps that state agencies will take in all of the policy areas covered by the Safeguarding California Plan. State government must deepen its commitment to addressing the systemic burdens that California's most vulnerable populations bear, especially as climate change exacerbates these burdens. Decisions, plans and investments by agencies can help residents least able to cope with damage to their homes, communities, and physical and mental health. Prioritizing services, resources, training and jobs can improve living standards, build avenues for meaningful participation in decision-making, and improve resiliency. Robust engagement of vulnerable communities pulls different perspectives into government decision-making, which leads to more responsive decisions, increased acceptance of decisions and support for implementation.

Related Recommendations

EM-4 E-6 L-5 P-1 T-5 B-6 O-5 W-6 PC-6

PRINCIPLE 3:

Support continued climate research and data tools.

Preparing for future climate change impacts requires current, accessible, and user-friendly scientific findings. Greenhouse gas emissions will continue to determine the pace and scale of climate impacts, and direct observation of climate impacts will help refine and improve our modeled projections of climate risks. Decision makers, planners, and the public must be able to visualize and understand how the changing environment will impact communities. Continuous investments in climate science and data tools across multiple disciplines is necessary so that long-term planning processes and state programs can regularly incorporate new climate information and update management practices and goals accordingly. While California's Fourth Climate Change Assessment is making crucial advances in science to inform adaptation policy, a formal and sustainable process for investing and applying climate science is needed. The new climate change research program established under the Strategic Growth Council in September 2017 is a promising step towards this end.

Related Recommendations

EM-1 E-1 P-7 T-1 F-8 O-3 W-7

2 Climate Justice Working Group, "Advancing Climate Justice in California: Guiding Principles and Recommendations for Policy and Funding Decisions." August 2017. http://www.healthyworldforall.org/en/express-img/17081516-3570-img1.pdf

PRINCIPLE 4:

Identify significant and sustainable funding sources to reduce climate risks, harm to people, and disaster spending.

Making adequate investments to prepare for near and longer-term climate risks now can help protect California's people, economy and natural resources over time. Although needed investments are substantial, spending now will offset much greater expenses later. Existing infrastructure investments should be leveraged to maximize matching funds and climate benefits. Innovative risk sharing and financing mechanisms will also need to be considered and utilized. Newly appropriated funds for the Wildlife Conservation Board from the Greenhouse Gas Reduction Fund and proposed programs in the "California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access For All Act" set for the June 2018 ballot are examples of potential approaches to long-term climate risk reduction.

Related Recommendations

E-5 L-6 P-7 F-6

PRINCIPLE 5:

Prioritize natural infrastructure solutions that build climate preparedness, reduce greenhouse gas emissions, and produce other multiple benefits.

Wherever possible, California's efforts to adapt to climate change should bring multiple benefits. For example, a project to improve flood management might involve setting levees back from a river to boost its flood-flow capacity, but also serve to recharge groundwater and foster riverside habitat. Actions that reduce climate risks across multiple sectors and actions that address multiple climate risks should be prioritized. Restoration and conservation of natural systems such as forests, grasslands and shrublands, agricultural lands, and wetlands lend themselves to multiple benefits. California is investing in natural infrastructure for urban areas through the Urban Greening Grant Program, planning for green solutions through the Central Valley Flood Protection Plan, and recognizing the climate value of conserving natural lands. Investments, planning, and protection must be coupled with innovation and partnerships with local governments, non-profits, and others to scale up their impact as climate change intensifies.

Related Recommendations

B-3 F-5 O-2 W-8 PC-3 T-4

PRINCIPLE 6:

Promote collaborative adaptation processes with federal, local, tribal, and regional government partners.

Successful climate adaptation requires close coordination among all levels of government and communities in order to leverage expertise, build capacity, raise awareness and maximize funding. Climate change is impacting communities across California in different ways, and the State must coordinate and empower the public, local and regional governments, and federal agencies to be partners in bolstering resilience. Through the Integrated Climate Adaptation and Resiliency Program and the updated General Plan Guidelines, the Governor's Office of Planning and Research is establishing new capacity and guidance to align adaptation planning and initiatives for the greatest benefit for residents. By synthesizing and presenting the State's investments in science at a regional scale in California's Fourth Climate Change Assessment, collaborative adaptation initiatives can build on a common foundation of climate research. Where possible, the state shouldalso work with partners at all levels of government to integrate climate adaptation and mitigation effoerts.

Related Recommendations

E-4 L-2 P-6 F-7 O-6 PC-6 T-4 T-5

PRINCIPLE 7:

Increase investment in climate change vulnerability assessments of critical built infrastructure systems.

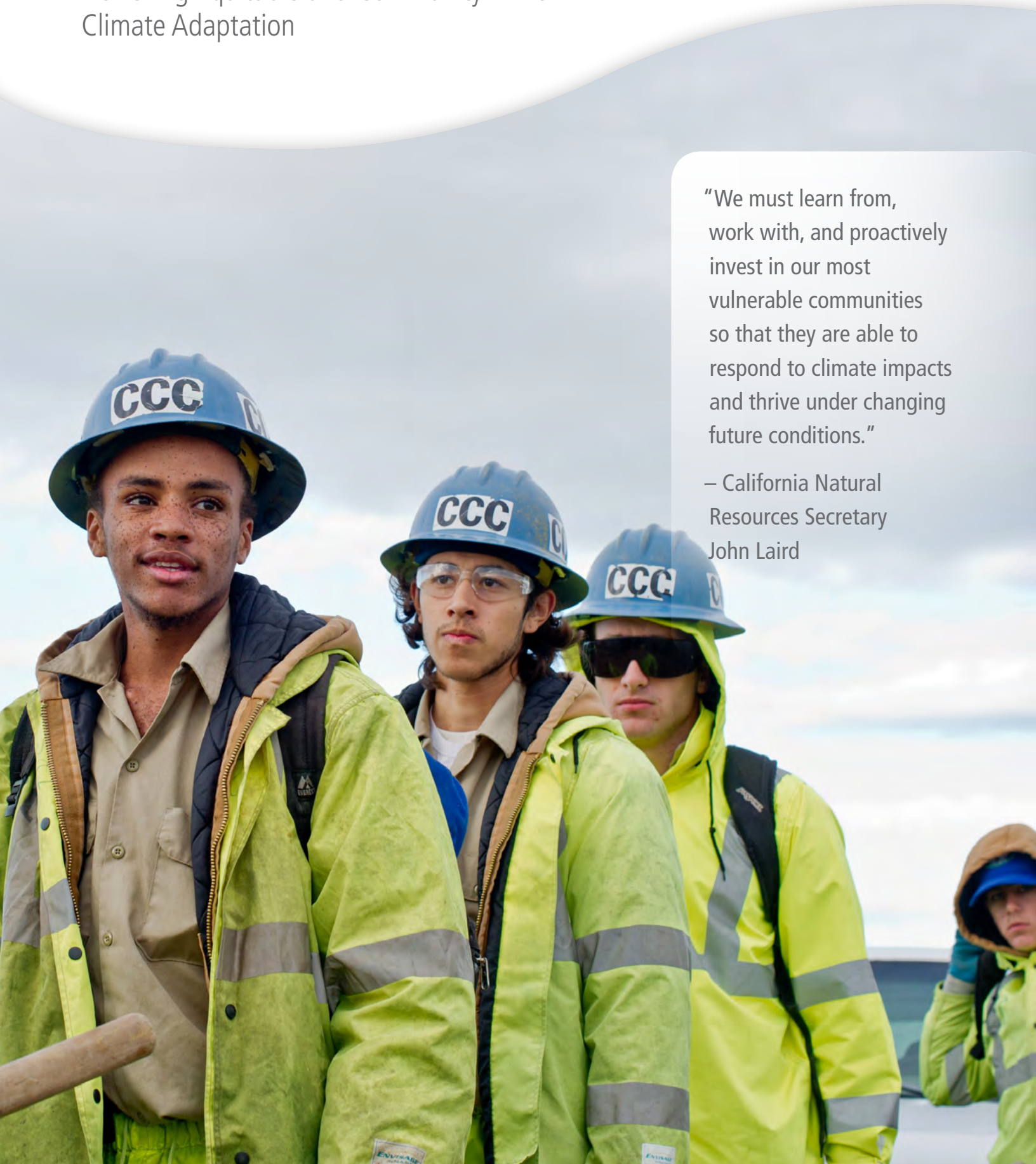
Aging water, energy, transportation, and other built infrastructure systems must be retrofitted so that they can continue to provide critical services despite changing climate extremes. Vulnerability assessments are essential for understanding how essential infrastructure systems are exposed to, susceptible to, and able to withstand adverse climate impacts. They are the basis for developing risk mitigation strategies to protect critical infrastructure and making informed decisions about where to prioritize adaptation investments. The Department of Transportation and the Department of Water Resources are conducting vulnerability studies of their systems, and the Energy Commission and Public Utilities Commission are working with public- and investor-owned utilities to increase energy sector resilience as well. The State must maintain the critical services this infrastructure provides while the changing climate intensifies chronic and acute stresses.

Related Recommendations

E-3 T-2 O-1 W-7

Climate Justice

Achieving Equitable and Community-Driven Climate Adaptation



"We must learn from, work with, and proactively invest in our most vulnerable communities so that they are able to respond to climate impacts and thrive under changing future conditions."

– California Natural Resources Secretary John Laird

Climate Justice

While all Californians are impacted by climate change, different groups are affected in unique and overlapping ways. Certain communities and groups are in a better position to respond, recover, and adjust as these changes occur, while others are more vulnerable. In many cases, the most vulnerable are the same communities that already experience social, racial, health, and economic inequities.

Building a resilient California requires increasing the capacity of communities and people to be able to withstand and recover from climate-related disruptions, and learning to adapt in the face of this change. As California's state agencies set out to achieve the outlined strategies to prepare for and respond to impacts related to climate change, their many commitments to achieve equitable community-responsive preparedness are part of a broader effort to achieve climate justice. This section serves as a reference for public agency staff, community leaders, and philanthropic partners to understand how equity is woven through the plan, collaborate with state agencies on initiatives, create accountability, and illuminate the areas where further immediate attention is needed.

While these are important commitments, it's important to note that they are part of incremental progress towards the imperative of achieving equity and climate justice for all Californians. This is the first iteration of a cross-sector strategy for climate justice, and represents just one part of the State's overall commitment to equity and disadvantaged communities.

Climate justice is addressed throughout this climate adaptation strategy, including in the Vision, the Principles for Safeguarding California section preceding this chapter, and specifically in several sector recommendations. The following Climate Justice Goals for Safeguarding California organize the 153 next steps that advance climate justice drawn from the 11 subsequent policy chapters.

These commitments to making California's most vulnerable communities resilient to climate change respond to over a year of stakeholder conversations, presentations, reports and recommendations. As part of the 2018 Update to the Safeguarding California Plan, the California Natural Resources Agency, the Governor's Office of Planning and Research, and the California Department of Public Health took part in the Resources Legacy Fund's Climate Justice Working Group, comprised of non-profit organizations whose missions explicitly seek to advance environmental justice.

What is Climate Justice?

Climate justice entails ensuring that the people and communities who are least culpable in the warming of the planet, and most vulnerable to the impacts of climate change, do not suffer disproportionately as a result of historical injustice and disinvestment.[1]

1 Climate Justice Working Group, "Advancing Climate Justice in California: Guiding Principles and Recommendations for Policy and Funding Decisions." August 2017. http://www.healthyworldforall.org/en/express-img/17081516-3570-img1.pdf

The Climate Justice Working Group published its report "Advancing Climate Justice in California: Guiding Principles and Recommendations for Policy and Funding Decisions" in August 2017, and this chapter seeks to show the tangible steps that state government agencies are taking to realize its vision of an equitable and resilient California.

To ensure that California is following through on its commitment to climate justice, state agencies will report annually on their progress in implementing this strategy.[2] Additionally, the Governor's Office of Planning and Research has produced guidance for state agencies that helps them take into account the complex intersections that contribute to vulnerability to climate impacts in all planning, policy-making, and investment decisions. While this chapter does not represent the entirety of ongoing work to support climate justice in adaptation initiatives, it shows substantial investments and progress in promoting equity.

California's state government will continue to work with community members, nonprofits, and other organizations to engage with and proactively invest in our most vulnerable communities, and these next steps are a part of that path to climate justice.

CLIMATE JUSTICE IN ACTION

Additional examples illustrating projects that are advancing climate justice on the ground can be found embedded throughout the following 8 principles. These projects highlight the communities, nonprofit organizations, and foundations that are taking the lead to promote climate justice with state government.

Climate Justice Goals for Safeguarding California

1. Actively engage, educate, and partner with communities to enable early, continuous, and meaningful participation in adaptation initiatives.
2. Identify the most vulnerable communities to climate change to prioritize initiatives and build grassroots capacity.
3. Support and coordinate adaptation efforts across jurisdictions and policy areas to maximize community resilience.
4. Promote holistic approaches to climate adaptation that maximize co-benefits and economic development.
5. Make equity an integral consideration for climate research.

2 See the "Tracking Progress" section on page 226 for more information about how state government will report on implementation of the hundreds of next steps in this update for greater transparency and accountability for adaptation progress.

CLIMATE RESILIENCE PLANNING AMONG CALIFORNIA NATIVE AMERICAN TRIBES

The Blue Lake Rancheria ("Tribe"), a federally-recognized tribe in rural Humboldt County has undertaken an aggressive, integrated strategy to improve public health, lower greenhouse gas (GHG) emissions, and adapt to a changing climate. Pollution and climate hazards are amplified on these tribal lands due to geographic isolation: the region's main roads are prone to landslides and connections to outside electricity, natural gas, and communication grids are tenuous. The Tribe has identified nearby hazardous infrastructure and air and water pollution concerns, and these impacts are exacerbated by the effects of climate change.

Aligning with California climate efforts, the Tribe's government, elected leaders, and staff have made significant progress toward clean energy, GHG reductions, and community resilience. The Tribe has implemented a wide range of projects to address these goals, including steps to ensure greater critical infrastructure and resource reliability during emergencies. For example, with funding from the [California Public Utility Commission's Electric Program Investment Charge], the Tribe developed a low-carbon, community-scale microgrid with a 500-kW solar array, a 1-MWh Tesla battery storage system, and a Siemens microgrid management system. Backed by numerous partners, including the California Energy Commission, Schatz Energy Research Center, California State University at Humboldt, Pacific Gas and Electric Company, Idaho National Laboratory, Siemens, Tesla, REC Solar, McKeever Energy, Colburn Electric, Kernen Construction, and the American Red Cross, the microgrid enables the Tribe to supply its own power to a campus of critical infrastructure during emergencies, and has resulted in energy savings of $200,000/year, a 10% increase in clean energy employment, and a reduction of at least 150 tons/year of GHG emissions. Other projects to improve the Tribe's resilience to climate change include 1) development of a smart community water system, 2) a food sovereignty initiative, 3) development of a Resilience Training and Innovation Center, 4) transition to green transportation, including development of regional Electric Vehicle (EV) infrastructure, adding EV buses within the Tribe's public transit system, and biodiesel manufacturing using the Tribe's waste cooking oil, and 5) an agreement with the American Red Cross to serve as a shelter-in-place in the event of a regional emergency. The Tribe's efforts include significant mitigation of greenhouse gas emissions, the improved energy and water efficiency, and plans to shelter and protect indigenous and other communities in the event of climate emergencies or extreme events, all of which are critical for sustainable climate change adaptation.

Source: Images supplied by the Blue Lake Rancheria

GOAL 1 | Actively engage, educate, learn from, and partner with communities to enable early, continuous, and meaningful participation in adaptation initiatives.

NEXT STEPS TO IMPLEMENT THIS GOAL ARE IDENTIFIED ACROSS FOUR KEY THEMES:

- Develop and implement best practices for engagement.
- Promote education initiatives.
- Foster partnerships to address community concerns.
- Deepen and focus engagement with frontline communities.

Climate resilience strategies, no matter how well designed or implemented, will ultimately fail if they do not engage the communities that they serve from the onset of their development. To work towards climate justice, the most vulnerable populations must be engaged as partners in adaptation work. State government must utilize a range of actions to create enabling conditions for frontline communities' early and meaningful participation in climate adaptation. Actively partnering with communities, especially those who are experiencing and will continue to experience disproportionate environmental impacts, must be a foundational practice for state government.

Partnerships with community organizations that work directly with vulnerable populations can offer unique insight into how to tailor investments and policies to ensure that all residents' quality of lives are improved. In order to create durable climate adaptation and resiliency initiatives, community members and public serving organizations are necessary to ensure ongoing action, accountability, and in many instances, financing and/or funding options.

DEVELOP AND IMPLEMENT BEST PRACTICES FOR ENGAGEMENT

L-1.1. Highlight and share case studies that demonstrate how the State is partnering with local governments, stakeholders and community leaders to successfully integrate climate preparation and readiness concepts into land use planning activities, resulting in neighborhoods that are engaged and intent on building a healthier and more resilient environment for residents.

O-5.1. Develop best practices for seeking inclusive participation in planning decisions related to sea level rise and climate change along the coast, such as: using targeted, culturally-sensitive communication to engage underserved, low income, and linguistically isolated communities and communities of color, providing interpreters, offering a variety of venues for public comment, and locating community meetings so that they are accessible to public transportation and closest to communities most affected by climate impacts.

P-2.6. CDPH will promote a bilingual English/Spanish multi-media climate change and health equity curriculum for health promoters.

P-5.1. Ensure that warning tools are multi-lingual and accessible to diverse communities.

PROMOTE EDUCATION INITIATIVES

B-6.1. Continue existing climate education initiatives such as Climate Science Alliance South-Coast Climate Kids initiative and the Department of Fish and Wildlife's internal Climate Course for its employees.

E-6.5. Make information more accessible to residents, recognize community needs, and include more robust outreach and targeted demonstrations in disadvantaged communities.

EM-2.5. Expand training and education opportunities to include courses that increase awareness, understanding, and competency about climate adaptation.

F-7.9. Increase public education on the link between fire risk and the elevated importance of preventative fuels treatment projects, the responsibilities of living in the wildland, and necessary prevention measures.

O-5.4. Engage communities and increase education opportunities through citizen and community science projects that further our understanding of climate impacts.

O-5.6. Expand existing public awareness programs like the California King Tides website and the Whale Tail Program.

O-5.7. Conduct outreach and communication on impacts to beaches, dunes, and wetlands from "coastal squeeze," when shoreline protection and other development prevent the inland migration of shoreline habitats, leading to inundation of that land area and loss of habitat/beach area. Communicate best practices for avoiding, minimizing, and/or managing coastal squeeze, such as ecosystem restoration and nature-based infrastructure.

P-2.3. Translate climate science to make it locally relevant and accessible for community members, and highlight health, climate, and equity impacts and opportunities.

P-7.10. Identify and promote climate change-related opportunities for citizen science such as Smoke Sense, a United States Environmental Protection Agency (EPA) study that will help determine the extent to which exposure to wildland fire smoke affects health and productivity, and Identifying Violations Affecting Neighborhoods (IVAN), an environmental monitoring system that connects the community with staff that can help solve local environmental problems.

P-7.12. CDPH's Center for Chronic Disease Prevention and Health Promotion will draw on published research to educate people to prevent illness and injury when conditions are not optimal for active transportation (e.g. during extreme heat or poor air quality days).

PC-1.12. Incorporate educational elements into coastal adaptation projects to teach the public about the risks of sea level rise and options for adaptation.

T-4.7. Educate those who use active transportation (bicycle and pedestrian) about heat illness prevention and treatment. Along pedestrian facilities with high-heat days, provide shade sidewalks/paths, and public water fountains to prevent heat illness. Where possible, use pervious pavement for bicycle and pedestrian pathways to increase water infiltration. Refer to California Environmental Protection Agency's Urban Heat Island Index analysis to help identify best locations for these efforts.

W-6.2. The Water Board will work to develop and provide information and public outreach on potential climate change impacts to water quality, and options and funding opportunities for adapting to those impacts, including protecting source watersheds, drinking water and wastewater treatment infrastructure.

FOSTER PARTNERSHIPS TO ADDRESS COMMUNITY CONCERNS

A-5.4. Scale outreach programs to farms of all sizes, being inclusive of all crops, demographics, and regions.

L-5.5. Collaborate with foundations, non-profits, and community groups to foster greater engagement with State agencies on policy that can improve equity and grassroots resilience.

O-1.12. Safeguard cultural and archeological resources threatened by sea level rise and ensure California Native American tribes and other affected groups have a leadership role in planning efforts to address these impacts.

O-5.3. Conduct relevant outreach directly with specific marine resource users and sector communities, like fishers and seafood industry, who may be impacted by climate change.

P-1.7. Solicit input from mental health professionals, consumers and advisory boards, regarding how to reduce the mental health impacts of climate change, and to aid in recovery from these impacts.

P-2.12. Leverage efforts of national and state-wide organizations that are engaged in climate resiliency, such as the American Planning Association, American Public Health Association, Urban Land Institute, American Institute of Architects, American Society of Landscape Architects, American Public Works Association, Medical Society Consortium on Climate & Health, and others working at the intersection of climate change, equity, and health.

P-2.5. CDPH will promote and disseminate "Climate Change, Health, and Equity: A Guide for Local Health Departments" to assist local health departments with integration of climate change and health equity work into traditional public health programs and core functions.

P-6.6. Engage with The Alliance of Regional Collaboratives for Climate Adaptation (ARCCA) and its member regional climate collaboratives on urban heat island reduction efforts and other initiatives to advance health and climate resiliency benefits.

P-6.7. Through CDPH's Occupational Health Branch, participate on a Cal/OSHA advisory committee process to gather stakeholder input for legislation passed in 2016 (SB 11677; Chapter 839, Statutes of 2016) requiring Cal/OSHA to pass an occupational heat illness prevention standard applicable to indoor work environments by January 1, 2019.

P-6.8. Convene local public health departments to share best practices on health equity and climate change adaptation through CDPH CalBrace.

W-1.11. DWR and the Water Board will collaborate with federal, State and local agencies as well as the research and academic community to assess the adverse impacts to human health and safety, industries, water and other physical infrastructures, communities and ecosystems of floods and related extreme events.

T-1.2. Collaborate with local, tribal, and regional agencies to share and exchange data, tools, and maps in order to enable discussion of vulnerabilities, additional analysis, and coordinated adaptation planning.

DEEPEN AND FOCUS ENGAGEMENT WITH FRONTLINE COMMUNITIES

A-3.3. Seek input from communities with dairy-dependent economies regarding the benefits and drawbacks of different dairy management practices.

B-1.4. Engage and support local and tribal communities in their planning processes where significant ecological resources are concerned.

L-1.2. Require state entities and grantees to incorporate a variety of appropriate community engagement strategies, including identifying and engaging the most vulnerable individuals in a planning or project area, in all relevant land use planning and community development grant applications.

L-1.4. Explore opportunities to incorporate resident empowerment, leadership, and decision-making such as training programs, guided reviews of plans, neighborhood scans, and mapping activities as part of resident-led planning.

L-1.5. Directly engage urban, rural, vulnerable populations and disadvantaged communities to participate in the development of state guidance documents and other resources.

L-1.6. Explore funding and other resources to continue community based efforts to enhance participation of vulnerable populations and disadvantaged communities in land use decision making.

O-4.2. Incorporate input into vulnerability assessments from residents, beach users, local businesses, and other stakeholders affected through workshops and community events, and ensure that these workshops are accessible to the most vulnerable stakeholders.

O-5.2. Ensure that those most vulnerable to the impacts of sea level rise and coastal climate change have equity and agency in the decision-making process for coastal planning within their communities.

P-2.1. Identify opportunities for engagement and capacity building with vulnerable populations. Strengthen the skills, knowledge, and abilities of communities, local government planning and public health departments and community-based organizations (e.g. neighborhood associations) to participate in and influence decision-making processes.

P-2.10. Support outreach and engagement of farmworkers regarding strategies to address extreme heat, air quality, and worker health.

PC-1.13. Maximize opportunities for the public to participate in and inform coastal planning processes that affect recreational resources, including both residents of coastal communities and those who visit the coast to recreate, such as inland communities.

PC-3.2. Involve communities and stakeholders from the onset of urban park planning through robust outreach, feedback and consultation, and consensus seeking.

T-5.3. Engage public organizations and individuals to discuss the expected impacts of climate change on the transportation system, and to identify adaptation solutions that protect nearby communities, especially those with vulnerable and/or disadvantaged populations.

W-6.2. The Water Board will increase outreach to environmental justice and disadvantaged communities and Native American tribes in collaboration with non-governmental organizations.

CLIMATE JUSTICE EXAMPLE:

Inclusive Climate Adaptation Conversations

In January 2017, the State sponsored the California Climate Change Symposium in Sacramento, CA. Researchers, policy makers, practitioners and community leaders came together to discuss the opportunities and challenges arising from the evolution of climate change research. The California Natural Resources Agency, the Governor's Office of Planning and Research, and the non-profit Climate Resolve worked to create an open forum on how communities can drive the next generation of research to inform and empower communities and the government as partners in resilience. In an effort to enable participation of all voices, Resources Legacy Fund provided scholarships for Californians that work to advance environmental justice and social equity.

GOAL 2 | Identify the most vulnerable communities to climate change to prioritize initiatives and build local community-based capacity.

NEXT STEPS TO IMPLEMENT THIS GOAL ARE IDENTIFIED IN TWO KEY THEMES:

- Identify and prioritize populations that are low-income and otherwise disproportionately vulnerable to climate impacts.
- Directly build and support grassroots capacity to adapt to climate impacts.

To prioritize the most vulnerable, state agencies should use existing information and demographic indicators as a starting point for climate adaptation efforts. By working with organizers in communities and conducting robust public engagement, agencies can partner to address and improve pertinent quality-of-life factors. Supporting communities' abilities to address climate hazards is crucial for increasing resilience, but state agencies need to invest in relationships over time to build trust as partners in communities that have suffered historical injustice and disinvestment.

IDENTIFY AND PRIORITIZE POPULATIONS THAT ARE LOW-INCOME AND OTHERWISE DISPROPORTIONATELY VULNERABLE TO CLIMATE IMPACTS

E-6.1. Address equity issues identified in the Low-Income Barriers Study and link efforts related to its implementation to climate resilience.

E-6.3. Address programmatic, funding, and financing barriers for energy/water efficiency retrofits for low-income households and small businesses. Coordinate with local and tribal governments to provide low-income and disadvantaged community energy efficiency and demand response services.

EM-4.3. Ensure that the climate change-related impacts, which exacerbate risks to access and functional needs populations, are incorporated within all threat and hazard analysis conducted by the State.

EM-4.4. Utilize existing climate change projections and datasets to determine the impacts on access and functional needs communities at OAFN.

EM-4.5. Explore integration of access and functional needs demographic information within Cal- Adapt and other state agency resources and planning tools at OAFN.

L-4.5. Look for transferability of elements from the SB 350 Low-Income Barriers Study to realize potential synergies between emissions reduction and economic development initiatives, especially in low-income communities.

L-5.10. Assess and address the climate impact and hazard vulnerability of state funded or administered developments and facilities such as housing, shelters, migrant centers and mobile home parks that accommodate vulnerable populations including households with lower incomes or special needs (e.g., farmworkers, homeless, senior and persons with disabilities). Protect HCD and other state invested

properties from climate change, including special needs populations, mobile home and manufactured homes, by taking actions that mitigate climate risk. HCD will continue seeking out and collecting information that helps analyze geospatial information in the context of risks from climate change and hazard mitigation.

L-5.3. Ensure that vulnerable community members in rural areas are included in State equity strategies such as housing, health, employment, preparedness, education and climate justice.

O-1.10. Prioritize the remediation of hazardous material cleanup sites on the coast and in high flood risk areas so that they do not spread contamination later due to flooding.

O-1.11. Assess and plan for relocation, retrofit, inland migration, or replacement of coastal public access points, coastal recreation, and the landward migration of public trust lands so that the loss of beaches does not disproportionately burden the public, especially inland and underserved populations.

P-1.2. Support prioritizing residential energy efficiency funding and programs to populations with relatively higher exposures to impacts of climate change, vulnerability to impacts of climate change, and health disadvantage.

P-7.4. Identify populations with climate vulnerabilities or limited access to transportation to assist planning for climate-related emergency events, and to address access challenges during nonemergency times to build community adaptive capacities (i.e. improved pedestrian, bicycle, and trail infrastructure, and electric car share programs at affordable housing developments).

PC-3.1. Identify park-poor communities and ensure that new urban parks and trail systems are within walking distance to underserved populations and are connected to high-density infill, homes and offices

DIRECTLY BUILD AND SUPPORT GRASSROOTS CAPACITY TO ADAPT TO CLIMATE IMPACTS

F-1.5. Partner with California Native American Tribes (Tribes) to learn from Traditional Ecological Knowledge of prescribed fire and forest activities and form cooperative agreements to facilitate the application of indigenous knowledge.

F-1.8. Expand grants and cost share agreements to Tribes, public agencies, nonprofit organizations, and landowners for selectively removing hazardous wildlife fuels.

F-6.3. Work with Tribes to protect access to non-timber forest products and traditional activities such as cultural burns and activities related to subsistence in forests such as hunting, fishing, and trapping.

F-7.5. Develop county and regional fire readiness plans with input and engagement from fire safe councils, fire and land management agencies, Tribes, and individual community members; include provisions for local emergency response through cooperative fire protection agreements with local, State, and federal partners.

F-7.6. Further support landowner-initiated hazardous fuels reduction through grants, cost-share agreements, and streamlined permitting for hazardous fuels reduction activities.

L-2.1b. Work with local jurisdictions and communities using a variety of state adaptation resources to ensure that State efforts respond to local information and resource needs.

L-2.1d. Utilize funding resources as venues for technical assistance such as SGC's Sustainable Communities Planning Grant and Incentives Program that facilitate the adoption of best climate planning practices across the state, focusing particularly on disadvantaged and vulnerable communities.

O-4.1. Provide continual grants and funding for community-based vulnerability assessments.

O-5.5. Employ community-based habitat restoration, involving individuals, organizations, and academic institutions, in helping to improve and restore coastal habitat in their communities.

P-2.2. Support and strengthen community social networks and other assets to build climate resilience. For example, fund or solicit participation from schools, faith-based communities, neighborhood-based groups, health equity or environmental justice groups, and businesses in climate resilience planning. Learn from and disseminate best practices developed by community groups or local jurisdictions.

P-2.16. Seek to support sea-level rise planning and adaptation planning for resiliency in coordination with California Native American tribal governments.

W-6.1. The State will ensure disadvantaged communities receive an equitable and timely distribution of benefits from State processes and technical and financial assistance programs, and assist communities with climate change information about where climate change might pose undue burden.

W-6.4. DWR will award grants to small communities protected by facilities of the State Plan of Flood Control to complete feasibility studies that have the goal of increasing small community flood protection to the 100-year level. Improving the level of flood protection should include climate change projections.

W-6.5. The Water Board will develop funding guidelines for a new $9.5 million grant program that will improve access to clean drinking water in public schools and prioritize funding small disadvantaged communities.

W-6.6. The Water Board and the Office of Environmental Health Hazard Assessment will identify communities most vulnerable to climate change impacts to ensure access to information and technical assistance.

W-6.7. The Water Board will work to provide technical assistance and financial support to protect drinking water systems that are highly vulnerable to climate change impacts, with emphasis on disadvantaged communities and vulnerable populations as directed by the March 2017 resolution for comprehensive response to climate change.

CLIMATE JUSTICE EXAMPLE:

Swift Relief during California's Drought

With the assistance of Governor Brown's office, the State Water Resources Control Board, and other partners, the Rural Community Assistance Corporation offered the California Household Well Loan Program to assist California's hardest hit homeowners during one of the worst droughts on record. As time was of the essence, funding came swiftly from the non-profit organization to these homeowners, complete with information on inspections and maintenance and operations, water quality testing and water conservation.

GOAL 3 | Support and coordinate adaptation efforts across local, regional, and tribal jurisdictions and policy areas to maximize community resilience.

NEXT STEPS TO IMPLEMENT THIS GOAL ARE IDENTIFIED IN FOUR KEY THEMES:

- Develop, share, and implement best practices for promoting resilience in public policy.
- Coordinate across policy areas and jurisdictions.
- Coordinate adaptation initiatives by state agencies for maximum impact.
- Provide technical assistance to local governments and community groups to support adaptation planning.

New partnerships and cooperation are required to support vulnerable communities' resilience to climate impacts. From avoiding unintended negative impacts from adaptation actions to acknowledging systemic barriers to local capacity, a comprehensive approach to climate justice will require coordinating and sharing best practices across policy areas, jurisdictions, and state agencies. Local governments and communities must receive technical assistance and guidance to address vulnerabilities through climate planning.

The impacts of climate change are bringing completely new challenges to established institutions, and new levels and forms of coordination will be needed to adapt to emerging hazards.

DEVELOP, SHARE, AND IMPLEMENT BEST PRACTICES FOR PROMOTING RESILIENCE IN PUBLIC POLICY

F-5.7. Develop urban forestry protocols to ensure that communities are engaged in site choice and project development from the onset of planning.

L-2.6. Explore and disseminate best practices for building local capacity, including in disadvantaged communities and vulnerable populations.

L-2.9. Analyze and assemble best practices that empower residents to stay and thrive in their communities while improving resilience to climate change.

L-2.9a. In appropriate programs, integrate anti-displacement language like that found in the Affordable Housing and Sustainable Communities Program so that vulnerable populations are not pushed out of climate-safe and supportive neighborhoods.

L-5.6. Develop methods to assess the potential for displacement related to climate change and seek tools to preserve and maintain access to communities for vulnerable populations.

L-5.7. Make equity a key part of best practices dissemination, including the Sustainable Communities Grant and Incentives Program and Integrated Climate Adaptation and Resiliency Program clearinghouse.

L-5.8. Pilot the use of health and vulnerability screening and access to community development opportunities (e.g., regional opportunity index) tools to complement available tools for identifying disadvantaged communities.

P-1.1. Identify best practices and disseminate lessons learned from a pilot program whereby vulnerable populations with health conditions are referred by public health nurses for housing improvements such as weatherization, energy assistance, or appliance upgrades. Collaborate with the Department of Community Services and Development to assess the feasibility of expanding this model statewide.

COORDINATE ACROSS POLICY AREAS AND JURISDICTIONS

E-6.2b. Work with public health agencies to coordinate energy resilience and public health efforts.

EM-4.1. Assess opportunities for inclusion of the Equity Checklist in the guidance "Planning and Investing for a Resilient California" in order to ensure compliance with Executive Order B-30-15.

F-5.1. Establish local tree canopy cover goals (locally and regionally) and work towards the Forest Carbon Plan's objective of increasing total urban tree canopy statewide by one-third above current levels, to 20 percent coverage of urban areas by 2030.

F-5.5. Work with federal, research, and other entities to assist local governments and others in controlling the introduction and threat of pests and pathogens to urban forests.

F-5.6. Obtain and share tree canopy coverage data with local governments on a periodic basis and support adoption of long-term comprehensive urban forest management plans, including relevant tree inventories.

L-3.1. Track and promote general plan and other planning measures to address climate and hazard impacts such as the utilization of OPR's General Plan Guidelines update that provides guidance on how to incorporate climate consideration

P-1.5. Promote use of the Healthy Places Index (formerly the Health Disadvantage Index) and Climate Change and Health Vulnerability Indicators for California for use by local, regional, and state agencies to prioritize funding, community engagement, jobs, and services for communities facing disproportionate climate and health risks.

P-2.14. CDPH's Office of Health Equity will explore the mental health impacts of climate change and associated extreme events by identifying tools, resources, interventions, and best practices. This information will be shared with grantees of the California Reducing Disparities Project whose aims are to evaluate the effectiveness of community-defined evidence practices to reduce mental health disparities in African American, Asian and Pacific Islander, Latino, LGBTQ, and Native American communities.

P-5.2. Encourage partnerships between local emergency responders and local health departments to identify and reach vulnerable populations in need of access to cooling centers or personal cooling resources.

P-5.5. Encourage agencies to make resources available to support people suffering mental health consequences due to the emergencies caused by climate change.

PC-2.8. Work across federal, state, and local agencies to provide affordable parking, accessible and convenient transportation options, and shuttles to make inland, mountain, and freshwater recreation areas easier to reach and to minimize the impact of increased private vehicle use.

COORDINATE ACTIVITIES BY STATE AGENCIES

E-6.4. Work to coordinate energy-related programs that target low-income communities with broader climate adaptation efforts.

E-6.2b. Assess opportunities with the Department of Community Services and Development to coordinate on low-income weatherization and solar programs.

EM-4.2. Explore integration and utilization of all state resources and planning capabilities to address, accommodate, and meet the environmental justice impacts of climate change.

L-5.2. Work with the Office of Health Equity in the Department of Public Health to identify key strategies to link resilience efforts in public health, land use planning, and community development.

L-6.4. Ensure programs and investments across state government agencies address the need to consider climate change, including hazard avoidance and mitigation in state funding criteria and prioritize vulnerable populations and disadvantaged communities.

P-1.3. Support and create direct ties to health equity in the implementation of Senate Bill 350 (De León)1 by participating on the Governor's Office-led multi-agency Task Force, which is working to implement recommendations to increase access for low-income and other vulnerable communities to energy efficiency, renewable energy and clean transportation and mobility options.

P-1.4. Encourage combined funding of weatherization programs to the extent possible to improve housing conditions through a holistic "healthy homes" model that addresses energy efficiency, indoor air improvements, other housing improvements, and health improvement.

P-1.6. CDPH will, in collaboration with the Governor's Office of Planning and Research and Strategic Growth Council, provide technical assistance and monitoring of progress by State agencies toward protecting climate-vulnerable communities while accounting for climate change in all infrastructure and investment plans as required by Executive Order B-30-15.

P-2.15. CDPH will support the Office of the Governor surrounding the 2018 Global Climate Action Summit, providing input on the health and equity impacts of climate change and how mitigation and adaptation can lessen them.

P-3.6. Continue to provide CDPH input to State grant and program guidelines for identifying communities vulnerable to the health impacts of climate change, strategies to lessen vulnerability and promote health equity and resilience, and metrics to measure progress. Some examples include Senate Bill 1 (Beall) transportation programs, the Active Transportation Program, and Greenhouse Gas Reduction Fund Programs such as Transformative Climate Communities, Urban and Community Forestry Program, and Affordable Housing and Sustainable Communities grants.

P-5.3. Provide health equity input to the Governor's Office of Emergency Services, in collaboration with the Office of Access and Functional Needs, regarding planning efforts, such as the State Hazard Mitigation Plan and the Adaptation Planning Guide to address and integrate considerations for access and functional needs populations before, during and after climate-related incidents and events.

P-6.3. Provide CDPH health equity review of the literature and guidance on the upcoming Natural and Working Lands Implementation Plan, to be developed in 2018 by CNRA.

P-6.4. Consider collaborating with State agencies focused on green buildings and energy efficiency to include climate adaptation and health and equity considerations into State initiatives, planning, and policies, including updates to the California Building Code and California Energy Efficiency Standards.

P-6.5. Continue implementation of recommendations in "Preparing California for Extreme Heat", a 2013 multi-agency state guidance document.

T-4.9a. Work with the Governor's Office of Emergency Services to identify vulnerable segments that disadvantaged communities will rely on during future climate events to address inequitable impacts during emergencies.

PROVIDE TECHNICAL ASSISTANCE

F-5.2. Help local governments identify optimal locations for green infrastructure and increased tree canopy cover in the 372 communities identified in CAL FIRE's 2010 Forest and Rangeland Assessment as high-priority areas for urban tree planting in order to conserve energy and improve air quality.

F-5.3. Assist local governments and community organizations with establishing policies and management plans to develop urban forests and incentivize the use of best practices for the long-term maintenance and preservation of urban trees.

F-7.3. Provide State guidance and support for local and tribal governments, public agencies, and communities to implement fuel breaks, fire safe landscaping, removal of hazardous vegetation, inspections for fire safe clearance around homes, forest health treatment, fire prevention, and fire safe building standards that reduce human loss and property damage from wildland fires.

F-7.4. Assist local and tribal governments in integrating policies within general plans and other local planning documents that discourage development in the wildland urban interface to avoid putting more people at risk of extreme fire.

L-2.7. Promote local and regional performance targets for reducing climate impacts (like the urban heat island effect) and provide technical support for identification and implementation of measures to meet those goals.

L-2.1c. Develop new ways for communities to access technical support in implementing adaptation practices, prioritizing efforts to provide support to vulnerable communities.

L-3.4a. Support locally and regionally consistent adaptation planning via documents such as regional transportation plans, regional adaptation plans, local general plans, Local Agency Formation Commission municipal service reviews and other appropriate plans and programs.

L-3.5d. Consider changes to land use laws to integrate climate adaptation. Expand existing guidance and seek modifications to housing element and related law to integrate climate adaptation, including more clarity related to growth allocation methodologies (Regional Housing Need Allocation), sites planned for future growth and climate and hazard impact avoidance and mitigation strategies and analysis and programs for vulnerable populations.

L-5.4. Make climate justice in local planning a key connection to state activities around climate adaptation.

L-5.4a. Support local implementation of general plan statute requirements on climate justice.

O-1.3. Facilitate planning and implementation of adaptation measures in communities with unequal burdens from climate risks or insufficient resources to respond to these risks, and incorporate environmental equity into various grants for local adaptation.

P-5.4. Through CDPH, provide sample health equity language for climate change-related health impacts to local governments for updates of Local Hazard Mitigation Plans and general plan safety elements pursuant to Senate Bill 379 (Jackson).

P-6.9. Through CDPH, support incorporation of health, climate adaptation, and equity considerations in general plans, environmental impact assessments, climate action planning, and other planning processes.

GOAL 4 | Promote holistic approaches to climate adaptation that maximize co-benefits and economic development.

NEXT STEPS TO IMPLEMENT THIS GOAL ARE IDENTIFIED IN TWO KEY THEMES:

- Promote the integration of economic development and climate adaptation to provide sustainable and resilient benefits.
- Ensure that adaptation initiatives provide multiple co-benefits to improve the quality of life in vulnerable communities.

Supporting multiple co-benefits, including economic and workforce development, through adaptation promotes more holistic resilience to climate impacts. Adaptation initiatives in vulnerable communities must be environmentally, socially, and economically sustainable to be fully resilient. As jobs are created in the transition towards climate adaptation, workforce development and training opportunities can ameliorate the lack of investment historically underserved and vulnerable communities.

INTEGRATE ECONOMIC DEVELOPMENT AND CLIMATE ADAPTATION TO PROVIDE SUSTAINABLE AND RESILIENT BENEFITS

F-5.8. Support the creation of jobs, training programs, and workforce development in urban forest management, tree planting, and green infrastructure development to provide sustained economic benefit and ensure long-term capacity for maintenance.

F-6.7. Train individuals to enter wood products-related jobs by expanding related community college, youth, and apprenticeship programs.

L-4.3. Include metrics to track the progress of grantees in meeting workforce training, employment, and local business expansion goals under SGC's Transformative Climate Communities program.

L-4.4. Promote workforce training and development programs that help businesses become more resilient to climate change and disasters and accelerate the creation of green jobs in fields such as brownfield cleanup and redevelopment, urban agriculture, installation and maintenance of green energy and technologies, energy efficiency weatherization and retrofitting, planting and maintenance of urban forestry and parks, habitat restoration, and sustainable timber harvesting and biomass utilization.

L-4.6. Expand pathways to the CivicSpark Governor's AmeriCorps Initiative, California Conservation Corps, and associated workforce development programs that train and place Californians in professions that increase climate resilience.

PC-3.4. Create job, training, and internship opportunities in urban forestry and park development, planting, and maintenance to ensure their upkeep long-term and to benefit local economies.

CLIMATE JUSTICE EXAMPLE:

Education and Employment

Climate adaptation and resiliency offers new job opportunities of all types in all sectors of California's economy. The transformation in the energy sector to renewable energy generation, distribution, and storage serves as a notable example. Rising Sun Energy offers pre-apprenticeship job training program for adults, job placement assistance, and job opportunities for youth.

ENSURE THAT ADAPTATION INITIATIVES PROVIDE MULTIPLE CO-BENEFITS TO IMPROVE THE QUALITY OF LIFE IN VULNERABLE COMMUNITIES

A-2.2. Identify a process for estimating co-benefits to water and air quality at a community level.

F-5.9. Fund urban tree planting and green infrastructure projects where they yield multiple benefits such as energy reduction, storm water capture, or job creation.

F-7.11a. Conduct rapid post-fire assessments and project implementation to protect access and functional needs and other communities, to minimize flooding, protect water quality, limit sediment flows, and to reduce other risks.

O-2.3. Analyze the economic costs and co-benefits of managed retreat and nature-based infrastructure projects in comparison to grey alternatives, such as reduced flood risk and stormwater runoff; include market and non-market values (e.g. ecosystem services) in these evaluations.

O-2.8. Support and encourage the implementation of management strategies aimed at beach preservation, including beach nourishment projects and managed retreat efforts that maximize the beach's ecological and recreational values.

P-3.4. Take potential benefits and harm into account in transportation models used in local, regional, and state planning. CDPH works with Metropolitan Planning Organizations and other state agencies to integrate health and active transportation into transportation planning through tools such as the Integrated Transportation and Health Impacts Model (ITHIM).

P-7.2. Support prioritization of community greening funding based on identification of urban heat islands (with tools such as CalEPA's maps and Trust For Public Lands' Climate Smart Cities tool) and California Building Resilience Against Climate Effects' impervious surfaces data.

PC-2.4. Consider shading and usability of resources on hot days when designing inland trails, parks, and freshwater recreation areas and when acquiring new land for recreation.

PC-2.7. Promote water safety with robust public education, free life vests, and other safety measures.

PC-3.3. Ensure that communities have ownership of their neighborhood parks by integrating local cultural assets such as stories, public art, cultural activities, artists, and traditions into park design.

PC-3.5. Provide large trees to shade existing park recreation areas and trails in urban areas.

PC-3.6. Create new park designs that offer a variety of land cover including dense trees, scattered trees, and lawn to provide recreation opportunities and shading.

PC-3.7. Build trail connections to urban parks and green spaces to form a network of biking, walking, and equestrian options that increase the reach of parks.

PC-3.8. Retrofit existing facilities and underutilized spaces for parks when aligned with the community's vision for sites: consider converting vacant lots to community gardens, eliminating or consolidating parking lots, beautifying levees, remediating and reclaiming brownfields and vacant waterfronts, utilizing abandoned rail lines, and adding parks to decking over freeways or rooftops.

PC-3.9. Use climate-smart landscaping and native plants where possible to restore native habitat and decrease water use.

T-4.6. In the transit sector, provide service to cooling centers in easily accessible locations, encourage public transit design decisions that lower urban heat island, and use passive cooling where possible at transit stops.

GOAL 5 | Make equity an integral consideration for climate research.

Since the best available science is a foundational element of California's climate adaptation and mitigation strategies, equity must be an integral part of the State's research agenda.

Cutting-edge climate change research performed by scientists from a background of fields serves to refresh the State's understanding of impacts related to climate change. By including community members, research can offer relevant policy recommendations while simultaneously building public awareness and support. Climate research that incorporates concerns about equity and environmental justice issues is a critical element to promoting climate justice in the State's adaptation strategy.

E-1.1. Develop research strategies to downscale statewide data to community impacts to prepare for California's Fifth Climate Change Assessment.

E-1.3d. Continue supporting cross-sector research such as urban heat island effects (with public health) and low carbon vehicles and vehicle-grid integration (with transportation, waste, wastewater, and forests).

E-6.4. Investigate and address environmental justice issues around supporting community solar projects for low-income customers.

EM-1.3. Pursue and support research regarding climate impacts, identification of vulnerable populations and other risk factors, as well as the physical risks to essential services and facilities.

L-3.3. Analyze the locations of potential future growth in context to potential impacts of climate change for consideration as land use plans, policies and programs are proposed at the state, regional and local level.

L-5.1. Make equity a key consideration for State-funded research on and assessment of climate impacts.

L-5.1a. Use regional assessments that synthesize best available science as part of California's Fourth Climate Change Assessment to create baselines of knowledge about region-specific impacts to vulnerable communities.

O-4.4. Assess the vulnerability of archaeological and historic sites and cultural resources to sea level rise in coordination with California Native American tribes and the California Office of Historic Preservation.

O-4.8. Conduct integrated social-ecological climate vulnerability assessments on the impacts of ocean acidification and increased temperatures on California's marine and estuarine fisheries, fishing communities, and food supply and integrate results into climate-ready management strategies.

P-4.4. Utilize the new occupational health indicator on "incidence of work-related emergency department visits for heat illness" adopted by the CDPH Occupational Health Branch. Results are to appear in the 2017 California Wellness Plan Progress Report, and data are obtained from the Office of Statewide Health Planning and Development (OSHPD).

P-4.5. Through the CDPH Occupational Health Branch, complete a new analysis using California's Workers' Compensation Information System (WCIS). OHB has created a surveillance case definition for heat-related illness and will be extracting and analyzing claims from 2000 through 2016. The analysis will help to identify industries and occupations at highest risk, to inform prevention activities.

P-7.3. Through the Health in All Policies Task Force, facilitate the development of maps that layer school parcel data over urban heat island, urban tree canopy, and Disadvantaged Community (DAC) designations to identify school campuses located within priority communities, and will disseminate information on California Climate Investment opportunities regarding urban greening and forestry to educational agencies.

P-7.5. Evaluate negative health consequences of adaptation strategies that may worsen public health outcomes by exacerbating pollen, gentrification and displacement, vector borne disease, indoor air quality, or other impacts.

P-7.8. Identify a research agenda for climate adaptation and health equity with the California Energy Commission, which oversees climate research.

P-7.13. Convene partners to design a collaborative research plan to assess the health benefits or possible harms, including potential protection from poor air quality and extreme heat, associated with weatherization and energy efficiency services provided to low-income households in California, through CDPH coordination.

T-3.2. Develop economic assessment strategies for evaluating impacts of climate change on the state's transportation system which include social and environmental metrics in order to help facilitate alternatives analysis and project prioritization.

CLIMATE JUSTICE EXAMPLE:

Participatory Research with Communities Suffering From Environmental Injustice

IVAN (Identifying Violations Affecting Neighborhoods) connects community with people that can help solve local environmental problems. The environmental monitoring system is built on the idea that residents, those most impacted, are the most knowledgeable about their environment and therefore should have a place at the table with regulatory agencies. The IVAN model has expanded to seven locations in California with the support of the Department of Toxic Substances Control and local government agencies.

Measure Progress in a Transparent Way

While the Safeguarding California Plan includes actions focuses on the public sector setting, non-profit organizations, research think tanks, academic institutions and philanthropic partners serve as critical sources for evaluation. By establishing a baseline with key community characteristics through a community profile and community members, public agencies are able to track larger, but relevant, outcomes. For example, for public agencies to know how many people are experiencing homelessness may provide a quantitative goal for local communities. This information also helps to inform the work of public agencies across different policy arenas ranging from public health to housing to transportation to parks. Reporting this in a transparent way enables a wide range of stakeholders and community members to engage on the issue.

Guidance is being produced that will direct California's state government to take into account the complex intersections that contribute to vulnerability to climate impacts in all planning, policy-making, and investment decisions.

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Social Systems and the Built Environment

Each community is unique and will experience climate change differently, depending upon its built and natural environments and social, economic and demographic factors. The terms "social systems" and "built environment" refer to the interrelationships among individuals, groups, and institutions, as well as the physical constructed environment around them.

Safeguarding the public requires understanding the way that climate change can impact people's health and well-being, the critical infrastructure they rely on, their spatial environment, pre-existing inequities of power and resource distribution that impact resilience, and the way these factors interact. Public health and resilience to disasters requires reliable and durable roads, energy and water systems, health systems, housing, and other physical infrastructure crucial to maintain public safety under both acute and chronic effects caused by changing climatic conditions. In addition to stable physical infrastructure, public health and community climate resilience require strong social networks, viable safety nets and regulatory programs, and active engagement of communities in the decisions that affect their living conditions. Vibrant and prosperous communities must have the foresight to avoid emerging hazards while creating the social and physical foundations to rebound from systemic shocks, especially for those most vulnerable.

The dozens of recommendations and hundreds of ongoing actions that protect the social systems and the built environment from the impacts of climate change are presented in five chapters:

Emergency Management

Energy

Land Use and Community Development

Public Health

Transportation

The recommendations and ongoing actions of this chapter have inextricable linkages to the "Natural and Managed Resource Systems" chapter of this plan. Urban areas depend on ecosystem services from rural regions, and this connection is addressed throughout the document. Many issues straddle classifications of the built environment and natural and managed resources, such as drinking water and flood management infrastructure. This demonstrates the need for integrated and holistic approaches to climate adaptation.

Emergency Management

According to the United Nation's Intergovernmental Panel on Climate Change (the international body for assessing climate change and science), climate change will continue to increase the frequency and severity of extreme weather events.[1] Extreme weather is defined as events, such as droughts or floods, that have historically occurred on average only once in 100 years and vary from "the norm" in severity or duration. California is currently experiencing unprecedented impacts from extreme weather. Severe drought, which started in 2011-12, was intensified by the driest four-year statewide precipitation on record (2012-2015) and the smallest and second smallest recorded Sierra snowpack (2015 and 2014). Further, 2014, 2015, and 2016 were the warmest years on average.[2] In contrast, 51 out of 58 counties declared states of emergencies during the 2017 Winter Storms for flooding, which resulted in three federal disaster declarations.[3] Record breaking wildfires also continue to impact California with increasing frequency, size, and devastation. Two of the three largest wildfires in California's history have occurred in the past five years, burning a total of 529,225 acres.[4] In 2015 alone, two of the top ten most destructive wildfires in California's history occurred.[5] Climate change is anticipated to increase and exacerbate these and other hazards, including extreme heat events, sea level rise, tsunamis, and flooding associated with atmospheric rivers, like those experienced in the 2017 winter storms, as well as slower onset changes like rising temperatures which have additional impacts (e.g. increasing the severity of extreme heat events and wildfires). Climate change impacts emergency preparedness, response, and recovery; therefore, it is critical to ensure community resilience against its effects.

In the context of emergency management, the term **"mitigation"** refers to efforts to lessen potential adverse impacts of physical hazards. While many climate change-related documents reference climate change mitigation efforts that reduce human impacts on the climate system by reducing greenhouse gas emissions and enhancing greenhouse gas sinks, this chapter in particular focuses on hazard mitigation to reduce risk from climate impacts.

The Governor's Office of Emergency Services (Cal OES), which leads state disaster preparation, response, and recovery, continues to incorporate climate change-associated risks into the State's Multi-Hazard Mitigation Plan. It also works with local stakeholders to increase awareness of future climate change impacts and incorporate associated countermeasures in their local plans, as directed by the Legislature (Senate Bill 379, Jackson).

1 Core Writing Team, Pachauri, R.K., and Meyer, L.A. "Climate Change 2014: Synthesis Report." Intergovernmental Panel on Climate Change, 2015. http://www.ipcc.ch/report/ar5/syr/

2 Office of the State Climatologist. Hydroclimate Report Water Year 2015. Department of Water Resources, December 2016. http://www.water.ca.gov/climatechange/docs/2016/a3037_Hydroclimate_report_v11.pdf

3 Brown, Jr., Edmund G. "Governor Brown declares State of Emergency in counties across California following severe winter storms." Office of Governor Edmund G. Brown, Jr., January 2017. https://www.gov.ca.gov/news.php?id=19668

4 California Department of Forestry and Fire Protection. "Top 20 Largest California Wildfires." http://www.fire.ca.gov/communications/downloads/fact_sheets/Top20_Acres.pdf

5 California Department of Forestry and Fire Protection. "Top 20 Most Damaging California Wildfires." http://www.fire.ca.gov/communications/downloads/fact_sheets/Top20_Destruction.pdf

EMERGENCY MANAGEMENT

The Public Health and Emergency Management chapters of this document incorporate recommendations to address the vulnerabilities of at-risk communities, especially those with access and functional needs (i.e., people with disabilities, seniors, children, limited English proficiency, and transportation disadvantaged). Cal OES through its Office of Access and Functional Needs and our public health partners are working together to better understand climate change's impact on access and functional needs populations and collaboratively plan for these considerations.

Despite planning and mitigation efforts, disasters are not preventable and will inevitably continue to occur. Therefore, Cal OES will work with local, regional, state, federal, tribal, and private sector partners to incorporate climate change into longer-term resiliency strategies. This will enable the entire state to better withstand the increasing weather extremes that result from climate change. Ultimately, Cal OES strives for an emergency management discipline-wide approach to adaptation, interlocking all efforts toward a more resilient and climate-ready California.

HAZARD MITIGATION AT DONNER TRAIL ELEMENTARY SCHOOL

Climate change will prompt variable and unpredictable snowfall in California's mountainous areas. As extreme weather becomes more frequent, buildings and infrastructure must undergo renovations to withstand the impacts of these events. Donner Trail Elementary School in the Tahoe-Truckee Joint Unified School District is prone to receiving between 200-400 inches of snow in the wintertime. The school building, with a snow load rating of approximately 130 pounds per square foot in the winter (well below the Nevada County Building code's required 252 pounds per square foot) was at risk of collapse under the weight of an increased snow load. Recognizing the dangers to the building and the public health risk in the event of heavy snow accumulation, the District applied for the California Office of Emergency Services' Hazard Mitigation Grant for support in renovating the roof of the school and increasing the school's snow load capability to meet Building Code requirements. In January 2017 after the project was complete, the area experienced one of the worst winter storms and snowfalls on record with approximately 300 inches of snow. As a result of the facility's structural improvements, the school withstood what could have previously been a catastrophic winter event.

Clockwise from left: Donner Trail Elementary School from the outside; the interior of the roof before it was renovated to meet local building code specifications; the interior of the roof after it was renovated to meet building code requirements.

EM-1 | Employ research and deploy tools and data to demonstrate how climate change will affect all phases of emergency management and identify how climate change exacerbates factors and existing conditions that impact emergencies and disasters.

Research, resources, and data are the crucial underpinning for policy across California, and nowhere is science more critical to informing action than in emergency management. California is actively investing in the best available science including cutting-edge findings from California's Fourth Climate Change Assessment and the data it provides to the State's Cal-Adapt.org platform. Cal OES and its partners are working to incorporate the efforts to reduce climate risks through hazard mitigation activities where climate science provides critical support including, but not limited to: fire hazard reduction, enabling climate-resilient rehabilitation, and improving flood protection. These areas and many others will be important to managing risks and supporting disaster resiliency.

NEXT STEPS

EM-1.1. Review recent disasters (e.g. by utilizing data and tools developed in academia and in conjunction with California's Fourth Climate Change Assessment) and determine the extent to which they were exacerbated by climate change to better define appropriate countermeasures.

EM-1.2. Review and incorporate necessary updates to the California Adaptation Planning Guide, as directed by Senate Bill 246 (Wieckowski). This may include development of an interactive web application to support the state's Adaptation Planning Guides as well as utilizing novel climate relevant data and tools.

EM-1.3. Pursue and support research regarding climate impacts, identification of vulnerable populations and other risk factors, as well as the physical risks to essential services and facilities.

EM-1.4. Leverage both pre- and post-disaster assistance programs to support resilient planning, mitigation, and reconstruction that take into account future climate conditions, including:

- **EM-1.4a.** Leverage the Hazard Mitigation Grant Program to support resilient planning.
- **EM-1.4b.** Leverage the California Disaster Assistance Act to support resilient planning.

EM-1.5. Support risk-sharing mechanisms and advocate for climate-resilient development in areas vulnerable to hazards (e.g. fire, drought, and flooding) intensifiec by climate change.

ONGOING ACTIONS

- Continue to align Pre-Disaster Management and Flood Mitigation Assistance funding opportunities for projects that maximize whole community climate readiness and resilience.
- Continue to provide guidance to local communities on incorporating climate change risks and adaptation components into Local Hazard Mitigation Plans.

EM-2 | Enhance preparedness and coordination to address climate change impacts and inform emergency management policy.

A fundamental component of emergency management is effective interagency coordination across sectors and disciplines before, during, and after disasters. Preparedness and coordination mitigate damage from disasters and emergencies, including those events exacerbated by climate change. CalOES utilizes ad hoc and recurring advisory bodies to help guide the challenges of coordination across agencies on complex issues.

NEXT STEPS

EM-2.1. Improve integration of climate impacts and adaptation strategies into all phases of emergency management.

EM-2.2. Coordinate across agencies and levels of the emergency management sector to document mitigation efforts that achieve community and climate resilience.

EM-2.3. Develop and expand mechanisms and pathways to increase climate awareness and investments in resilience in all areas of the emergency management sector.

EM-2.4. Train and credential emergency management personnel within Cal OES and state government and across emergency management in California to ensure consistent and robust support to local emergency response efforts, bolster mutual aid, and provide for maximum surge capacity.

EM-2.5. Expand training and education opportunities to include courses that increase awareness, understanding, and competency about climate adaptation.

ONGOING ACTIONS

- Cal OES' Climate Change Working Group maximizes interagency coordination and information across programs to ensure projects and planning take into account impacts of climate change.
- As a convener and leader for coordinating emergency management actions, CalOES addresses climate change through a number of advisory bodies to ensure that planning, response strategies, and rebuilding efforts incorporate climate considerations.
  - The California Tree Mortality Task Force has been convened to address the Governor's State of Emergency Proclamation, and its working groups work on initiatives beneficial to climate adaptation in forests. This task force coordinates with state-level initiatives like the Forest Climate Action Team, the Forest Biomass working group, and wood products initiatives to further strategies that address tree mortality and associated climate impacts.[6]
  - The Fire Service Task Force on Climate Impacts is developing its final policy and operational recommendations associated with the effect of future conditions on California's fire service and the safety of Californians. The task force is working to evaluate the most current climate threats, science, studies and recommendations, and, as

necessary, develop new or updated recommendations related to wildfire preparedness and mitigation needed to successfully adapt to California's changing climate.

- Cal OES is also a key partner in implementing the Governor's State Water Action Plan, which is focused on increasing reliable water supplies, restoring important species and habitat, and creating more resilient, sustainably managed water resources that can better withstand inevitable and unforeseen pressures in the coming decades.
- Cal OES is the author of California's State Hazard Mitigation Plan, which encourages mitigation planning to protect the environment and to promote sustainable mitigation actions. In line with this priority, the plan aligns with the key principle of promoting and enhancing nature-based solutions, natural processes, and ecosystem benefits while minimizing adverse impacts to the environment. The plan also acknowledges, incorporates, and integrates recognized data on climate change impacts on hazards, risks, and vulnerabilities available from credible scientific sources, into state, local, tribal, and private sector mitigation plan, strategies, and actions.

6 Anderegg, William, et. al. "Tree mortality from drought, insects, and their interactions in a changing climate." *New Phytologist*, April 2015. https://www.fs.fed.us/rm/pubs_journals/2015/rmrs_2015_anderegg_w002.pdf

EM-3 | Incorporate climate considerations into emergency planning efforts at all levels.

Effective interaction between local, regional, state, federal, tribal, and private partners will help ensure that climate change consequences (e.g. extreme weather events) are considered in whole community planning and mitigation.

NEXT STEPS

EM-3.1 Consistent with other hazards such as earthquakes, integrate current and future climate projections into scenarios (to include exercises) that inform emergency planning and investments including:

- **EM-3.1a.** Incorporate climate considerations into wildfire emergency planning
- **EM-3.1b.** Incorporate climate considerations into inland flooding emergency planning, including impacts on levee and dam failure.
- **EM-3.1c.** Incorporate climate considerations into coastal flooding emergency planning, including tsunami risk and impacts from more extreme storms and rising seas
- **EM-3.1d.** Incorporate climate considerations into drought emergency planning
- **EM-3.1e.** Incorporate climate considerations into extreme heat emergency planning
- **EM-3.1f.** Incorporate climate considerations into emergency planning for secondary impacts to lifeline systems such as energy, transportation, and telecommunications during a climate change-exacerbated disaster
- **EM-3.1g.** Identifying barriers and solutions for properly integrating climate considerations into planning.

EM-3.2 Revise state guidance for Local Hazard Mitigation Plans to reflect climate adaptation requirements.

EM-3.3 Examine feasibility of integrating climate projections and sea-level rise (SLR) scenarios into Cal OES' MyHazards and MyPlan tools.

ONGOING ACTIONS

- The State Hazard Mitigation Plan, which is updated every five years, addresses climate-related hazards and mitigation efforts.
- Many ongoing research projects under California's Fourth Climate Change Assessment will directly inform state agency actions in emergency management.
- Cal OES will continue to incorporate best available science on climate risks in all phases of emergency management through existing protocols, systems, and reports including: the Threat Hazard Identification Risk Analysis, the State Preparedness Report, and agreements with private partners such as the California Utilities Emergency Association.

EM-4 | Identify access and functional needs communities exposed to greater risks from climate impacts and work collaboratively to build community resilience.

Extreme weather emergencies have disproportionate effects on individuals with disabilities and persons with access and functional needs. Access and functional needs considerations before, during, and after extreme weather emergencies include: reliance on electricity to power durable medical equipment and assistive devices; accessible transportation to and from cooling centers and shelters; limited resources to obtain air conditioning, health coverage, and building/home modifications; and accessible and multi-lingual preparedness materials. The Cal OES Office of Access and Functional Needs will collaborate with partners at all levels to integrate access and functional needs considerations into planning and mitigation.

NEXT STEPS

EM-4.1. Assess opportunities for inclusion of the Equity Checklist in the guidance "Planning and Investing for a Resilient California" in order to ensure compliance with Executive Order B-30-15.

EM-4.2. Explore integration and utilization of all state resources and planning capabilities to address, accommodate, and meet the environmental justice impacts of climate change.

EM-4.3. Ensure that the climate change-related impacts, which exacerbate risks to access and functional needs populations, are incorporated within all threat and hazard analysis conducted by the State.

EM-4.4. Utilize existing climate change projections and datasets to determine the impacts on access and functional needs communities at OAFN.

EM-4.5. Explore integration of access and functional needs demographic information within Cal-Adapt and other state agency resources and planning tools at OAFN.

ONGOING ACTIONS

- Cal OES' Office of Access and Functional Needs (OAFN) is continuing its collaborative approach and outreach efforts in increasing whole community preparedness, enhancing response, and encouraging local government agencies to partner together before disasters.

Energy

California's technology and environmental policies help power one of the world's largest economies. Supplying reliable and sustainable energy to this economic engine requires planning and policies underpinned by a commitment to utilization of the best available science.

California's energy infrastructure is designed to cope with the state's highly variable conditions and frequent disruptions from wildfires, storms and floods. But changing climate is expected to bring more frequent and intense natural disasters. Key climate parameters are starting to move outside of historically observed variability at a rate that makes historical data a poor predictor of future climate. For example, the warmest years on record in California occurred in 2014, 2015, and 2016. The 2016-17 water year broke the record as the wettest ever recorded in the northern Sierra Nevada mountains.

Changes in temperatures, precipitation patterns, extreme events and sea-level rise have the potential to decrease the efficiency of thermal power plants and substations, decrease the capacity of transmission lines, render hydropower less reliable, spur an increase in electricity demand, and put energy infrastructure at risk of flooding.

The State's bold targets for renewable energy, renewable distributed generation, energy efficiency, and building retrofits all bolster and incorporate climate adaptation. These goals provide more sources of supply and reduce demand, improving system reliability.

The California Energy Commission (CEC) and the California Public Utilities Commission (CPUC) are not waiting to address the ripple effects of climate disruption on the energy sector. In line with Governor Brown's directive to develop and utilize the best available science for planning and investment, the CEC and CPUC have prioritized actionable research. The energy sector is also working with vulnerable communities to better understand how to partner and invest for more resilient outcomes.

The State's bold targets for renewable energy, renewable distributed generation, energy efficiency, and building retrofits all bolster and incorporate climate adaptation. These goals provide more sources of supply and reduce demand, improving system reliability.

The State's high-level recommendations and next steps presented here represent new cutting-edge commitments for integrated energy policy.

ENHANCING ENERGY EFFICIENCY IN THE SANTEE UNIFIED SCHOOL DISTRICT

Climate Change is impacting energy needs in the state of California. During periods of extreme heat, for example, energy demand increases as more people rely on air conditioning to stay cool. As climate-related events become more frequent, improved energy efficiency will enhance the state's resilience to climate change. The Santee Unified School District recognized the opportunity to improve its energy efficiency by retrofitting the entire district with over 8,000 new LED lighting fixtures. In partnership with the California Conservation Corps' Vista Energy Center, California Energy Commission, Santee Unified School District, and Department of Education, the District used Proposition 39 funding to implement the project between June and September of 2016. With the new lighting fixtures, the district saves a projected 720,000 Kilowatt hours per year, which translates to 171 metric tons of annual greenhouse gas emission reduction. Not only does this project reduce the school's routine energy use and the cost of the utility, but prepares the district with more efficient means to maintain function during extreme climate events when energy demands fluctuate.

Image provided by the California Energy Commission.

E-1 | Continue to support climate research for the energy sector to better inform climate adaptation and mitigation strategies.

Multiple lines of evidence clearly demonstrate that the energy system is more vulnerable to climate impacts than previously believed.[1] For example, increased temperatures will decrease the efficiency of thermal power plants, transformers, and transmission and distribution lines and increase electricity demand.[2] Since all of these detrimental effects are amplified and happen simultaneously during heat waves, the cumulative impacts on the energy system would be more significant without adaptation measures. Additional research is needed to better understand how efforts to reduce emissions and safeguard the energy sector align. The 2015 *Climate Change Research Plan for California* and the *Electric Program Investment Charge Proposed 2018 through 2020 Triennial Investment Plan* describe high-level research needs.

NEXT STEPS

E-1.1. Develop research strategies to downscale statewide data to community impacts to prepare for California's Fifth Climate Change Assessment.

E-1.2. Continue the translation of key findings from the *Climate Change Research Plan* into action and results.

E-1.3. Further advance research on adaptation and mitigation for the energy sector, ensuring that analyses are coordinated with interdependent sectors.

- **E1.3a.** Analyze climate vulnerability of the petroleum sector.
- **E1.3b.** Continue supporting adaptation research for the natural gas sector.
- **E1.3c.** Support research on the water-energy nexus.
- **E1.3d.** Continue supporting cross-sector research such as urban heat island effects (with public health) and low carbon vehicles, and vehicle-grid integration (with transportation, waste, wastewater, and forests).

ONGOING ACTIONS

- The CEC is leading energy sector adaptation research for California's Fourth Climate Change Assessment.
- The CEC sponsors online climate change data on the DataBasin platform to support the Desert Renewable Energy Conservation Plan process, a multi-agency effort to protect desert ecosystems while identifying areas for renewable energy development.
- The CEC supports adaptation research for the natural gas sector via the Natural Gas Research and Development program.

1 Stoms, David, Guido Franco, Heather Raitt, Susan Wilhelm, Sekita Grant. 2013. Climate Change and the California Energy Sector. California Energy Commission. Publication Number CEC-100-2013-002. http://www.energy.ca.gov/2013publications/CEC-100-2013-002/CEC-100-2013-002.pdf.

2 California Energy Commission. 2013. 2013 Integrated Energy Policy Report. Publication Number: CEC-100-2013-001-CMF. http://www.energy.ca.gov/2013publications/CEC-100-2013-001/CEC-100-2013-001-CMF.pdf.

- The Energy Commission manages the EPIC Challenge: Accelerating the Deployment of Advanced Energy Communities program as a catalyst for pilot projects and innovation in the energy sector.
- The Energy Commission continues to study how renewable energy generation could be affected by climate change and how to integrate it effectively onto the electricity grid.

E-2 | Use common climate scenarios in all energy research and planning, and work to help standardize climate scenarios across state government planning and investment.

The Energy Commission has been a key player in creating standardized climate scenarios for state government planning and investment. It participated in the Executive Order B-30-15 Technical Advisory Group that developed guidance for State agencies on how to determine which climate scenarios to plan for in the future, and how to approach planning and investment in an uncertain and changing future. It is expected that the guidance will point to the same scenarios as the CEC's 2016 Integrated Energy Policy Report and the Climate Action Team Research Working Group. The Technical Advisory Group guidance will identify CEC's Cal-Adapt website, which synthesizes California climate change scenarios and climate impact research, as a resource for exploring climate scenarios compatible with its recommendations. The Ocean Protection Council will issue updated guidance on sea-level rise in early 2018, and efforts are underway to link its sea-level rise projections to ongoing climate scenario development.

NEXT STEPS

E-2.1. Ensure that state guidance to implement Executive Order B-30-15 is consistent with and supported by the best available science.

E-2.1a. Work with the Government Operations Agency to incorporate reporting on the vulnerability of state facilities to climate impacts into sustainability roadmaps of state infrastructure.

E-2.2. Share and discuss the scenarios developed for California's Fourth Climate Change Assessment with other state agencies.

E-2.2a. Assess the feasibility of making the climate scenarios used for the Fourth Climate Change Assessment more broadly accessible to the public.

ONGOING ACTIONS

- By assisting with the development of the Ocean Protection Council sea-level rise guidance document, the CEC is able to more tightly link emerging science on sea-level projections to ongoing climate scenario development and coordination.
- CEC has worked with the Department of Water Resources' Climate Change Technical Advisory Group to integrate its work with both CEC's ongoing energy research and planning and the Fourth Climate Change Assessment.
- The California Water Commission used the CEC and Department of Water Resources' work on best available climate science to create guidance for analysis of projects applying for funding from Proposition 1, the 2014 $7.5 billion water bond.
- The CEC gave Caltrans the climate scenarios being used for the California's Fourth Climate Change Assessment to inform ongoing vulnerability assessments of the state highway system.

E-3 | Continue incorporating implications of climate change into all energy sector planning and decision-making.

The CEC and the CPUC are committed to accelerating efforts to incorporate climate science and adaptation into landscape level and infrastructure planning activities. Building off the climate adaptation strategy developed for the Desert Renewable Energy Conservation Plan, the CEC accelerated the incorporation of climate change scenarios and improved planning tools according to the four guiding principles of Executive Order B-30-15: Prioritize win-win solutions for emissions reduction and preparedness, promote flexible and adaptive approaches, protect the state's most vulnerable populations, and prioritize natural infrastructure solutions. Recent adaptation legislation (Assembly Bills 1482 and 2800, Senate Bills 246 and 379) creates legal mandates to continue the work identified in the Executive Order. AB 2800 also requires the Natural Resources Agency to set up a process with scientists and engineers to identify how engineering codes and standards should be reviewed and updated so that infrastructure is designed to withstand climate change impacts. A report to the Legislature is due by the summer of 2018.

NEXT STEPS

E-3.1. Further investigate adaptation strategies through the CEC's 2017 Integrated Energy Policy Report.

- **E-3.1a.** The Energy Commission will continue to explore, in collaboration with CPUC and other energy entities, best practices for incorporating climate change and adaptation into the investor-owned utilities' and publicly owned utilities' planning processes.
- **E-3.1b.** The CEC will collaborate with the CPUC and other energy entities to incorporate the climate scenarios into energy planning. For example, the 2017 Integrated Energy Policy Report will identify climate parameters such as temperature extremes at specific locations and timeframes that can be drawn from the climate scenarios for energy planning purposes.

E-3.2. Support the implementation of Assembly Bill 2800 to promote climate-safe infrastructure, ensuring that its findings are also useful for the design of all energy-related infrastructure

E-3.3. Apply energy-related findings from the Fourth Climate Change Assessment to CEC and CPUC policy.

E-3.4. Complete and implement the 2017 Energy Adaptation Working Group action plan.

E-3.5. Coordinate cross-sector planning to maintain energy system resilience, including wildfire risk and biomass utilization, hydropower, and low carbon vehicles.

ONGOING ACTIONS

- The Energy Adaptation Working Group was established to implement the March 2015 energy sector implementation action plan. Its successes include bolstering the U.S. Department of Energy's Partnership for Energy Sector Climate Resilience.

- The implementation of the Renewable Portfolio Standard, which requires electricity retailers to purchase at least 33 percent of their power from renewable sources by the end of 2020, is informed by the AB 2800 Climate-Safe Infrastructure Working Group.
- The Energy Commission will continue to support the deployment of low carbon vehicle fueling infrastructure.
- Energy Commission staff is exploring options for incorporating climate impacts in energy equity indicators for Senate Bill 350 (De León).
- The Department of General Services is directing the diversification of electricity supply to state-owned facilities.

E-4 | Support local adaptation planning efforts and increase outreach about available analytical tools.

The state operates several programs to promote clean energy generation and energy efficiency. In January 2016, the CPUC issued a guidance document to investor-owned utilities calling for robust vulnerability assessments and resilience plans as part of their obligations under the U.S. Department of Energy's Climate Resilience Partnership Memorandum of Understanding.

NEXT STEPS

E-4.1. Work with privately and publicly owned utilities on resilience planning in concert with the U.S. Department of Energy under its Partnership for Energy Sector Climate Resilience initiative.

E-4.2. Work with California natural gas utilities to implement an initiative similar to the federal Partnership for Energy Sector Climate Resilience.

E-4.3. Encourage cooperation and collaboration between all utilities and the statewide Alliance of Regional Collaboratives for Climate Adaptation (ARCCA) and its member regional climate collaboratives that focus on specific regional needs.

ONGOING ACTIONS

- Continue to inform regional climate adaptation collaboratives and local entities about the resources and analytical tools available for adaptation work in the energy sector (e.g., Cal-Adapt and the web application Climate Console). Seek input from such groups about their information and decision support needs.
- The CEC continues to support local implementation of energy resilience measures through ongoing efforts, including:
  - customer-side renewable distributed generation.
  - microgrid incentives and support.
  - the Self-Generation Incentive Program.
  - energy efficiency programs.
  - water efficiency programs.
  - demand response strategies.
  - energy storage programs.

E-5 | Investigate means to provide long-term support for Cal-Adapt advancement, maintenance, and expansion.

Cal-Adapt (Cal-Adapt.org) is an interactive web data portal initially developed under the CEC's Public Interest Energy Research program to make California climate science available and accessible to the public, utilities, and decision makers. Senate Bill 379 (Jackson) requires local hazard mitigation plans developed by cities and counties to address climate adaptation and resilience. The legislation explicitly names Cal-Adapt as a source of information to help cities and counties assess local vulnerabilities to climate change. To date, Cal-Adapt has been sporadically funded through research grants for system upgrades and incorporation of new data. Now that the website is operational, the state needs to commit continuous funding to keep it operating in support of local climate adaptation/hazard mitigation planning. Funding also is needed to incorporate data from other sectors, an effort which cannot be funded from public goods charges in the electricity or natural gas programs.

NEXT STEPS

E-5.1. Provide peer-reviewed data from the Fourth Climate Change Assessment to the public through Cal-Adapt 2.0.

E-5.2. Seek ways to integrate all data and resources from the Natural Resources Agency portfolio of Fourth Climate Change Assessment projects into Cal-Adapt.

E-5.3. Support the development of tools based on the Cal-Adapt Application Program Interface to improve and enhance the capabilities and uses of Cal-Adapt while expanding its user base.

E-5.3a. Work with the Government Operations Agency and the California Department of Technology to help develop a tool that will provide relevant climate data for all state-owned facilities to inform management and sustainability.

ONGOING ACTIONS

- The UC Berkeley Geospatial Innovation Facility beta-tested a new update to Cal-adapt.org, and is making new datasets of downscaled climate impacts available on an ongoing basis.

E-6 | Increase climate resiliency in low-income and disadvantaged communities.

Senate Bill 350 (De León) requires the Energy Commission to study barriers to and opportunities for low-income and disadvantaged communities to increase access to energy efficiency and renewable energy investments and programs. The Low-Income Barriers Study finalized in December, 2016, recommends that the CEC's Electric Program Investment Charge Program should target 25 percent of technology demonstration and deployment funding for sites located in disadvantaged communities.

NEXT STEPS

E-6.1. Address equity issues identified in the Low-Income Barriers Study and link efforts related to its implementation to climate resilience.

E-6.2. Work to coordinate energy-related programs that target low-income communities with broader climate adaptation efforts.

- **E-6.2a.** Assess opportunities with the Department of Community Services and Development to coordinate on low-income weatherization and solar programs.
- **E-6.2b.** Work with public health agencies to coordinate energy resilience and public health efforts.

E-6.3. Address programmatic, funding, and financing barriers for energy/water efficiency retrofits for low-income households and small businesses. Coordinate with local and tribal governments to provide low-income and disadvantaged community energy efficiency and demand response services.

E-6.4. Investigate and address environmental justice issues around supporting community solar projects for low-income customers.

E-6.5. Make information more accessible to residents, recognize community needs, and include more robust outreach and targeted demonstrations in disadvantaged communities.

ONGOING ACTIONS

- The State is working with regional climate adaptation collaboratives and other organizations to ensure that the needs of low-income and disadvantaged communities are considered.
- The CEC released the Low-Income Barriers Study and committed to invest 25 percent of Electric Program Investment Charge technology and deployment funds for sites in disadvantaged communities.
- The Energy Commission is developing a framework and indicators to measure low-income customers' access to energy efficiency, weatherization, and renewable energy investments in California. Tracking progress on the indicators will be ongoing.

- As required by SB 350, the CPUC and the CEC are creating a Disadvantaged Communities Advisory Group to provide advice on programs proposed to achieve clean energy and pollution reduction.
- The CPUC has opened a proceeding to increase access to affordable energy in the San Joaquin Valley under AB 2672.

Land Use and Community Development

The Land Use and Community Development Sector plays a foundational role to how Californians are able to prepare for and respond to impacts related to climate change. Development patterns, land conservation and protection, and land management practices can help or hinder the State's long-term community health, environmental, and economic goals. California, with 50 million residents anticipated in 2050, can harness the multiple perspectives from its diversity, grow in prosperity, and protect and enjoy its natural bounty through deliberate and coordinated policy decisions. The ability for all Californians to withstand impacts to climate change is dependent on considering climate change impacts in policy discussions and coordinating public agencies, private landowners, community organizations, and philanthropic partners to address these issues.

> With climate change already making sudden and prolonged shocks more severe and frequent, Californians need to rely on each other more than ever.

In the 2018 Update to the Safeguarding California Plan, the Governor's Office of Planning and Research (OPR), the Department of Housing and Community Development (HCD), and the Strategic Growth Council (SGC) commit to a suite of strategies that advance climate adaptation and resiliency efforts.

These three state agencies will continue to develop policy guidance, coordinate cross-sector conversations, and administer grant programs. Partnership is key to these efforts, exemplified by initiatives such as the Integrated Climate Adaptation and Resiliency Program's Technical Advisory Council, the California Financing Coordinating Committee, No Place like Home Advisory Committee, and more.

The proposed suite of strategies also includes integrating hazards, including those related to a changing climate, in the State's policy guidance and grant programs. As climate change exacerbates inland and coastal flooding, wildfires, droughts, extreme heat and other hazards, Californians and their public agencies must make land use and community development decisions that prioritize long-term safety and resilience.

With 95% of Californians living in urban areas,[1] public agencies, community organizations, businesses and philanthropic partners are helping to highlight the benefits from walkable, mixed-income and mixed-use neighborhoods. These types of neighborhoods help people reach needed services, access public amenities such as parks, schools and libraries, and capitalize on cheaper forms of transportation such as walking, bicycling and public transportation. By helping to create these kinds of neighborhoods, public agencies can help foster relationships among neighbors that lead to better outcomes before, during, and after extreme events. With climate change already making sudden and prolonged shocks more severe and frequent, Californians will need to rely on each other more than ever. OPR, SGC and HCD can play a part in building a community of practice around the best approaches to land use planning and community development. These state agencies can then apply these approaches to their own grant programs and policy guidance. For example, SGC and HCD incorporate climate adaptation and resiliency as

1 U.S. Census Bureau. "Growth in Urban Population Outpaces Rest of Nation, Census Bureau Reports." March, 2012. https://www.census.gov/newsroom/releases/archives/2010_census/cb12-50.html

well as anti-displacement measures in the Affordable Housing and Sustainable Communities grant program. Also, HCD has incorporated disaster planning into the State's Community Development Block Grant (CDBG). Applicants that include strategies to address these issues receive more points in this highly competitive grant program.

The six recommendations described here each represent critical building blocks to not only prevent harm but also to improve the quality of life for all Californians.

STORMWATER CAPTURE AT KATELLA HIGH SCHOOL

Katella High School Stormwater Capture Project received a Drought Response Outreach Program for Schools (DROPS) grant from the State Water Resources Control Board to implement the use of Low Impact Development best management practices strategies for storm water capture and groundwater recharge at the high school. Katella High School in Anaheim, California qualifies as a Disadvantaged School, with 84% of students eligible for Free and Reduced Price Lunch. The project, designed to capture and infiltrate approximately 6 acre-feet per year of storm water and dry weather flows, replaced existing impervious surfaces with permeable pavers, vegetated bioswales, rain gardens, and native, water-wise gardens. In addition to capturing storm water, the project contributes to the high school's resiliency to impacts of climate change through urban greening and reduced urban heat island effect. The added vegetation helps reduce the risk of flooding while also conserving water. Stormwater infiltration is improved and both augments the local water supply and enhances stream habitat. Now that construction is complete, the high school continues to raise awareness about water sustainability through school and community education and outreach.

Image provided by the Anaheim Unified School District.

LAND USE AND COMMUNITY DEVELOPMENT

L-1 | Develop innovative governance models and equitable public engagement strategies to engage residents, especially vulnerable and disadvantaged communities, to be sustainable and resilient.

All Californians need to be provided with opportunities to effectively and genuinely participate in planning processes and development decisions, and they should clearly understand how they can address their current needs and be included in conversations that anticipate future risks. To build collective community support for climate adaptation, the State and local governments first need to raise awareness of climate hazards and build capacities to empower participation of everyone in the decision-making process. Participatory community events, trainings, web-based surveys, public workshops, and other events can be used to engage residents in the community planning process.

Public engagement must prioritize the most vulnerable communities. The State, in conjunction with local, regional, and tribal governments, should employ a variety of methods (e.g., translation services, accessible meeting places, etc.) and organizations, including those based in communities, to assure meaningful participation. State and local governments must continue to protect the most vulnerable populations, prioritizing investments to help prepare for and respond to the impacts related to climate change in disadvantaged communities.

NEXT STEPS

L-1.1. Highlight and share case studies that demonstrate how the State is partnering with local and tribal governments, stakeholders, and community leaders to successfully integrate climate preparation and readiness concepts into land use planning activities, resulting in neighborhoods that are engaged and intent on building a healthier and more resilient environment for its residents.

L-1.2. Require state entities and grantees to incorporate a variety of appropriate community engagement strategies, including identifying and engaging the most vulnerable individuals in a planning or project area, in all relevant land use planning and community development grant applications.

L-1.3. Develop and share innovative practices for public engagement in the development of state grant guidelines, policies, and programs.

L-1.4. Explore opportunities to incorporate resident empowerment, leadership, and decision-making such as training programs, guided reviews of plans, neighborhood scans, and mapping activities as part of resident-led planning.

L-1.5. Directly engage urban, rural, vulnerable populations and disadvantaged communities to participate in the development of state guidance documents and other resources.

L-1.6. Explore funding and other resources that continue community-based efforts to enhance participation of vulnerable populations and disadvantaged communities in land use decision making.

L-1.7. Support engagement and outreach regarding changes in the California Environmental Quality Act guidelines that address long-term environmental impacts of projects per the California Supreme Court's decision in California Building Industry Association v. Bay Area Air Quality Management District.

ONGOING ACTIONS

- SGC engages local governments and diverse segments of neighborhoods and communities by leading extensive public outreach efforts and community workshops in order to gather input and integrate local perspectives into grant programs such as SGC's Transformative Climate Communities grant program.
- Community engagement is a scored component of SGC grant programs, including the Affordable Housing and Sustainable Communities grant, the Sustainable Communities Grant and Incentive Program, and prior grant programs such as rounds 2 and 3 of the Proposition 84 Sustainability Grants Program.
- The State is investing in social science research on overcoming governance and financing barriers to climate adaptation in the Fourth Climate Change Assessment, which will help spur new models that better address the needs of communities pertaining to the impacts of climate change.
- HCD's 2017 Community Development Block Grant Notice of Funding Availability requires community participation and includes disaster resiliency planning and furthering fair housing as priority activities.

L-2 | Provide technical support, guidance, and capacity building to implement climate adaptation initiatives in local, regional, tribal, and state governments and communities.

To advance local adaptation implementation, local governments, tribes, and community groups need the most up-to-date information, skills, abilities and knowledge on both climate impacts and solutions. The state has a role to disseminate information, update guidance and support efforts to build local capacity. For example, under the umbrella of the Integrated Climate Adaptation and Resiliency Program, the State of California is organizing many ongoing initiatives that provide information, case studies, technical and analytical resources, and support to jurisdictions. This program, which includes an advisory council of local, regional, and State leaders, will take on the critical task of coordinating these initiatives with local partners to ensure State resources respond to local needs. By expanding access to information and resources and supporting local capacity, the state can better assure effective climate related planning and investment.

NEXT STEPS

L-2.1. Collect, organize and carry out information, training and outreach for coordinated state, regional, and local adaptation action through efforts such as the Integrated Climate Adaptation and Resiliency Program.

- **L-2.1a** Develop the Adaptation Clearinghouse to compile and point to adaptation resources, including best available science and research, local implementation case studies, policy guidance, and links to funding and analytical resources.
- **L-2.1b.** Work with local jurisdictions and communities using a variety of state adaptation resources to ensure that State efforts respond to local information and resource needs.
- **L-2.1c.** Develop new ways for communities to access technical support in implementing adaptation practices, prioritizing efforts to provide support to vulnerable communities.
- **L-2.1d.** Utilize funding resources as venues for technical assistance such as SGC's Sustainable Communities Planning Grant and Incentives Program to facilitate the adoption of best climate planning practices across the state, focusing particularly on disadvantaged and vulnerable communities.

L-2.2. Support the update of the Adaptation Planning Guide, prepared by the California Emergency Management Agency (now the Office of Emergency Services) and the Natural Resources Agency, to reflect the best available science, best local adaptation practices, and current state policy.

L-2.3. Update guidance included in OPR's General Plan Guidelines document on a regular basis to reflect industry practice and norms, case studies and other appropriate content for use by local governments in developing responses to climate change.

L-2.4. Provide technical assistance to disadvantaged communities to facilitate their participation in the development of state guidance documents and other resources.

L-2.5. Continue to support local capacity building. One example of this effort is CivicSpark, a Governor's AmeriCorps Initiative to build local government capacity to address climate change and land use related challenges in line with State goals. The initiative places professionals in local governments around the state to build local capacity and support climate action.

L-2.6. Explore and disseminate best practices for building local capacity, including in disadvantaged communities and vulnerable populations.

L-2.7. Promote local and regional performance targets for reducing climate impacts (like the urban heat island effect) and provide technical support for identification and implementation of measures to meet those goals.

L-2.8. Ensure that best available science continues to be available through Cal-Adapt.org.

L-2.9. Analyze and assemble best practices that empower residents to stay and thrive in their communities while improving resilience to climate change.

L-2.9a. In appropriate programs, integrate anti-displacement language like that found in the Affordable Housing and Sustainable Communities Program so that vulnerable populations are not pushed out of climate-safe and supportive neighborhoods.

ONGOING ACTIONS

- SGC is developing a technical assistance program to support disadvantaged communities and provide assistance to enable these communities to develop competitive plans and applications for programs supported by the Greenhouse Gas Reduction Fund.
- Through the Integrated Climate Adaptation and Resiliency Program, OPR has convened a Technical Advisory Council that seeks to advance local implementation plans through coordination and communication.
- OPR supports CivicSpark, a Governor's AmeriCorps initiative, so that its services are aligned with State priorities.
- OPR is an ex-officio board member of the Alliance of Regional Collaboratives for Climate Adaptation, helping to connect climate priorities of major regions in California to State goals, policy initiatives and program efforts.
- The Sustainable Communities Grant and Incentive Program provides funding for local governments to develop and implement best practices that can be highlighted and transferred to jurisdictions around the state.
- The Fourth Climate Change Assessment has several ongoing projects that support local government climate actions through technical assistance, data, and tool development.

L-3 | Coordinate state laws, regulations, guidelines and policies to promote climate resilience and hazard avoidance and mitigation through local, regional and state planning.

The State supports many aspects of local and regional planning. Integrating climate change considerations in local planning processes (e.g., general plans, zoning, etc.) will be an ongoing and iterative process. This recommendation provides next steps for aligning state laws, regulations, guidance and local practice for climate resilience.

In 2015, the State defined a resilient community in its successful application to the National Disaster Resilience Competition administered by the U.S. Department of Housing and Urban Development:

> *A resilient community is able to resist and rapidly recover from disasters or other shocks with minimal outside assistance. Reducing current and future risk is essential to the long-term vitality, economic well-being, and security of all communities. By identifying future risk and vulnerabilities, resilient recovery planning can maximize preparedness, save lives, and bring benefits to a community long after recovery projects are complete.*

This vision for resilient communities drives next steps and ongoing actions to boost resilience for Californians where they live.

NEXT STEPS

L-3.1. Track and promote general plan and other planning measures to address climate and hazard impacts such as the utilization of OPR's General Plan Guidelines update that provides guidance on how to incorporate climate considerations (Senate Bill 379) and environmental justice (Senate Bill 1000) in local general plans.

- **L-3.1a.** Track and evaluate implementation of Senate Bill 379 through zoning codes, grading ordinances, subdivision regulations, development incentives and other tools. Pursue approaches (e.g., funding, regulatory, education and assistance) to assure effective implementation, as appropriate.

L-3.2. Improve monitoring and evaluation of hazard areas with residential development.

L-3.3. Analyze the locations of potential future growth in context to potential impacts of climate change for consideration as land use plans, policies and programs are proposed at the state, regional and local level.

L-3.4. Develop and adopt guidance for how State agencies can support local government efforts on climate change.

- **L-3.4a.** Support locally and regionally consistent adaptation planning via documents such as regional transportation plans, regional adaptation plans, local general plans, Local Agency Formation Commission municipal service reviews and other appropriate plans and programs.

L-3.5. Ensure plans, policies, guidance, regulations and laws across state, regional and local governments address the need to consider climate change.

L-3.5a. Seek approaches to incorporate climate adaptation into regional transportation plans and Sustainable Communities Strategies.

L-3.5b. Continue to integrate climate impacts and hazard avoidance and mitigation in state level planning and guideline activities such as the Environmental Goals and Policy Report, General Plan Guidelines, Statewide Housing Assessment, California Water Plan and State Transportation Plan.

L-3.5c. Pursue training and other resources for state entities to implement integration of climate adaptation in planning and investments.

L-3.5d. Consider changes to land use laws to integrate climate adaptation. Expand existing guidance and seek modifications to housing element and related law to integrate climate adaptation, including more clarity related to growth allocation methodologies (Regional Housing Need Allocation), sites planned for future growth and climate and hazard impact avoidance and mitigation strategies, and analysis and programs for vulnerable populations.

L-3.6. Assess and build on the work of the Assembly Bill 2800 Climate-Safe Infrastructure Working Group, which will assist in incorporating climate change in all state infrastructure engineering, in the context of State building codes and standards.

ONGOING ACTIONS

- OPR's Annual Planning Survey tracks on-the-ground progress that local governments are making in the areas of planning and climate action.
- Newly updated General Plan Guidelines incorporate climate change and environmental justice throughout the General Planning process.
- The Integrated Climate Adaptation and Resiliency Program's Technical Advisory Council provides a collaborative forum for state, regional and local governments to identify and guide state policy with local climate resilience practice.
- OPR's State Adaptation Clearinghouse provides resources to support local, regional and state planning for climate change adaptation.
- The *Safeguarding California* Climate Action Team provides an internal State venue to align State, local, and regional policy, planning, programs and practices.
- The Alliance for Regional Collaboratives for Climate Adaptation provides an opportunity for external coordination between state, regional and local entities.
- The State's Community Development Block Grant Program has been utilized to address pressing impacts like drought in flexible ways.
- The State's Community Development Block Grant Notice of Funding Availability already has been modified for disaster mitigation, demonstrating an ongoing integration of climate change.

L-4 | Integrate economic development initiatives with programs designed to bolster resilience.

Communities can support long-term, secure livelihoods for their residents through diverse economic development and employment opportunities. Business support, skills training programs, and access to financing options can help people and businesses respond to natural disasters and economic challenges linked to climate change.

NEXT STEPS

L-4.1. Actively identify and catalog opportunities to replicate or scale-up elements of the Community and Watershed Resilience Program being implemented to support post-Rim Fire recovery and resilience in Tuolumne County. (The Program is funded through a National Disaster Resilience Competition grant.)

L-4.2. Identify and develop innovative and equitable market-based strategies to support new approaches for implementing and financing resilience projects in communities and natural systems. This includes engaging with the insurance industry and piloting new methods such as environmental impact and enhanced infrastructure financing or pay-for-success approaches.

L-4.2a. Work to implement the recommendations from the Natural Resources Agency's Wood Products Working Group to address climate resilience and economic development.

L-4.3. Include metrics to track the progress of grantees in meeting workforce training, employment, and local business expansion goals under SGC's Transformative Climate Communities program and other state climate initiatives where applicable.

L-4.4. Promote workforce training and development programs that help businesses become more resilient to climate change and disasters and accellerate the creation of green jobs in fields such as brownfield cleanup and redevelopment, urban agriculture, installation and maintenance of green energy and technologies, energy efficiency weatherization and retrofitting, planting and maintenance of urban forestry and parks, habitat restoration, and sustainable timber harvesting and biomass utilization.

L-4.5. Look for transferability of elements from the SB 350 Low-Income Barriers Study to realize potential synergies between emissions reduction and economic development initiatives, especially in low-income communities.

L-4.6. Expand pathways to the CivicSpark Governor's AmeriCorps Initiative, California Conservation Corps, and associated workforce development programs that train and place Californians in professions that increase climate resilience.

ONGOING ACTIONS

- The Natural Resources Agency is collaborating with a broad range of agencies on the implementation of Senate Bill 859 (Committee on Budget and Fiscal Review) through the development of recommendations by the Wood Products Working Group, which should lead to actions that tie economic development and resilience to climate impacts.
- The State's Community Development Block Grant Program provides investments for economic development in many disadvantaged areas, and HCD has incorporated climate considerations into this program.
- HCD is administering over $70 million in federal funds from the National Disaster Resilience Competition to be invested in Tuolumne County, for recovery from the Rim Fire, in partnership with other state, federal, and local partners. The goal of this program is to support rural economic development and environmental resilience through community, forestry, and biomass utilization strategies.

L-5 | Ensure a coordinated and robust strategy is implemented across state, regional, local, and tribal governments to the state's most vulnerable populations and disadvantaged communities.

Climate change is already affecting California and it disproportionately affects the state's most vulnerable populations. The Governor and Legislature have indicated that protecting vulnerable populations is a guiding priority in all State climate adaptation plans, projects and investments. The following activities reflect the ongoing and future efforts tailored to achieve this outcome. Many of these activities intentionally engage with vulnerable populations as partner stakeholders.

NEXT STEPS

L-5.1. Make equity a key consideration for State-funded research on and assessment of climate impacts.

- **L-5.1a.** Use regional assessments that synthesize best available science as part of California's Fourth Climate Change Assessment to create baselines of knowledge about region-specific impacts to vulnerable communities.

L-5.2. Work with the Office of Health Equity in the Department of Public Health to identify key strategies to link resilience efforts in public health, land use planning, and community development.

L-5.3. Ensure that vulnerable community members in rural areas are included in State equity strategies such as housing, health, employment, preparedness, education and climate justice.

L-5.4. Make climate justice in local planning a key connection to state activities around climate adaptation.

- **L-5.4a.** Support local implementation of general plan statute requirements on climate justice.

L-5.5. Collaborate with foundations, non-profits, and community groups to foster greater engagement with State agencies on policy that can improve equity and grassroots resilience.

L-5.6. Develop methods to assess the potential for displacement related to climate change and seek tools to preserve and maintain access to communities for vulnerable populations.

L-5.7. Make equity a key part of best practices dissemination, including the Sustainable Communities Grant and Incentives Program and Integrated Climate Adaptation and Resiliency Program clearinghouse.

L-5.8. Pilot the use of health and vulnerability screening and access to community development opportunities (e.g., regional opportunity index) tools to complement available tools for identifying disadvantaged communities.

L-5.9. Explore potential for prioritizing vulnerable populations in disaster recovery efforts.

L-5.10. Assess and address the climate impact and hazard vulnerability of state funded or administered developments and facilities such as housing, shelters, migrant centers and mobile home parks that accommodate vulnerable populations including households with lower incomes or access and functional needs (e.g., farmworkers, homeless, senior and persons with disabilities). Protect HCD and other state invested properties from climate change, including housing for access and functional needs populations, mobile home and manufactured homes, by taking actions that mitigate climate risk. HCD will continue seeking out and collecting information that helps analyze geospatial information in the context of risks from climate change and hazard mitigation.

ONGOING ACTIONS

- The General Plan Guidelines, updated in 2017, outline how to meet new requirements for addressing environmental justice. OPR will conduct workshops throughout the state in 2017 and 2018 and provide ongoing technical support on meeting the new requirements.
- The Integrated Climate Adaptation and Resiliency Program Technical Advisory Council and Adaptation Clearinghouse will continue to support discussions, policy development and resources to continue progress in addressing climate justice communities.
- The Department of Public Health is producing county climate health profiles that compile demographic and climate risk information as part of its California Building Resilience Against Climate Effects program.

L-6 | Provide financial assistance to promote investment in climate adaptation through land use and community development.

The State is committed to reducing vulnerability and addressing climate risk through its investments in housing and community development. While the varying objectives of programs and agencies in this space make it difficult to analyze the efficacy of their outcomes as a whole, the State must strive to continually improve the ways it invests in and builds resilience as well as grow those investments. Across state agencies, efforts should continue to integrate climate adaptation with financial support for other priorities such as infill and compact development, affordable housing, and land conservation. These efforts will be part of a broader exploration of innovations and resources to improve resilience through land use and community development policy in California.

NEXT STEPS

L-6.1. Explore innovative approaches to finance local adaptation and resilience planning and projects and in existing programs/funding opportunities.

L-6.2. Continue to incorporate climate adaptation in new financial resources.

L-6.3. Continue to pursue approaches to disseminate information on funding opportunities to local and regional bodies, including technical assistance to potential applicants. Approaches should prioritize vulnerable populations and disadvantaged communities and could include clearinghouses, targeted and regular forums with multiple state agencies, and models such as the California Financing Coordinating Committee.

L-6.4. Ensure programs and investments across state government agencies address the need to consider climate change, including hazard avoidance and mitigation in state funding criteria and prioritize vulnerable populations and disadvantaged communities.

L-6.5. Utilize adaptation coordination efforts by CNRA and the Safeguarding California Climate Action team to promote financial assistance for land use and community development issues among SGC, HCD, Caltrans, DWR, the State Water Resources Control Board, Infrastructure and Development Bank, Housing Finance Agency, and Tax Credit Allocation Committee.

L-6.6. Explore new financial public and private resources to address climate adaptation in land use and community development.

L-6.7. Regularly evaluate the effectiveness of integrating climate adaptation into investments and modify programs, as appropriate.

ONGOING ACTIONS

- The State has many grant programs that support the goals of this recommendation, including:
  - The Affordable Housing and Sustainable Communities Program (SGCand HCD), which provides grants and affordable housing loans for compact transit-oriented development and related infrastructure and programs that reduce greenhouse gas emissions. Anti-displacement strategies are one consideration in administering allocation for the Affordable Housing and Sustainable Communities Program.
  - The Transformative Climate Communities Program (SGC), which supports the development and implementation of neighborhood-level transformative climate community plans that provide local economic, environmental, and health benefits to disadvantaged communities through multiple, coordinated GHG emissions reduction projects.
  - The Urban Greening Grant Program (Natural Resources Agency), which funds projects that transform the built environment into places that are more sustainable, enjoyable, and effective in creating healthy and vibrant communities. Projects will establish and enhance parks and open space, use natural solutions to improve air and water quality and reduce energy consumption, and create more walkable and bikeable trails, all while reducing greenhouse gases by sequestering carbon, decreasing energy consumption and reducing vehicle miles traveled.
  - The Urban and Community Forestry Grant Program (CAL FIRE), which provides funding to local governments and nonprofits for tree planting and urban forest expansion and improvement, urban forest management, and urban wood and biomass utilization.
  - The Sustainable Agricultural Land Conservation Program (SGC/Department of Conservation), which provides funding for conserving prime agricultural lands to support compact development and sustainable communities.

Public Health

The task of public health is to promote and protect the health of communities where they live, work, and play. While a doctor focuses primarily on treating individuals who are sick, the public health professional looks at the population level and concentrates on preventing people from becoming sick or injured in the first place. From conducting scientific research and monitoring diseases to educating the public and developing public policy that supports healthy behaviors and environments, the field of public health works to assure the conditions in which people can be healthy.[1]

Climate change threatens public health, as it is linked to more extreme heat and other severe weather events, frequent wildfires and droughts, a decline in air quality, rising sea levels, increases in allergens and in communicable and other diseases.[2] Climate change also threatens basic human life support systems – our water, air quality, food, shelter, and security. The resulting human health impacts are varied and include increases in the risk and occurrence of asthma, allergies, and other respiratory ailments, cardiovascular disease, vector-borne diseases, mental health impacts, civil conflicts and migrations, malnutrition, injuries, and heat-related illness and death.[3, 4] Climate change threatens the health and well-being of California's diverse population of nearly 40 million people and poses immense challenges for advancing health equity. Thus, it is imperative to both reduce greenhouse gas emissions that drive climate change, and simultaneously identify people most vulnerable to the health impacts of climate change already occurring and likely to get worse. Having identified people at highest risk, government can take action to lessen their vulnerability and increase their capacity to adapt to the impacts of climate change by prioritizing planning, resources, and services for them.

Climate change threatens the health and well-being of California's diverse population of nearly 40 million people and poses immense challenges for advancing health equity. Thus, it is imperative to both reduce greenhouse gas emissions that drive climate change, and simultaneously identify people most vulnerable to the health impacts of climate change already occurring and likely to get worse.

The individuals most vulnerable to the health impacts of climate change often live in the same communities that experience health inequities, which are systemic differences in health status that are preventable.[5] This includes people with low-incomes, some communities of color, people with existing health conditions such as chronic diseases and mental illness, people with disabilities, people experiencing homelessness, outdoor workers (i.e. those involved in construction, landscaping, farming, oil and gas extraction), incarcerated and formerly incarcerated people,

1 American Public Health Association. "What is Public Health?", 2015. https://www.apha.org/what-is-public-health.

2 Costello, Anthony, Mustafa Abbas, Adriana Allen, Sarah Ball, Sarah Bell, Prof Richard Bellamy, Sharon Friel, Nora Groce, Anne Johnson, Maria Kett, Prof Maria Lee, Caren Levy, Prof Mark Maslin, David McCoy, Bill McGuire, Hugh Montgomery, David Napier, Christina Pagel, Jinesh Patel, Jose Antonio Puppim de Oliveira, Nanneke Redclift, Hannah Rees, Daniel Rogger, Joanne Scott, Judith Stephenson, John Twigg, Jonathan Wolff, and Craig Patterson. "Managing the health effects of climate change." The Lancet Commissions 373 (9676): 1693-1733, 2009.

3 California Natural Resources Agency. "2009 California Climate Adaptation Strategy.", 2009

4 California Natural Resources Agency. "Safeguarding California: Reducing Climate Risk.", 2014

5 California Department of Public Health. "Portrait of Promise: The California Statewide Plan to Promote Health and Mental Health Equity. A Report to the Legislature and the People of California by the Office of Health Equity." Sacramento, CA, 2015.

immigrants (especially those with undocumented status), tribal communities, and geographically isolated people.[6] Young children, elderly people, and pregnant women also experience greater vulnerability to the health impacts of climate change.

People experiencing health inequities face additional challenges, as they are likely to have fewer resources to prepare for, adapt to, and recover from the health effects of climate change, whether that be sudden storms, fires, or changes to crop viability. Yet these communities have also developed skills, assets, and social networks to survive political, social, and economic challenges that have increased their capacity for resilience to inequities. Fostering health equity involves supporting development of resilience assets in communities facing inequities.

In addition to threatening people's health, climate change threatens health care facilities. Facilities can be harmed by extreme weather events. They can also experience slow but steadily increasing demand for health care services, such as dialysis centers if kidney disease increases with increasing heat and drought, home care providers if debilitating chronic diseases are exacerbated, and laboratory services to detect diseases borne by water, insects, or other vectors.

This chapter describes current actions and next steps to reduce vulnerability and protect people's health that are under the purview of the California Department of Public Health (CDPH), the California Environmental Protection Agency (CalEPA) and its Office of Environmental Health Hazard Assessment (OEHHA), and other state agencies.

The agency or program responsible for the action items has been identified wherever possible. Where no agency or program is identified to carry out the action items, the activity was deemed important enough to include in the document, but implementation will require collaborative approaches.

6 Shonkoff, Seth B., Rachel Morello-Frosch, Manuel Pastor, Jim Sadd. "The climate gap: environmental health and equity implications of climate change and mitigation policies in California—a review of the literature." Climatic Change, 485-503, 2011.

UPGRADING STREETS, SIDEWALKS, AND ALLEYS FOR A RESILIENT AND HEALTHYCALIFORNIA

California State Water Resources Control Board provided multiple grants from the Proposition 84's Storm Water Grant Program to the City of Santa Barbara to implement Low Impact Development (LID) designs within parking lots, alleys, and streets. The City replaced more than 230,000 square feet of asphalt and concrete with permeable interlocking concrete pavers to treat stormwater, allow runoff to infiltrate into the soil, and provide groundwater recharge and flood protection. The projects capture and infiltrate approximately 8 acre-feet of rainfall in Santa Barbara per year. The elimination of runoff mitigates public health risks associated with pooling, flooding, and polluted runoff resulting from recurring flash storms, and also reduces the risk of flash floods and prevents habitat damage downstream. The infiltrated water increases the amount of groundwater, which is pumped, treated and distributed to residents for municipal water. Increased infiltration and higher groundwater levels contribute to higher base flows in the creeks, thereby enhancing the stream habitat benefits for aquatic organisms. The city's century-old Italian pine trees displayed some of the most surprising results; the trees, which had previously displaced cemented sidewalks with their water-deprived roots, began to grow deeper to reach the newly-replenished water source far belowground and showed visible signs of improved health soon after the projects were implemented. The trees will further help to filter pollutants from water, improve air quality, and reduce urban heat island effect in the city. The light color of pavers also helps reduce the urban heat island effect. The environmental and public health benefits are especially important with the threat of storms becoming more frequent and extreme and the number of extreme heat days increasing with climate change. Recognizing multiple benefits, ease of maintenance, reusability, and durability of permeable pavers, city staff are now favoring LID practices over traditional methods for managing stormwater and dry weather flows.

Image provided by the State Water Resources Control Board.

P-1 | Promote community resilience and health equity by improving underlying economic, environmental, social, and living conditions.

The conditions in which people live, learn, work, and play affect individual and community vulnerability to climate change. Inequitable distribution of social, political, and economic power are at the root of systems, such as the economy, transportation, and housing that create the physical and social conditions that drive both health outcomes and climate change. Communities that suffer from health inequities often also suffer the first and worst health impacts from climate change.

The capacity for resilience in the face of climate change is significantly driven by living conditions and the forces that shape them (including wealth, education, housing, transportation, environmental quality, social capital, and the experience of violence or other trauma) and access to resources and services, such as health care, healthy foods, and safe spaces for physical activity. Thus, strategies such as alleviating poverty, improving living conditions, increasing access to opportunity, and reducing health and social inequities will result in more climate-resilient communities.

Strategies that ensure that all Californians have their basic physical, social, and economic needs met promote not only a robust emergency response for weathering a storm or heat event, but also build a foundation of climate resilience and equity for all – before, during, and after climate-related events.

State decisions, plans, and investments can help residents least able to cope with damage to their homes, communities, or physical and mental health by prioritizing services and resources for these residents so that their quality of life is not worsened due to climate change, but rather their living standard is improved through climate change-related investments. State guidelines and funding can incentivize or require that local jurisdictions follow state agency guidance to assess and promote equity as they implement state-funded or state-mandated programs.

The condition of housing impacts residents' health and well-being, and can be affected by exposure to climate variation such as excess heat or cold, poor air quality, and moisture intrusion from floods or rising sea levels. Housing conditions can be improved through weatherization services, which include installing such measures as energy efficient light bulbs, ceiling fans and appliances, insulation (ceiling, wall, floor), microwaves, solar water heating and solar photovoltaics, weather-stripping, caulking, water heater blankets, and heating/cooling system repairs.

The health benefits of weatherization programs are significant. Weatherization can reduce persistent colds and headaches, thermal stress on occupants, asthma-related medical care, missed days of work, the "heat or eat" choice dilemma,[7] carbon monoxide poisonings, home fires, doctor and emergency room visits, and hospitalizations. In addition, households are better able to pay for food, energy and medical bills, and have increased productivity at home and work due to improvements in sleep.[8] Weatherization programs are described under Ongoing Actions below.

7 The "heat or eat" choice dilemma occurs when low income people do not have enough money to both pay utility bills and buy food and other basic necessities, and must make difficult choices about what basic needs to prioritize.

8 Tonn, Bruce, Erin Rose, Beth Hawkins, Brian Conlon. "Health and household-related benefits attributable to the weatherization assistance program." Environ. Sciences Division, UT-Battelle. Oak Ridge, TN: US Dept. of Energy, 2014.

NEXT STEPS

P-1.1. Identify best practices and disseminate lessons learned from a pilot program whereby vulnerable populations with health conditions are referred by public health nurses for housing improvements such as weatherization, energy assistance, or appliance upgrades. Collaborate with the Department of Community Services and Development to assess the feasibility of expanding this model statewide.

P-1.2. Support prioritizing residential energy efficiency funding and programs to populations with relatively higher exposures to impacts of climate change, vulnerability to impacts of climate change, and health disadvantage.

P-1.3. Support and create direct ties to health equity in the implementation of Senate Bill 350 by participating on the Governor's Office-led Multi-Agency Task Force, which is working to implement recommendations to increase access for low-income and other vulnerable communities to energy efficiency, renewable energy and clean transportation and mobility options.

P-1.4. Encourage combined funding of weatherization programs to the extent possible to improve housing conditions through a holistic "healthy homes" model that addresses energy efficiency, indoor air improvements, other housing improvements, and health improvement.

P-1.5. Promote use of the Healthy Places Index (formerly the Health Disadvantage Index) and Climate Change and Health Vulnerability Indicators for California for use by local, regional, and state agencies to prioritize funding, community engagement, jobs, and services for communities facing disproportionate climate and health risks.

P-1.6. CDPH will, in collaboration with the Governor's Office of Planning and Research and Strategic Growth Council, provide technical assistance and monitoring of progress by State agencies toward protecting climate-vulnerable communities while accounting for climate change in all infrastructure and investment plans as required by Executive Order B-30-15.

P-1.7. Solicit input from mental health professionals, consumers, and advisory boards regarding how to reduce the mental health impacts of climate change and to aid in recovery from these impacts.[9]

ONGOING ACTIONS

- The California Department of Community Services and Development (CSD) administers the federal Department of Energy Weatherization Assistance Program, designed to help low-income individuals and families increase the energy efficiency of their homes without regard to whether they are rented or owned. The program also provides assistance in reducing the total cost of heating and cooling and helps to improve the health and safety of families (i.e. through better sealing homes while ensuring proper ventilation; fixing or replacing windows; testing appliances for safety; and ensuring proper insulation levels).

9 See the report "Mental Health and Our Changing Climate" by American Psychological Association in partnership with Climate for Health and ecoAmerica for guidance.

- CSD also offers the Low-Income Weatherization Program (LIWP), funded by the California Greenhouse Gas Reduction Fund, which provides free weatherization services, solar water heaters, and solar photovoltaic installations for homeowners and renters who live within a qualified disadvantaged census tract.
- The federal Low-Income Home Energy Assistance Program administered by CSD provides assistance to eligible low-income households to meet immediate residential heating and/or cooling needs. The program also provides weatherization services that address energy efficiency and health and safety needs of households.
- The California Public Utilities Commission offers the Energy Savings Assistance Program, which provides weatherization services at no cost to households who meet California Alternate Rates for Energy (CARE) income guidelines.
- The California Energy Commission's 2016 Existing Buildings Energy Efficiency Action Plan includes a strategy to establish deeper subsidies for full participation in energy efficiency upgrades by low-income households, including in multifamily rental units.
- The Public Health Alliance of Southern California in partnership with CDPH has completed interactive census tract-level visualizations of the Climate Change and Health Vulnerability Indicators for California. The data layers are available on the Healthy Places Index (formerly the Health Disadvantage Index). This tool provides graphic overlays of indicators of climate and health risks, vulnerabilities, including climate exposures, population characteristics that increase vulnerability, and adaptive capacities. These indicators are available on the same website as the Healthy Places Index score, which incorporates layers from CalEnviroScreen showing pollution burden. The website also provides policy briefs outlining best policies and practices to address the climate vulnerabilities.
- The California Environmental Protection Agency (CalEPA) Environmental Justice Small Grants Program offers funding opportunities to assist eligible non-profit community organizations and federally recognized Tribal governments address environmental justice issues in areas disproportionately affected by environmental pollution and hazards.
- CDPH provides technical assistance to other State agencies to identify ways to promote health and equity through their bi-annual Sustainability Roadmap processes, coordinated by the Department of General Services.

P-2 | Educate, empower, and engage Californians to reduce vulnerability to climate changes through mitigation and adaptation.

The State can provide information and tools to the public regarding climate change and its effects on health, particularly to climate-vulnerable populations, that aid in the development of community awareness as well as strategies and policies that build resilience. Residents, businesses, organizations, and governments all have a role in building resilience to the health impacts of climate change.

Robust engagement of vulnerable communities in state agency decisions brings about better decisions through increased information about the conditions that we seek to improve and the viability of the solutions we adopt, and increases support for decisions and their implementation. It is also an important government role to partner with communities to provide them a voice in decisions that affect their lives. State agencies can improve decision-making by actively soliciting input from diverse populations, making opportunities for input accessible in terms of formats (e.g., online, in public meetings, by mail, etc.), venues (e.g., at school and community events, community centers, libraries, transit hubs, etc.), hours (i.e., evening or weekend as well as daytime), and languages (i.e., language accessible to lay people and translated into the principle languages of the relevant communities, including accessible media such as caption videos). The input provided should influence agencies' decisions.

NEXT STEPS

P-2.1. Identify opportunities for engagement and capacity building with vulnerable populations. Strengthen the skills, knowledge, and abilities of communities, local, and tribal government planning and public health departments, and community-based organizations (e.g. neighborhood associations) to participate in and influence decision-making processes.

P-2.2. Support and strengthen community social networks and other assets to build climate resilience. For example, fund or solicit participation from schools, faith-based communities, neighborhood-based groups, health equity or environmental justice groups, and businesses in climate resilience planning. Learn from and disseminate best practices developed by community groups or local jurisdictions.

P-2.3. Translate climate science to make it locally relevant and accessible for community members, and highlight health, climate, and equity impacts and opportunities.

P-2.4. Explore mechanisms to fund community-based organizations to prepare for the health impacts of climate change.

P-2.5. CDPH will promote and disseminate "Climate Change, Health, and Equity: A Guide for Local Health Departments" to assist local health departments with integration of climate change and health equity work into traditional public health programs and core functions.

P-2.6. CDPH will promote a bilingual English/Spanish multi-media climate change and health equity curriculum for health promoters.

P-2.7. Encourage participation in climate resilience planning on the part of community health clinics, nonprofit organizations, community groups, local and state public health programs such as nutrition promotion programs, mental health centers, health navigators, and others.

P-2.8. CDPH will continue to expand the OutsideIn project, a state-wide climate and health communication campaign for local and regional partners.

P-2.9. Integrate climate change messages into extreme weather advisories, such as heat advisories.

P-2.10. Support outreach and engagement of farmworkers regarding strategies to address extreme heat, air quality, and worker health.

P-2.11. Encourage community organizations and businesses to engage with regional climate collaboratives through the statewide Alliance of Regional Collaboratives for Climate Adaptation.

P-2.12. Leverage efforts of national and state-wide organizations that are engaged in climate resiliency, such as the American Planning Association, American Public Health Association, Urban Land Institute, American Institute of Architects, American Society of Landscape Architects, American Public Works Association, Medical Society Consortium on Climate & Health, and others working at the intersection of climate change, equity, and health.

P-2.13. CDPH will support local health departments in using the county-level vulnerability assessments, Climate Change and Health Profile Reports, and the Climate Change and Health Vulnerability Indicators for California through the California Building Resilience Against Climate Effects (CalBRACE) Project.

P-2.14. CDPH's Office of Health Equity will explore the mental health impacts of climate change and associated extreme events by identifying tools, resources, interventions, and best practices. This information will be shared with grantees of the California Reducing Disparities Project whose aims are to evaluate the effectiveness of community-defined evidence practices to reduce mental health disparities in African American, Asian and Pacific Islander, Latino, LGBTQ, and Native American communities.

P-2.15. CDPH will support the Office of the Governor surrounding the 2018 Global Climate Action Summit, providing input on the health and equity impacts of climate change and how mitigation and adaptation can lessen them.

P-2.16. Seek to support sea-level rise planning and adaptation planning for resiliency in coordination with California Native American tribal governments.

ONGOING ACTIONS

- CDPH provides input to state grant and program guidelines on suggested best practices for robust engagement of communities in climate change policy decisions, such as Executive Order B-30-15 and the Adaptation Planning Grant created by Senate Bill 1.

- CDPH engages with communities facing disproportionate impacts of climate change through participation on the Climate Justice Working Group facilitated by the Resources Legacy Fund, joint workshops with World Institute for Disability and Resilient Communities Initiative, and partnering with community-based organizations to facilitate engagement on plans such as Safeguarding California.
- CDPH's California Fatality Assessment Control & Evaluation (CA/FACE) program investigates worker deaths and produces written educational materials and videos highlighting best practices. CA/FACE collaborates with and promotes program materials to employers, workers, and trade associations in the tree care industry who then use them in safety trainings and to improve work practices.
- CDPH and CalEPA co-host the quarterly Public Health Workgroup of the Climate Action Team, to present and discuss issues regarding climate change and health equity.
- CDPH's Safe and Active Communities Branch partners with CalTrans to provide technical assistance to Active Transportation Program grantees to increase safe walking and bicycling to improve health, and reduce injuries, greenhouse gas emissions, congestion, and pollution.

P-3 | Promote mitigation and adaptation strategies with public health and equity benefits, and assure they do not have unintended consequences for health equity.

Climate change mitigation efforts are essential in tandem with adaptation, because many of the strides being taken towards climate change adaptation are based on various scenarios of climate change mitigation and associated projections of exposures. In addition, climate change adaptation activities may not be sufficient if climate impacts increase in frequency and severity. Many mitigation and adaptation strategies bring with them a variety of benefits to health, protecting people while combating climate change.[10] These strategies include active transportation, urban greening, mixed-use zoning, affordable and energy-efficient housing, sustainable forestry, agroecology or climate-smart farming, and consumption of locally grown produce.[11] This approach includes engaging with local initiatives that are already building resilience to threats to human health.

While mitigating and adapting to climate change generally yield health benefits, certain strategies may negatively affect public health in unforeseen ways. For example, while the intent of transit oriented development and mixed-use zoning is to reduce greenhouse gas emissions, improve neighborhood conditions, increase housing choices, and improve community cohesion, policies must be put in place to limit displacement of existing residents as livability improves and property values rise. When implemented in a way that explicitly considers the needs of low-income communities and communities of color, transit oriented development increases access to fresh and healthy foods, job opportunities, affordable housing, transit options, and safe places to walk, "roll", and recreate. All of these improvements are likely to increase resilience to the impacts of climate change.

However, transit investments and other amenities may drive up median area income, property values, and rents. A possible result of such changes is that existing residents and small business owners may no longer be able to afford living or doing business in the area, and will be forced to move farther away. As described in P-1, the quality and stability of housing impacts people's resilience to the effects of climate change. People with low incomes and people of color are currently most affected by displacement. Displaced residents may end up further away from quality employment opportunities, schools, and health-promoting resources such as healthy food retail and parks.[12] The consequences of displacement may include a decrease in sense of community and social capital, increased driving to get to services and jobs, and the decrease in health status that accompanies more sedentary behavior. Other health effects of housing unaffordability, insecurity, or displacement can include households with high housing costs scrimping on health care, medications, food, or other needs, called the "heat or eat dilemma"; and accepting poor quality housing that has mold or pests that can trigger asthma or has dangerous appliances that can cause fires or carbon monoxide poisoning. There are also mental health impacts of housing insecurity and displacement on children and adults. The impacts on children include behavioral problems, educational delays, school absences, and

10 Morello-Frosch, Rachel, Manuel Pastor, Jim Sadd, Seth Shonkoff. "The Climate Gap: Inequalities in How Climate Change Hurts Americans & How to Close the Gap.", 2009.

11 California Natural Resources Agency. "Safeguarding California: Reducing Climate Risk.", 2014.

12 Pollack, Stephanie, Barry Bluestone, and Chase Billingham. "Maintaining diversity in America's transit-rich neighborhoods: tools for equitable neighborhood change." Durkakis Center for urban and Regional Policy, Northeastern University, 2010.

lower math and reading achievement, all of which increase underlying vulnerability to climate effects. Measures can be put in place before investments in livability and transit to stabilize residents, rents and neighborhoods, and preserve and improve existing affordable housing, in addition to producing more affordable housing.[13, 14, 15, 16]

As another example of possible unintended consequences, storing rain in rain barrels could result in more mosquitos and vector-borne illness. The CDPH Vector-Borne Disease Branch monitors for these types of adverse effects.

Another climate strategy with implications for health is active transportation. Shifting from driving to walking and bicycling (active transportation) not only reduces greenhouse gases, but can also contribute to climate adaptation. People living with chronic diseases experience higher vulnerability to the health impacts of climate change, such as heat illness and cardiovascular disease worsened by high heat and poor air quality. More than one in three Californians (around 14 million) are currently living with at least one chronic condition, and more than half of this group has multiple chronic conditions.[17] Approximately 23,000 deaths per year are directly attributable to lack of physical activity, according to conservative estimates. This is over 9 percent of total deaths in California.[18, 19, 20] Many of these chronic diseases and deaths would be prevented, lessened, or delayed if people exercised more. Walking and bicycling, including on the way to and from transit stops, increases physical activity levels, which improves health by reducing the risks of a variety of chronic conditions, including heart disease, stroke, diabetes, colon and breast cancer, dementia (Alzheimer's), and depression.[21] Increasing active transportation rates for Californians to meet the US Surgeon General's daily physical activity recommendations of 21.4 minutes per day could lead to 8,057 fewer lives lost per year, and dramatic decreases in debilitating chronic diseases, thus increasing resilience to the impacts of climate change.[22] However, unless changes to increase safety are made in the way transportation facilities are planned and constructed, increasing active transportation rates would also result in a higher number of walker and cyclist traffic injuries and deaths.

An additional area of potential concern to human nutrition and health is the impact of climate change on food. Climate change is expected to threaten global food production[23] due to changes in rainfall, severe weather events, and increasing competition from weeds and pests on crops.[24, 25] While the US will be less affected than many

13 Centers for Disease Control and Prevention - Division of Community Health. "A practitioner's guide for advancing health equity: Community strategies for preventing chronic disease.", 2013.

14 Centers for Disease Control and Prevention. "Healthy Places: Health effects of gentrification.", 2013. https://www.cdc.gov/healthyplaces/healthtopics/gentrification.htm

15 Bay Area Regional Health Inequities Initiative. "Displacement Brief.", 2016.

16 Justa Causa: Just Cause. "Development without Displacement.", 2014.

17 Brown, Paul M, Mariaelena Gonzalez, Ritem Sandhu, Shannon M, Conroy, Steve Wirtz, Caroline Peck, and Jessica M. Nunez de Ybarra. "Economic Burden of Chronic Disease in California 2015." California Department of Public Health. Sacramento, California, 2015.

18 California Department of Public Health. California Vital Statistics Query System. http://informaticsportal.cdph.ca.gov/CHSI/VSQS/, 2013.

19 Institute for Health Metrics and Evaluation. "Global Burden of Disease Study 2010 (GBD 2010)" - United States Results by Risk Factor (IHME_USA_GBD_2010_RISK_1990_2010.csv). Seattle, WA: University of Washington; 2014. http://ghdx.healthdata.org/record/united-states-global-burden-disease-results-1990-2010

20 Barnes, Deborah and Kristine Yaffe . "The projected impact of risk factor reduction on Alzheimer's disease prevalence." Lancet Neurol.;10:818-828, 2011

21 Maizlish Neil, James Woodcock, Sean Co, Bart Ostro, Amir Fanai, and David Fairley. "Health Co-benefits and Transportation-Related Reductions in Greenhouse Gas Emissions in the San Francisco Bay Area." American Journal of Public Health: 103, 703-709, 2013.

22 Maizlish Neil, James Woodcock, Sean Co, Bart Ostro, Amir Fanai, and David Fairley. "Health Co-benefits and Transportation-Related Reductions in Greenhouse Gas Emissions in the San Francisco Bay Area." American Journal of Public Health: 103, 703-709, 2013.

23 Hoegh-Guldberg, Ove, and John F. Bruno. "The impact of climate change on the world's marine ecosystems." Science, 328, 1523-1528, 2010.

24 Asseng, Senthold, Ian Foster, and Neil C. Turner. "The impact of temperature variability on wheat yields." Global Change Biology, 17, 997-1012, 2011.

25 Ziska, Lewis H. "Climate change, carbon dioxide and global crop production: Food security and uncertainty." Handbook on Climate Change and Agriculture, A. Dinar, and R. Mendelsohn, Eds., Edward Elgar Publishing, 9-31, 2011.

countries,[26, 27] food prices are expected to rise in response to declining food supply, which impacts food security.[28, 29] Already, more than one in four children in California live in households with limited or uncertain access to adequate food.[30] People cope with food insecurity by consuming nutrient-poor but calorie-rich foods, and/or they go hungry, with consequences ranging from micronutrient malnutrition to obesity.[31] Food-insecure children are more likely to experience developmental, cognitive, behavioral, and mental health problems. Among pregnant women, food insecurity is associated with physical and mental health problems, as well as birth complications. Children and communities of color are disproportionately affected by food insecurity.[32] Californians with particular dietary patterns or reliance on traditional foods, such as Native Americans, may experience shortages of key foods such as salmon.[33, 34, 35] In addition, more weed and pest control measures such as applying herbicides and pesticides and using integrated pest management practices are expected because of increased growth of pests[36] and weeds[37] as well as decreased effectiveness[38] and duration[39] of some pesticides. As agricultural practices, food distribution systems, and consumer food choices affect possible impacts on human health as a result of a changing climate, concerted adaptation planning and health promotion on the part of the State and others can reduce the health impacts of the anticipated food-related consequences of climate change.[40]

A centralized platform called Climate Smart Agriculture has been developed by the California Department of Food and Agriculture (CDFA) to address adaptations in agricultural food production systems in California. Climate Smart Agriculture utilizes on-farm management practices, such as cover crops, that take carbon from the atmosphere and put it back into soils where it has beneficial effects on farms, on human health and climate resiliency. Healthy soils contain carbon, in the form of soil organic matter, which can help to store water more effectively. This may result in greater water efficiency and in some cases use of less water for irrigation, reduce impacts to crops and food

26 Gregory, Peter J., John S. I. Ingram, and Michael Brklacich. "Climate change and food security." *Philosophical Transactions of the Royal Society B: Biological Sciences*, 360, 2139-2148, 2005. http://rstb.royalsocietypublishing.org/content/360/1463/2139

27 Lloyd, Simon J., Sari Kovats, and Zaid Chalabi. "Climate change, crop yields, and undernutrition: Development of a model to quantify the impact of climate scenarios on child undernutrition." *Environmental Health Perspectives*, 119, 1817-1823, 2011.

28 Neff, Roni A., Cindy L. Parker, Frederick L. Kirschenmann, Jennifer Tinch, and Robert S. Lawrence "Peak oil, food systems, and public health". *American Journal of Public Health*, 101, 1587-1597, 2011.

29 Brown, Molly E., and Christopher C. Funk. "Food security under climate change." *Science*, 319, 580-581, 2008.

30 "Children living in food insecure households", 2014. Kidsdata.org.

31 Bloem, Martin W., Richard D. Semba, and Klaus Kraemer."Castel Gandolfo Workshop: An introduction to the impact of climate change, the economic crisis, and the increase in the food prices on malnutrition." *The Journal of Nutrition*, 140, 132S-135S, 2010.

32 California Department of Public Health. "Portrait of Promise: The California Statewide Plan to Promote Health and Mental Health Equity. A Report to the Legislature and the People of California by the Office of Health Equity." Sacramento, CA, June 2015.

33 Brubaker, Michael, James Berner, Raj Chavan, and John Warren. "Climate change and health effects in Northwest Alaska." *Global Health Action*, 4, 1-5, 2011.

34 Lynn, Kathy, Daigle, John, Hoffman, Jennie, Lake, Frank, Michelle, Natalie, Ranco, Darren, Viles, Carson, Voggesser, Garrit, and Williams, Paul. "The impacts of climate change on tribal traditional foods". *Climatic Change* 120 no. 3: 545-556, 2013.

35 California Environmental Protection Agency Office of Environmental Health Hazard Assessment. "Indicators of climate change in California". 2013. https://oehha.ca.gov/climate-change/document/indicators-climate-change-california#downloads

36 Chakraborty, Swati, and Adrian C. Newton. "Climate change, plant diseases and food security: An overview." *Plant Pathology,* 60, 2-14, 2011.

37 Franks, Steven J., Sheina Sim, and Arthur E. Weis. "Rapid evolution of flowering time by an annual plant in response to a climate fluctuation." *Proceedings of the National Academy of Sciences*, 104, 1278- 1282, 2007. www.pnas.org/content/104/4/1278.full.pdf+html

38 Ziska, Lewis H., and John R. Teasdale. "Sustained growth and increased tolerance to glyphosate observed in a C3 perennial weed, quackgrass (*Elytrigia repens*), grown at elevated carbon dioxide." *Australian Journal of Plant Physiology*, 27, 159-166, 2000

39 Bailey, Steven W. "Climate change and decreasing herbicide persistence." *Pest Management Science*, 60, 158-162, 2004

40 Luber, George, Kim Knowlton, John Balbus, Howard Frumkin, Mary Hayden, Jeremy Hess, Michael McGeehin, Nicky Sheats, Lorraine Backer, C. Ben Beard, Kristie L. Ebi, Edward Maibach, Richard S. Ostfeld, Christine Wiedinmyer, Emily Zielinski-Gutiérrez, and Lewis Ziska, "Ch. 9: Human Health". *Climate Change Impacts in the United States: The Third National Climate Assessment*, Jerry. M. Melillo, Terese (T.C.) Richmond, and Gary. W. Yohe, Eds., U.S. Global Change Research Program, 220-256, 2014.

production from drought, and also help to manage unpredictable rainfall events and floods.[41] Soil organic matter binds heavy metals and pesticides, potentially reducing these in runoff.[42] Healthy soils with significant amounts of organic matter improve plant health, increasing yields and increasing nutrient content of foods,[43] and have fewer disease and pest problems. These soils may require less application of pesticides, herbicides, and fertilizers,[44] resulting in lower risk of accidental poisoning in farmers and farmworkers. These potential benefits make farming more resilient to the extreme weather associated with climate change.[45] When farming is more resilient to the impacts of climate change, farmers and farmworkers are less likely to experience threats to their livelihoods, as they did during the recent historic California drought. CDFA has developed a program called the California Healthy Soils Incentive and Demonstration Program.[46] One key element of the program is the use of compost, among other on-farm management practices, which has the potential to reduce water consumption and runoff, reduce soil erosion and dust, and increase soil organic matter.[47]

Next steps and ongoing actions on the part of state agencies in collaboration with other partners address the complex impacts of climate change on basic human needs of housing, physical activity, and nutritious food, among other actions at the intersection of climate, health, and equity.

NEXT STEPS

P-3.1. Through CDFA's Office of Farm to Fork, plan for phase two of the California Nutrition Incentive Program to expand to small businesses as well as farmers' markets.

P-3.2. Through the CDFA Healthy Soils Program (HSP) Incentives Program, provide up to $3.75 million in financial incentives to California growers and ranchers for implementation of agricultural management practices that sequester carbon, reduce atmospheric GHGs, and improve soil health from 2017-2019.

P-3.3. Through the CDFA HSP Demonstration Projects, provide up to $3 million in funding for on-farm demonstration projects that showcase conservation management practices that mitigate GHGemissions, increase soil health, and create a platform promoting widespread adoption of conservation management practices throughout the state from 2017-2019.

P-3.4. Take potential benefits and harm into account in transportation models used in local, regional, and state planning. CDPH works with Metropolitan Planning Organizations and other state agencies to integrate health and active transportation into transportation planning through tools such as the Integrated Transportation and Health Impacts Model (ITHIM).

41 Natural Resources Conservation Service (NRCS). Soil health key points. US Department of Agriculture, 2013. www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1082147.pdf.

42 Rodale Institute. "The farming systems trial: Celebrating 30 years.", 2013. 66.147.244.123/~rodalein/wp-content/uploads/2012/12/FSTbookletFINAL.pdf.

43 Averett, Nancy. "Healthy ground, healthy atmosphere: Recarbonizing the earth's soils." Environmental Health Perspectives, 124(2): A30–A35, 2016.

44 Averett, Nancy. "Healthy ground, healthy atmosphere: Recarbonizing the earth's soils." Environmental Health Perspectives, 124(2): A30–A35. 2016

45 Natural Resources Conservation Service (NRCS). "Manage for soil carbon." US Department of Agriculture, N.d. www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/mgnt/?cid=stelprdb1237584.

46 California Department of Food and Agriculture (CDFA). Office of Environmental Farming and Innovation. Healthy Soils Incentives Program, 2016. https://www.cdfa.ca.gov/oefi/healthysoils/.

47 Crohn, David M. "Impact of Compost Application on Soil Erosion and Water Quality." California Department of Resources Recycling and Recovery (CalRecycle), 2011. http://www.calrecycle.ca.gov/publications/Documents/1377%5C2011013.pdf

P-3.5. Support prioritization of shading, drinking water, and permeable paving on multi-use transportation corridors based on urban heat island mapping and analysis.

P-3.6. Continue to provide CDPH input to State grant and program guidelines for identifying communities vulnerable to the health impacts of climate change, strategies to lessen vulnerability and promote health equity and resilience, and metrics to measure progress. Some examples include Senate Bill 1 transportation programs, the Active Transportation Program, and Greenhouse Gas Reduction Fund Programs such as Transformative Climate Communities, Urban and Community Forestry Program, and Affordable Housing and Sustainable Communities grants.

P-3.7. Support mitigation for poor indoor air quality for new and existing buildings sited near major roadways. Examine San Francisco's Air Pollutant and Exposure Zone (APEZ) ordinance requiring enhanced ventilation for all urban infill sensitive use developments within designated zones exceeding protective standards for cumulative PM 2.5 concentration and cumulative excess cancer risk as a potential model.

ONGOING ACTIONS

- The CDPH Nutrition Education and Obesity Prevention Branch (NEOPB) creates innovative partnerships that empower low-income Californians to increase fruit and vegetable consumption, physical activity, and food security with the goal of preventing obesity and other diet-related chronic diseases. In regards to healthy eating, NEOPB looks at food production, access, purchasing, distribution methods, retail sites, consumption, and waste. For active living, NEOPB promotes walking and biking, and looks at policy and environmental changes in a variety of settings that impact pedestrians, cyclists, cars, and public transportation.
- The California Department of Food and Agriculture houses several programs in the Office of Farm to Fork that support local and regional food systems including access to safe nutritious foods. The Office of Farm to Fork helps increase access to healthy California-grown foods in underserved communities through the California Nutrition Incentive Program (CNIP). CNIP provides nutrition incentives to low-income Californians using nutrition benefits at Certified Farmers' Markets – effectively doubling the purchasing power of low-income shoppers buying fruits and vegetables. The Office of Farm to Fork also supports farm to school programs as the lead for the California Farm to School Network, which is a hub for connections and resources that bring California grown food to schools throughout the state, increasing access of school children and their families to nutritious foods.
- CalEPA's Department of Pesticide Regulation (DPR) protects human health and the environment by regulating pesticide sales and use, and by fostering reduced-risk pest management. DPR's Alliance Grants Program promotes the adoption and implementation of effective integrated pest management (IPM) systems that reduce risks from pesticide use to human health and the environment through collaboration among stakeholders in the adoption and implementation of urban and agricultural IPM practices. DPR's California Pesticide Information Portal (CalPIP) provides pesticide data to assess risk, food quality, worker exposure, endangered species protection, water and air quality, and to analyze pest management, and land use trends. DPR contracts with all 58 counties' agricultural commissioners (CACs) to enforce federal and state laws pertaining to the proper and safe use of pesticides. DPR provides worker safety resources to CACs, including heat-related illness prevention with employers during the summer months.

- CAL FIRE's Urban and Community Forestry Program works to expand and improve the management of trees and related vegetation in communities throughout California. Trees provide energy conservation, reduction of storm-water runoff, extend the life of surface streets, improve local air, soil and water quality, reduce atmospheric carbon dioxide, improve public health, reduce urban heat islands, provide wildlife habitat, and increase property values. They improve the quality of life in our urban environments which, increasingly, are where Californians live, work, and play.
- The Integrated Transportation and Health Impacts Model (ITHIM) is a tool to estimate the health benefits and potential harms from active transport and low carbon driving in urban populations.
- The Green Building Action Plan directs agencies and departments to green the State's buildings, reduce GHG emissions and improve energy efficiency. It requires all new and renovated state buildings larger than 10,000 square feet to achieve LEED Silver certification or higher, and to incorporate clean on-site power generation and clean back-up power supplies.
- The 2016 California Green Building Standards Code (CALGreen) provides enhanced building design and construction using building concepts that address both health and climate such as:
  - Site planning and design
  - Water efficiency and conservation
  - Building material conservation and resource efficiency
  - Environmental quality

P-4 | Establish, improve, and maintain robust surveillance mechanisms.

California scientists contribute to the field of climate change mitigation and adaptation by monitoring and mapping vulnerabilities, tracking vector-borne diseases, and collecting epidemiological data. State agencies are implementing a number of surveillance mechanisms to provide support for state, regional, and local health agencies and partners to prepare their communities, some of which are discussed below. Adaptation efforts are more effective when surveillance systems and analysis are integrated across sectors and systems to provide synergistic benefit. A major remaining surveillance need identified in *Preparing California for Extreme Heat* is to develop real-time syndromic surveillance capability to monitor heat illness and respond in a timely manner.

NEXT STEPS

P-4.1. Identify surveillance and tracking opportunities for heat and wildfire-related health impacts.

P-4.2. Seek opportunities to increase surveillance sampling of food commodities for pathogens and other toxins as it is a proven method to identify potential public health risks to consumers.

P-4.3. Through the California Environmental Health Tracking Program, participate in the CDC Waterborne Disease and Outbreak Surveillance System to track harmful algal blooms and associated human and animal effects.

P-4.4. Utilize the new occupational health indicator on "incidence of work-related emergency department visits for heat illness", adopted by the CDPH Occupational Health Branch. Results are to appear in the 2017 California Wellness Plan Progress Report, and data are obtained from the Office of Statewide Health Planning and Development (OSHPD).

P-4.5. Through the CDPH Occupational Health Branch (OHB), complete a new analysis initiated using the California's Workers' Compensation Information System (WCIS). OHB has created a surveillance case definition for heat-related illness and will be extracting and analyzing claims from 2000 through 2016. The analysis will help to identify industries and occupations at highest risk, to inform prevention activities.

P-4.6. Through the Ocean Protection Council and its Science Advisory Team, release the State of California Sea-Level Rise Guidance Document in 2018, based on the projections in *Rising Seas in California: An Update of Sea-Level Rise Science*.

ONGOING ACTIONS

- CalEPA has developed an Urban Heat Island Index to quantify the extent and severity of the urban heat island in California cities.
- The CDPH Vector Borne Disease Branch and partners have developed mosquito surveillance tools including:
  - Guidance for Surveillance of and Response to Invasive Aedes Mosquitoes and Dengue, Chikungunya, and Zika in California
  - The Invasive Aedes in California Map shows where these mosquitoes have been documented in California. Since these mosquitoes may be vectors of viruses including Zika, dengue, and chikungunya, this map can help local health departments assess potential local transmission risk from infected returning travelers as well as assist in mosquito control planning.
  - California Mosquito-Borne Virus Surveillance and Response Plan
- The CDPH Vector Borne Disease Branch partners with county vector control agencies to conduct primary door-to-door surveillance and education regarding disease vectors such as mosquitos.
- The CDPH California Environmental Health Tracking Program tracks data on heat-related illness, respiratory illnesses, pesticide application, air quality, water quality, and other indicators relevant to climate change and health.
- The California Natural Resources Agency and the State Water Resources Control Board (Water Board) maintain a freshwater harmful algal bloom map where freshwater harmful algal blooms (HABs) are voluntarily reported to the State Water Board's Surface Water Ambient Monitoring Program.
- CDPH's Environmental Health Investigations Branch works in partnership with State Water Board to respond to any report of human health symptoms from HABs.
- CDPH is a member of the California Cyanobacteria and Harmful Algal Bloom (CCHAB) Network, which works to maintain a comprehensive, coordinated program to identify and address the causes and impacts of cyanobacteria and HABs in California.
- CDPH's Environmental Management Branch implements a Marine Biotoxin Monitoring Program that focuses on the collection and testing of shellfish and mussels for paralytic shellfish poison, domoic acid, and amnesic shellfish poisoning. Another component of the monitoring program is a volunteer-based phytoplankton monitoring program to detect initial increases of toxin-producing species before shellfish and other seafood resources are impacted.

P-5 | Improve public health preparedness and emergency response.

The California Department of Public health, the Governor's Office of Emergency Services (Cal OES), local health departments, and other preparedness agencies collaborate, refine existing emergency preparedness plans, and conduct exercises to augment preparedness for events likely to increase with climate change. Agencies also are developing plans for the anticipated impacts of sea-level rise, saline intrusion into drinking water, and increase in the frequency of severe heat events in areas where they have previously been infrequent.[48] Furthermore, preparedness agencies are training communities on what to do before, during, and after an emergency.

Senate Bill 379, signed by Governor Brown in October 2015, requires local jurisdictions to address climate adaptation and resiliency strategies as they revise local hazard mitigation plans or in the safety element of the general plan (beginning in 2022, if the local jurisdiction has not adopted a local hazard mitigation plan). The law requires the update to include goals, policies, and objectives based on a vulnerability assessment identifying local climate change risks. CDPH and local health jurisdictions provide data on local health-related climate exposures and vulnerable populations.

Progress is being made to incorporate adaptation and mitigation measures in post-emergency responses to further increase communities' preparation as well as to reduce the impacts of subsequent climate change events. Such efforts include making provisions to provide healthcare despite power outages and hospital closures and ensure access to medication and medical records.[49] Social capital or connections and trust, also called social cohesion, can help ameliorate the mental health troubles associated with disasters, which include post-traumatic stress disorder, depression, nonspecific distress, and anxiety.

Having good health prior to disasters supports greater resilience in the disaster setting. People with chronic or poorly treated health conditions have found it more difficult to reestablish housing and healthcare following a catastrophe.[50] Psychological resilience is the ability to maintain positive adaptation and mental health despite stressors in the immediate and broader environment. Disasters can also impair psychological resilience if they disrupt social networks, thereby worsening overall population health. These are important considerations for preparedness and emergency response plans and after-event assistance and support to build resilience.

NEXT STEPS

P-5.1. Ensure that warning tools are multi-lingual and accessible to diverse communities.

P-5.2. Encourage partnerships between local emergency responders and local health departments to identify and reach vulnerable populations in need of access to cooling centers or personal cooling resources.

48 California Natural Resources Agency. "2009 California Climate Adaptation Strategy.", 2009.

49 California Natural Resources Agency. "Safeguarding California: Implementation Action Plans.", 2016.

50 Acosta, Joie, Anita Chandra, and Kevin C. Feeney. "Navigating the Long Road to Recovery: An Assessment of the Coordination, Communication, and Financing of Disaster Case Management Pilot in Louisiana." Santa Monica, CA: RAND Corporation, 2010.

P-5.3. Provide health equity input to the Governor's Office of Emergency Services, in collaboration with the Office of Access and Functional Needs, regarding planning efforts, such as the State Hazard Mitigation Plan and the Adaptation Planning Guide to address and integrate considerations for access and functional needs populations before, during and after climate-related incidents and events.

P-5.4. Through CDPH, provide sample health equity language for climate change-related health impacts to local governments for updates of Local Hazard Mitigation Plans and general plan safety elements pursuant to Senate Bill 379.

P-5.5. Encourage agencies to make resources available to support people suffering mental health consequences due to the emergencies caused by climate change.

P-5.6. Continue regular meetings between the Public Health and Emergency Management sectors to collaborate to advance mutual goals to protect the lives, health, and livelihoods of Californians.

ONGOING ACTIONS

- CDPH's Emergency Preparedness Office coordinates Public Health Emergency Preparedness Training Workshops for counties, local health care facilities, and state entities.
- Provide input to agencies and plans regarding assuring transportation access for low-income, disabled, elderly and other vulnerable communities, in rural, urban, and suburban areas, and to plan for how public transportation systems can be used to evacuate vulnerable people in the event of an emergency.
- CDPH will continue to conduct Community Assessments for Public Health Emergency Response (CASPER), a rapid community needs assessment method developed by the Centers for Disease Control and Prevention (CDC), for extreme events. This tool is used to assess local jurisdictions' preparedness for Zika, drought, wildfire, and earthquakes, as well as to assess health and mental health impacts after events.
- California counties can submit resource requests for public health assistance through the Standardized Emergency Management System (SEMS) and the California Public Health and Medical Emergency Operations Manual.
- CDPH provides coordination, guidance, resources, support, technical assistance, and communications related to public health during heat-related emergencies. During a heat-related emergency, CDPH response activities include:
  - Dissemination of information specific to the event to local health departments, local and regional emergency coordinators, and CDPH executive staff and programs via conference calls and/or the California Health Alert Network (CAHAN).
  - Coordination with various CDPH programs such as Licensing and Certification, Emergency Preparedness Office, and the Office of Public Affairs.
  - Depending on the scope of the event, CDPH may:
    - Collect local health-related information from local health departments in affected areas, such as cooling center data.

- Respond to the State Operation Center.
- In coordination with the Emergency Medical Services Authority (EMSA), activate the Medical and Health Coordination Center.

- The CDPH, Licensing and Certification (L&C) Program ensures the safety and continuity of care for patients/residents at the facilities it licenses during heat-related emergencies. During a heat-related emergency, CDPH L&C response activities include:
  - Advising health care facilities on caring for patients/residents during extreme heat conditions
  - Monitoring of heat-related unusual occurrences reported by health care facilities until resolved.
  - Investigation of patient/resident heat-related complaints. Investigations may include onsite visits to ensure the health and safety of patients/residents and verify facility operational status.
- Cal OES's Office of Access and Functional Needs (OAFN) works to identify the needs of individuals with disabilities and others with access and functional needs before, during, and after a disaster and to integrate those needs and resources into emergency management systems.
  - OAFN offers training and guidance to emergency managers and planners, disability advocates, and other service providers.
  - OAFN developed a geographic information system (GIS) based web map which provides demographic information and outlines where resources like accessible/adaptive transportation are located statewide.
  - OAFN engages with the CDPH Office of Health Equity to support its efforts related to climate change.

P-6 | Collaborate with multiple agencies and organizations at local, state, and federal levels.

Many agencies, individuals, organizations, educational institutions, and businesses across California are implementing activities to prepare for climate change impacts. Collaboration is essential to create the necessary system-wide changes to ensure resilience against the health and equity impacts of climate change.

One such collaboration is the Health in All Policies (HiAP) Task Force. HiAP is a collaborative approach to improving the health of all people by incorporating health, equity, and sustainability considerations into decision-making across sectors and policy areas. The approach recognizes that our greatest health challenges—like chronic illness, climate change, health inequities between populations, and increasing health care costs—are highly complex and influenced by policies, programs, and investments across sectors. HiAP, at its core, is an approach to addressing the social determinants of health that are the key drivers of health outcomes and health inequities. Health in All Policies supports improved health outcomes and health equity through collaboration between public health practitioners and those nontraditional partners who have influence over the social determinants of health.

The HiAP Task Force brings together 22 state departments, agencies and offices and is facilitated by CDPH, Strategic Growth Council, and the Public Health Institute. The Task Force creates multi-agency collaboration that increases climate resilience across many exposures and assets with HiAP initiatives including:

- Active Transportation: The Health in All Policies Task Force's Active Transportation Action Plan seeks to increase opportunities for safe and accessible active transportation (e.g., walking, biking, rolling, or public transportation) to school, work, other essential destinations, and as a recreational activity for all people. To achieve this goal, the Action Plan focuses on integrating safe and accessible active transportation through state grant programs and guidelines (e.g. Regional Transportation Plan Guidelines) and supporting active transportation in school and work environments.
- Healthy Public Policy: The goal for the Health in All Policies Task Force's Equity in Government Practices Action Plan is for the member agencies and departments to promote equity through guidance, grant programs, and institutional practices. For the purposes of this Action Plan the term "equity" is synonymous with fairness and justice. Equity is achieved when all have the opportunity to attain their full potential and none are disadvantaged from reaching this potential by any social position or socially determined circumstances. This Action Plan focuses on normalizing conversation of equity including creating shared understanding of terms, institutionalizing equity by building internal capacity and developing tools to systematically address equity, and operationalizing equity in policies and programs.
- Community Safety through Violence Prevention: The Health in All Policies Task Force's Action Plan to Promote Violence-Free and Resilient Communities seeks to build State agency capacity and support coordination to address structural drivers of violence and promote violence-free and resilient communities to increase health, safety, and equity. Exposure to violence is preventable and influences nearly all health and mental health outcomes ranging from an individual's ability to adopt healthy behaviors and manage stress, to chronic disease, trauma, and a community's weakened social ties and lack of economic investment. Building vibrant, sustainable communities where residents feel safe and are motivated to walk and bike to jobs, school, and other amenities and services is a key strategy to both improve health and increase resilience to climate impacts.

- Parks, Urban Greening, and Places to be Active: The goal of The Health in All Policies Task Force's Action Plan to Promote Parks and Healthy Tree Canopy is for priority communities to benefit from optimized access to tree canopy, open space, and parks, as well as maintenance of these essential community spaces as a result of increased State agency and department collaboration. The desired outcomes of the Plan are to increase park access, tree canopy and vegetation in priority communities.

"Urban greening" involves establishing vegetated streetscapes and open spaces to create cleaner, healthier, safer, and more aesthetically pleasing neighborhoods. Urban greening promotes a complex system of trees and smaller plants, wildlife, and associated organisms, soil, water, and air in and around cities. Urban forests can lessen the impacts of climate change by moderating climate, conserving energy use, reducing pollution and storm water run-off, enhancing health by cooling spaces, and cleansing the air and water. Additionally, urban greening has the potential to improve mental health by increasing community cohesion, therefore building social capital and decreasing feelings of isolation. Use of green infrastructure[51] for complete streets, landscaping, and creek/drainage corridors provides additional urban greening opportunities while also creating public health benefits through development of attractive places for people to increase physical activity, walk, bike, and socialize.

In rural areas, trees and forests also support health and resilience to climate change by providing jobs, revenue and recreation, cooling the air and soil, filtering the air and water and storing moisture, reducing flooding, providing habitat, fostering mental and physical health, cycling nutrients, and keeping soil in place to prevent erosion and landslides. Selective forest thinning to reduce fuel load can help to reduce the risk of wildfires, exacerbated by climate change. Native American tribes have had a rich tradition of sustainable forest management that can be renewed and fostered by State or local policies. Efforts to incorporate community greening can be based on information in Urban Heat Island maps from the California Environmental Protection Agency and on tree canopy cover and impervious surfaces maps and charts in forthcoming vulnerability assessments performed under CDPH's California Building Resilience Against Climate Effects Project (CalBRACE).

NEXT STEPS

P-6.1. Increase capacity at the California Department of Public Health and throughout the Health and Human Services Agency to promote adaptation and resilience.

P-6.2. Continue to work through the Tree Mortality Task Force, coordinated by CAL FIRE, and comprised of state and federal agencies, local governments, utilities, tribes, and various stakeholders to coordinate emergency protective actions, and monitor ongoing conditions to address the vast tree mortality resulting from four years of unprecedented drought and the resulting bark beetle infestations across large regions of the State.

P-6.3. Provide CDPH health equity review of the literature and guidance on the upcoming Natural and Working Lands Implementation Plan, to be developed in 2018 by CNRA.

P-6.4. Consider collaborating with State agencies focused on green buildings and energy efficiency to include climate adaptation and health and equity considerations into State initiatives, planning, and policies, including updates to the California Building Code and California Energy Efficiency Standards.

51 Per the US EPA, '[g]reen infrastructure uses vegetation, soils, and other elements and practices to restore some of the natural processes required to manage water and create healthier urban environments.' Green infrastructure strategies include the use of rain gardens and bioswales. For more information, see "What is Green Infrastructure", US EPA: https://www.epa.gov/green-infrastructure/what-green-infrastructure.

P-6.5. Continue implementation of recommendations in Preparing California for Extreme Heat, a 2013 multi-agency state guidance document.

P-6.6. Engage with The Alliance of Regional Collaboratives for Climate Adaptation (ARCCA) and its member regional climate collaboratives on urban heat island reduction efforts and other initiatives to advance health and climate resiliency benefits.

P-6.7. Through CDPH's Occupational Health Branch, participate on a Cal/OSHA advisory committee process to gather stakeholder input for legislation passed in 2016 (Senate Bill 1167) requiring Cal/OSHA to pass an occupational heat illness prevention standard applicable to indoor work environments by January 1, 2019.

P-6.8. Convene local public health departments to share best practices on health equity and climate change adaptation through CDPH CalBRACE.

P-6.9. Through CDPH, support incorporation of health, climate adaptation, and equity considerations in general plans, environmental impact assessments, climate action planning, and other planning processes.[52]

ONGOING ACTIONS

- CDPH's California Fatality Assessment Control & Evaluation (CA/FACE) works with California Division of Occupational Safety and Health (Cal/OSHA) to see that its educational materials are promoted as Cal/OSHA carries out a special emphasis enforcement program aimed at increasing safety in the tree care industry.
- The CDPH Office of Binational Border Health holds quarterly meetings for ongoing communication with the Epidemiology Department in the state of Baja California, Mexico, to enhance situational awareness regarding vector-borne diseases on both sides of the border.
- As part of the process of compiling the Governor's Five-Year Infrastructure Plan, the Infrastructure Working Group of the Strategic Growth Council has developed a survey tool, "Taking into Account Current and Future Climate Change Impacts of Infrastructure Projects", for state agencies' facilities management personnel to complete to better understand how climate adaptation is incorporated into newly-requested capital outlay projects. This instrument includes a number of questions of relevance to human health and resilience to climate change, such as "Does the project implement the voluntary measures of CalGreen to ensure healthy indoor air quality for occupants?" and "What is the project's projected impact on local heat island effects?"
- CDPH employs a One Health approach[53] looking at Rocky Mountain Spotted Fever (RMSF) and the role of dogs at reservoirs in Riverside and Imperial Counties. The urban life-cycle of RMSF involves the brown dog tick acquiring the *Rickettsia* bacteria from an infected dog thereby infecting subsequent life-stages of the tick. There is some evidence that expansion of habitat for the brown dog tick and human-biting activity by this tick increase with increasing temperatures, thus elevating the risk for human spotted fever group *Rickettsia* transmission.[54]

52 CDPH's publication, "Climate Action for Health: Integrating Climate Action into Planning" is a tool for local health departments and others to bring a health equity lens to climate action planning.

53 Per the CDC, 'The goal of a One Health approach is to encourage the collaborative efforts of multiple disciplines - working locally, nationally, and globally - to achieve the best health for people, animals, and our environment.' For more information, see One Health Basics, CDC: https://www.cdc.gov/onehealth/basics/index.html

54 Beugnet, Frederic, Michel Kolasinki, Paul-Antoine Michelangeli, Julien Vienne, and Harilaos Lukos. "Mathematical modelling of the impact of climatic conditions in France on *Rhipicephalus sanguineus tick* activity and density since 1960." Geospatial Health (2):255-63, 2011.

P-7 | Identify and assess impacts, conduct research, and use the best available data to inform policies and programs that protect health and equity.

Assessments and tools can help promote equity and resilience to climate impacts by identifying current and projected climate exposures, vulnerabilities, and adaptive capacities, so that planning and resources can best be prioritized.

More research is needed to inform strategies to protect the public health of Californians in light of climate change impacts. Research topics that would help the State develop programs to protect public health include evaluations of:

- The efficacy of early heat warning systems and cooling centers in reaching the most vulnerable people and preventing heat illness and death, and opportunities for neighborhood cooling sites (e.g., libraries and shopping centers).
- The past, current, and likely future impacts of climate change on the mental health of Californians, and successful interventions for preventing and lessening these impacts.
- To what extent climate change, including mitigation and adaption efforts, affect the range and prevalence of disease-carrying vectors such as *Aedes aegypti* (the yellow fever mosquito) and *Aedes albopictus* (the Asian tiger mosquito).
- Algal blooms in the Pacific Ocean and in local bodies of water, and their impact on shellfish, marine life, other plants and animals, and human health, to inform potential water management practices that can help mitigate harmful algal blooms.

Lack of air conditioning increases risk of illness or death in extreme heat events, which poses the greatest risk to the elderly; people with mental illness, chronic conditions, or low incomes; people who are homeless or incarcerated; and those experiencing social or health-related vulnerabilities. Urban heat islands disproportionately impact low-income communities of color.[55] To reduce inequities, it is imperative to plan keeping vulnerable populations cool and safe during heat events. Yet operating air conditioning increases greenhouse gas emissions, increases heat immediately outside artificially cooled buildings, can fail if peak demand causes power outages, and can be too costly for people with limited incomes. Research is needed to provide methods of cooling that eliminate the need for increased air conditioning. Effective techniques include urban greening, where (non-allergenic) trees provide shade and evaporative cooling, while greenery replaces pavement to reduce the urban heat island effect.

Green or living roofs and cool or light-colored roofs also help significantly lower temperatures. Buildings can be made more resistant to heat waves with weatherization and energy-efficiency upgrades, provided by programs of the Department of Community Services and Development, the California Public Utilities Commission, or by investor-owned utilities (see programs under P-1).

The Center for the Built Environment at the University of California at Berkeley is researching development of "personal comfort systems" that use small amounts of energy to keep people comfortable. However, these technologies are likely far from mass distribution. There may be a need to develop highly-efficient and inexpensive

55 Vanos, Jennifer, Laurence S. Kalkstein, David Sailor, Kurt Shickman, and Scott Sheridan, "Assessing the health impacts of urban heat island reduction strategies in the cities of Baltimore, Los Angeles, and New York". Global Cool Cities Alliance, 2014.

air conditioning units for distribution to low-income housing and senior housing in combination with other passive cooling techniques to decrease heat-related deaths and illness. Heat pumps are more efficient for both heating and cooling, but are still relatively expensive for home use without subsidies or rebates.

Many community-based organizations are engaged in community-based climate-relevant research, and are able partners for agencies, universities, and other researchers, so that research results are rooted in community experiences.

NEXT STEPS

P-7.1. Integrate data from CDPH's California Building Resilience Against Climate Effects (CalBRACE) Project into location-specific state and local government efforts in order to identify county-level climate change and health assets and risks.

P-7.2. Support prioritization of community greening funding based on identification of urban heat islands (with tools such as CalEPA's maps and Trust For Public Lands' Climate Smart Cities tool) and California Building Resilience Against Climate Effects' impervious surfaces data.

P-7.3. Through the Health in All Policies Task Force, facilitate the development of maps that layer school parcel data over urban heat island, urban tree canopy, and Disadvantaged Community (DAC) designations to identify school campuses located within priority communities. Disseminate information on California Climate Investment opportunities regarding urban greening and forestry to educational agencies.

P-7.4. Identify populations with climate vulnerabilities or limited access to transportation to assist planning for climate-related emergency events, and to address access challenges during nonemergency times to build community adaptive capacities (i.e. improved pedestrian, bicycle, and trail infrastructure, and electric car share programs at affordable housing developments).

P-7.5. Evaluate negative health consequences of adaptation strategies that may worsen public health outcomes by exacerbating pollen, gentrification and displacement, vector borne disease, indoor air quality, or other impacts.

P-7.6. Explore the feasibility of conducting research on low-carbon or net-zero emissions strategies for keeping people cool in extreme heat events.

P-7.7. Propose research on the health and climate change adaptation and mitigation co-benefits of energy efficiency policies and building standards and "net-zero" energy and energy-efficient buildings.

P-7.8. Identify a research agenda for climate adaptation and health equity with the California Energy Commission, which oversees climate research.

P-7.9. Through CDPH, collaborate with the University of Florida to conduct a study that analyzes how local health departments have engaged in adaptation planning for the health impacts of climate change through the Florida and California Public Health Departments' BRACE (Building Resilience Against Climate Effects) Projects.

P-7.10. Identify and promote climate change-related opportunities for citizen and community science such as Smoke Sense, a United States Environmental Protection Agency (EPA) study that will help determine the extent to which exposure to wildland fire smoke affects health and productivity, and Identifying Violations Affecting Neighborhoods (IVAN), an environmental monitoring system that connects the community with staff that can help solve local environmental problems.

P-7.11. Release an update to the 2013 report "Indicators of Climate Change in California" in 2017 through OEHHA.

P-7.12. Draw on published research to educate people to prevent illness and injury when conditions are not optimal for active transportation (e.g. during extreme heat or poor air quality days) through CDPH's Center for Chronic Disease Prevention and Health Promotion.

P-7.13. Convene partners to develop guidance for researchers and others to assess the health benefits or possible harms, including potential protection from poor air quality and extreme heat, associated with weatherization and energy efficiency services provided to low-income households in California, through CDPH coordination.

ONGOING ACTIONS

- CDPH supports many research efforts focused on climate and health in addition to those already cited in this report, including epidemiologic studies on heat, life cycle assessment and co-benefits of cool pavements, and the health impacts of wildfire smoke exposure.
- The 2013 report "Indicators of Climate Change in California" from the Office of Health Hazard Assessment includes a companion document that addresses equity and environmental justice indicators.
- CDPH's Safe and Active Communities' website EPICenter provides data for public access on heat injuries, deaths from walking, biking, and other traffic injuries.
- The CalBRACE program provides technical management for California's Fourth Climate Change Assessment research project "California Heat and Health".
- CalEPA's Office of Environmental Health Hazard Assessment (OEHHA), conducts research on the health impacts of extreme heat, drought, air pollution, trace chemicals of landfill biogas, and wildfire.
- CalEnviroScreen is a screening tool that can be used to help identify California communities that are disproportionately burdened by multiple sources of pollution. CalEnviroScreen maps indicators including pesticide use, drinking water quality, and toxic exposures such as ozone levels that will likely be exacerbated by higher temperatures associated with climate change.
- CDPH participates on the Research Workgroup of the Climate Action Team to provide a health equity perspective as resources allow.

Transportation

California's extensive, multi-modal transportation system is depended on by millions of people and thousands of communities and businesses. The State's transportation infrastructure is a global gateway for products entering and leaving the United States. It includes highways and roads, railways, seaports, airports, transit, and walking and biking networks. Besides providing access to destinations, the transportation sector is critical to emergency response, provides significant employment, and is essential to the state and the nation for the delivery of goods and services.

The State Department of Transportation (Caltrans) owns and operates more than 51,000 miles along 265 highways, as well as three of the busiest passenger rail lines in the nation. The High-Speed Rail Authority (HSRA) has started construction on an 800-mile system that will serve as the backbone of an integrated rail network. High-speed rail service along the initial operating segment will begin serving passengers in 2025 and linking major metropolitan regions by 2029. The statewide transportation system also includes 140,000 miles of roads, 500 transit systems, 27 commercial service and 217 general aviation airports, 359 hospital and emergency services heliports, and 11 seaports—all owned, operated, and maintained by local and regional governments and special districts. Bicycle and pedestrian networks provide travel options, reduce vehicle congestion, and improve access and livability. Supporting the transportation infrastructure, there are also interdependent systems including fuel pipelines, utility and communication lines, and levees.

Planning, designing, constructing, operating, and maintaining this complex system is the shared responsibility of state agencies, federal agencies, metropolitan planning organizations, regional transportation agencies, transit authorities, local governments, special districts, tribes, and private entities. Transportation planning requires continuous and frequent coordination across sectors and different levels of government.

Climate change impacts from sea-level rise to storm surge and coastal erosion are imminent threats to highways, roads, bridge supports, airports at or near sea level, seaports, and some transit system and rail lines.[1] Shifting precipitation patterns, higher temperatures, wildfire, and an increased frequency of extreme weather events threaten transportation assets at varying locations across the state. Temperature extremes and increased precipitation can increase the risk of road and railroad track failure, decrease transportation safety, and create higher maintenance costs. Given the significance of transportation infrastructure to California's economy and resident's livelihoods, damage from these impacts could result in catastrophic economic loss for the surrounding region and State.

As climate changes occur over time, the choices for the State and all the transportation partners are to build protection against the threat (defend), redesign the infrastructure (accommodate), or abandon and relocate (retreat). The economic cost associated with such fortification, alteration, or

The State provides critical assistance and funding to support

140,000
miles of roads,

500
transit systems,

244
public-use airports, and

11
major ports, all owned, maintained, and operated by local, regional, state, and federal governments.

1 Biging, Gregory, et. al. "Impacts of Predicted Sea Level Rise and Extreme Storm Events on the Transportation Infrastructure in the San Francisco Bay Region." California Climate Change Center (California's Third Climate Change Assessment), July, 2012. http://www.energy.ca.gov/2012publications/CEC-500-2012-040/CEC-500-2012-040.pdf

relocation of existing infrastructure has yet to be fully estimated but is it likely to be billions of dollars, and would significantly outweigh the costs of inaction.[2] Impending climate impacts have implications not only for the siting of new transportation infrastructure, but also for maintenance and operation, design features of transportation systems, and emergency planning and response for extreme climate events.

California is building upon the foundation provided by the previous climate adaptation strategies and plans. The information from former strategies and plans is still pertinent, and this update represents a continuation and expansion of those concepts and strategies. The focus continues to be on identifying climate-related vulnerabilities in the transportation infrastructure, developing adaptation plans to define types of actions, and working to prioritize those actions to make the most of limited funds for capital investments.

2 Kahrl, Fredrich and David Roland-Holst. "California Climate Risk and Response." University of California, Berkeley and Next 10, November, 2008. http://www.next10.org/sites/next10.org/files/California_Climate_Risk_and_Response.pdf

HIGHWAY 1 PIEDRAS BLANCAS REALIGNMENT

The California Department of Transportation (Caltrans) has realigned 2.8 miles of Highway 1 in northern San Luis Obispo County up to 475 feet inland of the original alignment to protect the route from severe coastal erosion exacerbated by the effects of climate change. The project will protect the highway for the next 100 years and provide access for vehicles, bicycles and pedestrians. Completed in 2017, the realignment of the highway at Piedras Blancas will not only restore the natural functions of nearby creeks by replacing three significant crossings with bridges but the removal of artificial revetments will enable bluff and intertidal zones to reestablish equilibrium. Furthermore, the permeable roadway subbase materials used during construction will maintain the hydrologic connectivity of adjacent wetlands. As climate-related extremes such as sea-level rise, drought and flooding impact the integrity of California's coastal areas, the realignment of this iconic highway is one adaptive measure that will uphold the built and natural environment for years to come.

Images provided by the California Department of Transportation.

T-1 | Understand climate trends that impact transportation.

As the climate in California continues to change, infrastructure within the state, including transportation, faces the threat of damage that may cause short-term disruptions or require complete reconstruction. To prepare for these potential impacts, it is imperative that transportation agencies continue to work toward a better understanding of statewide climate trends, and how they may impact the multi-modal transportation system. Moving forward, state government should enhance collaboration across agencies in furthering our understanding of climate science and trends to ensure a coordinated response to potential impacts.

NEXT STEPS

T-1.1. Work with Cal-Adapt, the State's online climate change data portal to further identify and refine climate metrics and projections that affect transportation system assets, including highways, sea ports, airports, rail, transit, bicycle, and pedestrian infrastructure.

T-1.2. Collaborate with local, tribal, and regional agencies to share and exchange climate change data, tools, and maps in order to enable discussion of vulnerabilities, additional analysis, and coordinated adaptation planning.

T-1.3. Study potential locations of land subsidence and impacts to the transportation system.

ONGOING ACTIONS

- Caltrans is studying climate changes that may impact the state highway system.
- The High Speed Rail Authority is studying climate trends that may impact the high-speed rail system, including subsidence.
- Caltrans is continuing to study the locations and impacts of urban heat islands to transportation infrastructure.
- Funds from Senate Bill 1 support planning actions at local and regional levels that advance climate change adaptation efforts on the transportation system, which may include vulnerability assessments.

T-2 | Complete analysis of vulnerability assessments and prepare adaptation plans to address identified vulnerabilities.

Vulnerability assessments are a critical element in understanding the potential climate change impacts and identifying specific locations that are likely to be affected. More climate data is becoming available to help state agencies develop their vulnerability assessments. Vulnerability assessments provide agencies with an understanding of their assets at risk, the scale, and the location of potential damage. They are essential in the development of climate adaptation plans. As transportation plays a significant role in connecting people to well-paying jobs, affordable housing, and economic opportunities, vulnerability assessments and adaptation plans should address the unique characteristics of the communities that may experience climate change impacts. The needs of communities on the frontlines of climate change without material resources to withstand exacerbated impacts need to be taken into account for effective strategies. Adaptation options are most effective when they include actions that protect both infrastructure and the individuals served; adaptation solutions should have multiple benefits including improving infrastructure, reducing pollution, providing multi-modal transportation options, and facilitating community engagement.

When vulnerable segments of the transportation system are identified, steps should be taken to protect infrastructure and ensure that the surrounding communities will continue to have access to vital destinations and services. The first step in this process is the development of adaptation plans. Adaptation means anticipating the adverse effects of climate change and taking action to minimize or prevent damage. Depending upon the function of the various transportation systems, adaptation measures should be identified that protect infrastructure now and in the future. Well-planned early adaptation measures save money, resources, and lives.

NEXT STEPS

T-2.1. Use climate change projections to analyze the vulnerability of transportation assets to climate change impacts and, where relevant, identify associated operational issues for both congestion management programs and emergency vehicle access and management plans.

T-2.2. Review and refine the outputs of vulnerability assessments with asset-specific information from departmental design, construction, maintenance, and survey engineers, professionals, and databases.

T-2.3. Create adaptation plans to address vulnerabilities identified in assessments.

T-2.4. Coordinate and integrate (wherever feasible) local, regional, and state adaptation plans.

ONGOING ACTIONS

- Caltrans is conducting vulnerability assessments for the state highway system, using projections of climate change/trends.
- Caltrans is developing adaptation strategies and recommendations including lifecycle cost, natural infrastructure solutions, best practices in public engagement, and a process for developing adaptive project alternatives.
- Funds from Senate Bill 1 support planning actions at local and regional levels that advance climate change adaptation efforts on the transportation system. There is $20 million available over the 3-year grant program.

T-3 | Inform the transportation decision-making processes.

Based in an understanding of climate projections and trends, completed vulnerability assessments and adaptation plans lay the groundwork for transportation agencies to successfully inform and change the transportation decision-making process. Climate change and resilience should be considered early in the planning process and carried through the project-delivery process. In some cases, existing design, construction, and management practices do not sufficiently consider climate change impacts and may not be capable of protecting transportation infrastructure in the long term. Therefore, climate change vulnerabilities and adaptation measures should be incorporated beyond the planning process into project design, funding, materials, contracting, construction, maintenance, and management. By doing so, climate change policies and strategies will be incorporated into existing transportation and investment decisions.

NEXT STEPS

T-3.1. Assess current policies, processes, and procedures to identify key entry points where climate change adaptation is or should be considered and incorporated.

T-3.2. Develop economic assessment strategies for evaluating impacts of climate change on the state's transportation system which include social and environmental metrics in order to help facilitate alternatives analysis and project prioritization.

T-3.3. Support and implement the recommendations of the Assembly Bill 2800 (Quirk) Climate-Safe Infrastructure Working Group to integrate consideration of climate impacts into all engineering, design, planning, and investment. The working group will:

- **T-3.3a.** Identify current informational and institutional barriers to integrating projected climate change impacts into state infrastructure design.
- **T-3.3b.** Identify critical information that engineers responsible for infrastructure design and construction need to address climate change impacts.
- **T-3.3c.** Determine how to select an appropriate engineering design for a range of future climate scenarios as related to infrastructure planning and investment.

T-3.4. Ensure that all state plans, grants, investments, design, and maintenance take into account the current and future impacts of climate change in accordance with Public Resources Code 71155(a).

ONGOING ACTIONS

- Caltrans is ensuring the consideration and incorporation of climate change impacts and vulnerabilities across divisions through a Departmental review of standard procedures, guidance, and tools.
- Caltrans is ensuring that California's zero-emission vehicle (ZEV) future is integrated into ongoing investments and is committed to supporting the Governor's ZEV Action Plan with its own Caltrans Zero-Emission Vehicle Action Plan.
- The California Transportation Commission included non-binding recommendations and information in the Regional Transportation Plan Guidelines to support incorporation of climate adaptation.

T-4 | Improve transportation system resiliency.

A resilient transportation system is one that is able to continue to provide essential mobility options during extreme weather caused by climate change. In order to create a more resilient system, transportation agencies must identify and implement adaptation strategies that protect the system from short- and long-term climate change impacts. New and innovative designs, materials, and maintenance practices will be necessary to increase the resiliency of the system as the climate continues to change. State transportation agencies should coordinate and collaborate with local, regional, and federal partners to create consistent solutions that increase the resiliency of the multi-modal transportation network and the communities they serve.

NEXT STEPS

T-4.1. Identify, promote, and incorporate successful adaptation strategies, designs, and building practices that can increase the transportation system's ability to address identified vulnerabilities.

T-4.2. Increase asset monitoring capabilities to identify climate-related changes to transportation infrastructure in order to direct maintenance to assets that require preventative maintenance.

T-4.3. Use innovative materials and infrastructure design to optimize transportation resilience and extend design life of assets.

T-4.4. Use both structural and natural infrastructure solutions such as wetland restoration and creation, as well as rock revetments and seawalls, to protect transportation assets.

T-4.4a. Investigate methods to blend the structural and natural solution techniques to achieve multiple benefits, such as groundwater recharge, stormwater management and flood prevention, mitigation of the urban heat island effect, neighborhood beautification, a more pleasant environment for pedestrians and bicyclists, and protection of transportation facilities.

T-4.5. Support and develop multimodal transportation routes to provide a variety of travel options in the case that a route is damaged.

T-4.6. In the transit sector, provide service to cooling centers in easily accessible locations, encourage public transit design decisions that lower urban heat island, and use passive cooling where possible at transit stops.

T-4.7. Educate those who use active transportation (bicycle and pedestrian) about heat illness prevention and treatment. Along pedestrian facilities with high-heat days, provide shade sidewalks/paths and public water fountains to prevent heat illness. Where possible, use pervious pavement for bicycle and pedestrian pathways to increase water infiltration. Refer to California Environmental Protection Agency's Urban Heat Island Index analysis to help identify best locations for these efforts.

T-4.8. Implement adaptation plans (see T-2.3) in order to reduce/eliminate vulnerabilities, as funding allows.

T-4.9. Provide information to the Governor's Office of Emergency Services about segments of the transportation system that are expect to be impacted by future climate events in order to enhance emergency preparedness.

T-4.9a. Work with the Governor's Office of Emergency Services to identify vulnerable transportation segments that disadvantaged communities will rely on during future climate events to address inequitable impacts during emergencies.

ONGOING ACTIONS

- Caltrans is supporting adaptation research and pilot projects including a study of State Route 37 in the San Francisco Bay, a green infrastructure study on State Route 1 at Elkhorn Slough in Monterey, and adaptation plans in Humboldt County for Highway 1.
- Caltrans' emergency management team works with the Office of Emergency Services to protect the public and prepare the transportation system for climate events.
- Build the statewide rail network as outlined in the 2018 State Rail Plan, including high-speed rail phase 1 and 2 in order to provide connectivity and multi-modal mobility options on every major corridor.
  - Build high-speed rail to provide reliable access to urban centers across the state with increased public transit and active transportation opportunities around stations
  - Caltrans' 2018 State Rail Plan identifies priority rail corridors and supports electrification of these corridors to increase the reliability and efficiency of the rail network, thus providing needed resiliency should climate-related emergencies compromise alternative routes.
- Caltrans projects incorporate "Complete Streets" elements that provide transit, biking, and walking throughout the transportation system. These alternative transportation routes connect communities, and provide equitable access to evacuation routes.
- Caltrans is installing electric and hydrogen fueling infrastructure to support the expansion of alternative fuel vehicles that reduce fuel dependency.

T-5 | Maintain and enhance information sharing and education.

Providing outreach and education and sharing information is essential in advancing the knowledge base on climate change and adaptation. Information sharing among transportation agencies, academia, and private entities is necessary to build a resilient system that can serve all California residents with vital transportation options. Transportation agencies should continue to conduct and support research, and provide education on the growing science behind climate change and the innovative resiliency measures being implemented. State agencies should take the lead in encouraging communication and collaboration among local, regional, federal agencies, the private sector, the public, and other stakeholders.

NEXT STEPS

T-5.1. Encourage collaboration and integration among state, regional, and local adaptation efforts.

T-5.2. Analyze and compare data and methodologies used for infrastructure vulnerability assessments in the Fourth Climate Change Assessment, Department of Water Resources' vulnerability assessment, Department of Transportation vulnerability assessment, and other relevant assessment products to understand best practices and opportunities for coordination.

- **T-5.2a.** Utilize the Research Working Group for the Climate Action Team to coordinate and scope all future initiatives that involve climate science.

T-5.3. Engage public organizations and individuals to discuss the expected impacts of climate change on the transportation system, and to identify adaptation solutions that protect nearby communities, especially those with vulnerable and/or disadvantaged populations.

T-5.4. Encourage advanced coordination between transit operators to facilitate evacuations during extreme climate events.

ONGOING ACTIONS

- Caltrans convenes and participates in climate adaptation workshops with local, regional, and federal partners, academia, and other transportation stakeholders.
- Caltrans and the California Coastal Commission created an Integrated Planning Team to coordinate policy implementation between agencies.

Natural and Managed Resource Systems

Climate change will affect the productivity of California agriculture and rangelands, the health and biodiversity of terrestrial, coastal, and marine ecosystems, and the function of our water systems in complex and interconnected ways. These natural and managed systems provide goods and services—including food, water, energy, climate regulation, carbon sequestration, protection from floods and natural disasters, disease and pest regulation, and cultural resources—that are vital to the social and economic well-being of the entire state. These lands must be safeguarded and restored so that they can continue to provide essential services for people and wildlife.

Safeguarding these goods and services will require ecosystem and landscape-level management. This section organizes these needs across the following five chapters under the umbrella of "Natural and Managed Resource Systems":

Agriculture

Biodiversity and Habitat

Forests

Ocean and Coast

Water

This section links directly to the prior section, "Social Systems and the Built Environment." Investment priorities for and around rural, tribal, and coastal communities support natural and managed systems while providing public health, infrastructure, and community development benefits. Strategies to safeguard oceans and coasts also support emergency management, land use, and community development strategies, protecting communities within coastal, San Francisco Bay, and Sacramento-San Joaquin Delta counties that host over 75 percent of California's population. Measures to protect forests, agricultural lands, and rangelands and to foster sustainable development align with land use planning strategies outlined in the "Social Systems and the Built Environment" section.

This section presents high-level recommendations and metrics to help evaluate climate impacts and related government responses. It shows how ongoing state-funded research is supporting and informing adaptation policy and action, then details each sector's ongoing actions and next steps for every high-level recommendation. This structure is also intended to link directly with the "Natural and Managed Resources and Systems, and Their Uses" chapter in the International Panel on Climate Change's Fifth Assessment Report. California's alignment with local, regional, national, and international efforts is part of its global efforts to lead climate action and make policy based on the best available science.

Agriculture

Successful food crop production is closely tied to weather, which are the conditions of the atmosphere over a short period of time. Climate change is changing the longer-term patterns of atmospheric conditions, and the resulting impacts are expected to worsen over the next century. Climate impacts like unpredictable water availability, rising minimum and maximum temperatures, extended heat waves, changes in the prevalence of plant and livestock pests and diseases, and impacts to beneficial species directly affect agricultural food crop and livestock production.

Climate change impacts on agricultural food production are complex and variable. Some crop yields may decrease due to changing average, minimum, and maximum temperatures.[1] For example, a reduction of winter chill hours is harmful to many high-value fruit and nut crops.[2] Extreme heat results in additional costs for livestock cooling and may lead to losses in production.[3] Changes in climate can also create or exacerbate other environmental concerns such as declines in water quality, groundwater security, soil health, and pollinator species, and increased pest pressures.

Despite the many ways that agriculture is threatened by the changing climate, the diversity of California agriculture and the State's unique micro-climates offer a suite of potential opportunities to improve the resiliency to climate change. Additionally, the use of precision agriculture technologies and sustainable on-farm management practices provide room for increasing climate change adaptation while at the same time reducing negative environmental impacts. An agricultural food production sector resilient to climate change will remain diverse and highly productive in the midst of disruptions. The State can support the efforts of California farmers and ranchers to adapt to climate change by developing tools, providing outreach and education opportunities, and incentivizing on-farm management practices that offer increased resiliency to climate change impacts.

Climate impacts like unpredictable water availability, rising minimum and maximum temperatures, extended heat waves, changes in the prevalence of plant and livestock pests and diseases, and impacts to beneficial species directly affect agricultural food crop and livestock production. This poses a significant threat to California, which grows over 33% of the U.S.'s vegetables and two-thirds of its fruits and nuts.

1 Lobell, David, Field, Christopher, Nicholas Cahill, Kimberly, & Bonfils, Celine. "Impacts of future climate change on California perennial crop yields: model projections with climate uncertainties." 2006.

2 Luedeling, Eike, Zhang, Minghua, & Girvetz Evan. "Climatic Changes Lead to Declining Winter Chill for Fruit and Nut Trees in California during 1950–2099." 2009. http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0006166.

3 Key, Nigel & Sneeringer, Stacy. "Greater Heat Stress from Climate Change Could Lower Dairy Productivity." *US Department of Agriculture, Economic Research Service.* 2014. https://www.ers.usda.gov/amber-waves/2014/november/greater-heat-stress-from-climate-change-could-lower-dairy-productivity/.

ADVANCING WATER MANAGEMENT IN MERCED COUNTY

Changes to the climate are impacting the already brief precipitation season in California. Seth and Michelle Rossow utilized funds from the California Department of Food and Agriculture's State Water Efficiency and Enhancement Program (SWEEP) to purchase and install an improved irrigation system on their farm in Merced County. Seth and Michelle Rossow Farms now automate irrigation of tomato and bell pepper crops on their 175 acres of land. The automation mechanism on their existing sub-surface drip irrigation system utilizes newly installed soil moisture probes to alert workers when the crops need water. The new system thus conserves water by utilizing smaller quantities more frequently and directly to the crop root zones. After replacing an above ground diesel-fueled sprinkler system, this automated irrigation technology is not only saving water, but also reducing diesel emissions, conserving electricity, and saving money. Efforts to accommodate for climate change by enhancing the water and energy efficiency of existing agricultural systems in this way are imperative components of a resilient future.

Clockwise from top right:
- Drip system installed in a stone fruit orchard.
- Drip system installed in a vineyard.
- Microsprinkler system installed in a walnut orchard.

A-1 | Advance water management and energy efficiency in agricultural operations.

California's Mediterranean climate makes it a unique and unparalleled agricultural food production region for the State, nation and world. However, the short precipitation season makes irrigation a necessity with a reliance on winter snow pack, which is declining.[4] California irrigation infrastructure includes snowpack, reservoirs and rivers, lengthy conveyance canals, pumping stations and groundwater aquifers. The movement of water throughout the state requires considerable energy input. The agriculture sector has been making strides in water and energy efficiency. By converting to lower carbon-emitting energy sources and by reducing the water applied, agriculture in California is reducing its overall water-energy footprint while becoming more resilient to increasingly variable water resources.

NEXT STEPS

A-1.1. Begin implementation of the 2017 State Water Efficiency and Enhancement Program (SWEEP).

A-1.2. Award funding for a project(s) that combines improvements to water conveyance with on-farm water conservation techniques through the 2017 California Department of Food and Agriculture and Department of Water Resources Joint Agricultural Water Use Efficiency & State Water Efficiency and Enhancement Program.

A-1.3. Coordinate with other State and Federal agencies such as the California Energy Commission to identify funding for research into water use efficiency impacts of on-farm practices.

ONGOING ACTIONS

- The California Department of Food and Agriculture uses stakeholder input provided at meetings of the Environmental Farming Act Science Advisory Panel to improve SWEEP.
- The California Department of Food and Agriculture released a joint request for proposals for a pilot program that uses Proposition 1 funds dedicated to agricultural water use efficiency to provide a range of benefits for those programs.
- The U.S. Department of Agriculture and the California Air Resources Board worked with the California Department of Food and Agriculture to investigate existing research and tools to estimate the water and greenhouse gas emission benefits of irrigation system improvements.
- The California Department of Food and Agriculture works to help bring farmers together with technical experts and conservation practitioners.

4 Bales, Roger. 2013. "Managing Forests for Snowpack Storage and Water Yield" presented at the California Department of Food and Agriculture Climate Change Adaptation Consortium, January 23, Monterey, CA.

A-2 | Build soil organic matter on farms and ranches to achieve multiple benefits.

Healthy soils provide a foundation for long-term agricultural sustainability, capture of atmospheric carbon dioxide greenhouse gases, and sequestration of that carbon in agricultural soils.[5] The United Nations declared 2015 the International Year of Soils and recognized the importance of sustainable soil management to future agricultural food security and reducing the magnitude of climate change impacts. California launched its own Healthy Soils Initiative in 2015, an interagency effort to increase soil carbon and reap other potential co-benefits such as improved plant health, enhanced microbial soil biodiversity, dust prevention and increased water retention of soils. These benefits extend off-farm and holistically benefit communities and the environment. The California Department of Food and Agriculture leads the Healthy Soils Initiative, promoting management practices with soil health benefits to the agricultural community.

NEXT STEPS

A-2.1. Collaborate with partner agencies to customize or develop tools that quantify the greenhouse gas benefits from management practice on various farm and ranch management practices.

A-2.2. Identify a process for estimating co-benefits to water and air quality at a community level.

A-2.3. Announce awards for the Healthy Soils Incentive and Demonstration Program to provide grants to agricultural operations to employ specific management practices that increase the carbon content in the soil.

A-2.4. Fund demonstration projects to showcase the multiple benefits that can be achieved through practices designed to enhance soil carbon.

A-2.5. Work with stakeholders and the California Air Resources Board to incorporate additional management practices into the Healthy Soils Incentive and Demonstration Program.

A-2.6. Build further collaboration between CDFA, CalRecycle, and other partner agencies to identify strategies on how healthy soils can contribute to achieving some of the other state agency waste reduction and environmental objectives and goals.

ONGOING ACTIONS

- The California Department of Food and Agriculture provides information on the Healthy Soils Initiative to the public through outreach events such as State Board of Food and Agriculture meetings, Healthy Soils Summits co-hosted by the U.S. Department of Agriculture Natural Resource Conservation Service, at meetings of the Environmental Farming Act Science Advisory Panel, and through Climate Smart Agriculture webinars.

5 Paustian, Keith et al. "Climate-smart soils." Nature. 2016. https://www.nature.com/nature/journal/v532/n7597/full/nature17174.html.

- The California Department of Food and Agriculture is administering the Healthy Soils Incentive and Demonstration Program.
- The California Department of Food and Agriculture continues to collaborate with the U.S. Department of Agriculture and other state agencies to investigate existing research and tools to estimate carbon benefits of soil management.

A-3 | Support dairies in climate smart management practices.

California's dairy sector has achieved extremely high levels of production efficiency over the last 20 years, increasing the milk produced per cow by 50 percent. Dairies however are a critical industry for reducing methane emissions from manure management to reduce methane greenhouse gases. Dairy operators need flexibility to implement greenhouse gas reduction management practice solutions suited to their particular dairy operation. The State can meet this need for flexibility by providing incentive programs focused on producing multiple benefits to continue to support high production efficiency while providing greenhouse gas emissions reductions and benefits in other sectors. The potential for synergies in renewable energy and soil health make dairies a key participant in climate resilience in California agriculture.

NEXT STEPS

A-3.1. Begin construction of the 18 projects selected as part of the California Department of Food and Agriculture's 2017 Dairy Digester Research and Development Program.

A-3.2. Announce awards for the 2017 Alternative Manure Management Program (AMMP).

A-3.3. Seek input from communities with dairy-dependent economies regarding the benefits and drawbacks of different dairy management practices.

A-3.4. Encourage dairy operators to take advantage of other California Department of Food and Agriculture incentive programs such as the Healthy Soils Incentive and Demonstration Program and State Water Efficiency and Enhancement Program in order to maximize benefits and synergies.

ONGOING ACTIONS

- Grants for dairy digesters, reduce methane emissions, address Senate Bill 1383 (Lara) implementation, and produce renewable energy through the Dairy Digester Research and Development Program.
- The California Air Resources Board and California Department of Food and Agriculture are convening a group of researchers and dairy industry representatives to provide recommendations on how to achieve greenhouse gas emission reductions on dairies and to identify opportunities for synergies with soil health and renewable energy.

A-4 | Increase farmland conservation.

As California's population increases, California farmland is increasingly threatened with conversion to urban uses. California's farmland offers multiple climate benefits in addition to agricultural production, such as carbon sequestration, groundwater recharge, and wildlife habitat. Permanently protecting California farmland with agricultural conservation easements ensures that farmland will remain available to provide food and co-benefits for future generations.

NEXT STEPS

A-4.1. Continue funding for the Department of Conservation's Sustainable Agricultural Lands Conservation Program and California Farmland Conservancy Program.

A-4.2. Continue working with land owners and local governments to support Williamson Act participation, identifying opportunities to improve implementation.

A-4.3. Provide funding to local governments and tribes to develop and implement agricultural protection policies like farmland mitigation policies, agricultural buffers, and right to farm ordinances.

A-4.4. Employ the 2017 update to OPR's General Plan Guidelines, which include new sections on protecting open space, including agricultural land.

ONGOING ACTIONS

- The Department of Conservation is leading the implementation of the Sustainable Agricultural Lands Conservation Program for the Strategic Growth Council.
- The Department of Conservation administers the Williamson Act, which provides farmers and ranchers with property tax incentives to keep their land in agricultural production.
- The Governor's Office of Planning and Research has released a General Plan Guidelines Update including consideration of Open Space and Agricultural Land Conservation.
- The research plan of the Climate Action Team includes investigation of the climate benefits of farmland conservation in the research agenda for the next five years.
- *Vibrant Communities and Landscapes: A Vision for California in 2050*, a document prepared collaboratively by many state agencies, focuses on the objectives of conservation and sustainable development.

A-5 | Grow the Climate Smart Agriculture outreach platform.

Climate Smart Agriculture is a platform that allows for the development of specific climate change adaptation and mitigation measures while at the same time sustainably increasing agricultural productivity. Climate-smart agriculture management practices are most efficiently and effectively shared by peer-to-peer, farmer-to-farmer interactions. The California Department of Food and Agriculture encourages communicating about management practices at the local and even international level, holding Climate Smart Agriculture events.

NEXT STEPS

A-5.1. Continue collaborations with research institutions and international partners to share experience and knowledge about solutions to climate change impacts.

A-5.2. Expand the utility of the California Department of Food and Agriculture Climate Smart Agriculture webpage for discussion of research and practical applications.

A-5.3. Through the use of incentive programs and advancement of assessment tools, increase awareness of technical and conservation expertise at California Resource Conservation Districts, USDA Natural Resource Conservation Service, and University of California Cooperative Extension.

A-5.4. Scale outreach programs to farms of all sizes, being inclusive of all crops, demographics, and regions.

ONGOING ACTIONS

- CDFA has developed a Climate Smart Agriculture webinar series to explore various climate resiliency efforts on an international level.
- Leadership at CDFA uses international agricultural delegation visits to learn and share insights on climate change adaptation.
- CDFA and partners such as the Strategic Growth Council and technical assistance providers continue to reach out to all members of the agricultural community (farming and livestock operations of all sizes and organizational structures) to increase awareness of funding opportunities made available through CDFA's Climate Smart Agriculture program.

Biodiversity and Habitat

California is home to one of 25 global hotspots for conservation, because of both its remarkable biodiversity and the significant threat of losing habitats and wildlife species unique to California.[1] California also has the highest number of native and endemic plant species of any U.S. state and is recognized as one of 34 global hotspots for plant diversity.[2] Climate change is one of the biggest threats to conserving the rich biodiversity found in this state.

> California has the highest number of native and endemic plant species of any U.S. state, but climate change is threatening much of our natural bounty.

Species and ecosystems in California are valued both for their intrinsic worth and for the services they provide to society. Air purification, water filtration, flood attenuation, food provision, recreational opportunities such as fishing, hunting, wildlife viewing, and more are all services provided by ecosystems. These services can only be maintained as long as ecosystems are healthy and robust, and continue to function properly under the impacts of climate change. A recent study examined the vulnerability of all vegetation communities statewide in California and found that 16 of 29 were highly or nearly highly vulnerable to climate change, including Western North American freshwater marsh, Rocky Mountain subalpine and high montane conifer forest, North American Pacific coastal salt marsh, and more.[3] Vegetation serves as the underlying support providing habitat for wildlife, so this projection indicates both the vulnerabilities of individual species and the magnitude of changes to come.

The 2009 *California Climate Adaptation Strategy* and the follow-up 2014 *Safeguarding California* Plan described the expected impacts of climate change on biological diversity and habitat in California, and outlined strategies to minimize these impacts. In this 2018 update, we do not provide a review of the impacts to biodiversity, but build upon the strategies developed in previous iterations of the Plan and identify steps to continue facilitating adaptation to climate change in the biodiversity and habitat sector.

While the biodiversity and habitat sector content is focused on climate adaptation, it should be noted that ecosystems in California also provide a means to mitigate climate change via natural sequestration and storage of carbon. This topic is explored in depth in both the Natural Resources Agency's Forest Carbon Plan and the Natural and Working Lands section of California's forthcoming 2014 Scoping Plan Update to meet 2030 greenhouse gas targets. Natural lands carbon sequestration is therefore not addressed in detail in this document. However, it is important to note that adaptation and mitigation efforts are intertwined, and many of the activities described throughout this chapter may also support the State's efforts to reduce greenhouse gases.

Many of the advancements to date in this sector can be attributed to strong partnerships with non-state organizations. These include partnerships with local governments, federal agencies, other state agencies, non-governmental organizations, and California Native American Tribes, as well as collaboratives such as the

1 Myers, N.R., C. Mittermeier, G. Mittermeier, G. da Fonseca, and J. Kent. "Biodiversity hotspots for conservation priorities". Nature 403:853-858. 2000.

2 Conservation International. "Biodiversity hotspots: California floristic province." 2015.

3 Thorne, J.H., Boynton, A., Stewart, J., Bjorkman, J. "A climate change vulnerability assessment of California's terrestrial vegetation." Information Center for the Environment, University of California, Davis. 2016.

U.S. Department of the Interior's regional Landscape Conservation Cooperatives, the Bay Area Ecosystem Climate Change Consortium, the Climate Science Alliance - South Coast, the San Diego Climate Collaborative, and many more. Further, the work of this sector is underpinned by the use of best available science which to date has been supported by the U.S. Department of Interior Climate Science Centers, U.S. Department of Agriculture Climate Hubs, and other entities. The collaboration among partners and the transfer of information—both scientific data and practical experience—will help to ensure that common pitfalls are avoided, and that we collectively maximize benefits to species and habitats while balancing the needs of humans and wildlife.

SOUTH BAY SALT POND RESTORATION

Tidal marshes are vegetated coastal wetlands that provide critical habitat for numerous species, including young salmon, steelhead trout, shorebirds, waterfowl, harbor seals, and endangered birds and mammals like the California Ridgeway's rail and salt marsh harvest mouse. As climate change challenges the integrity of these habitats, restoration efforts are critical to maintaining a resilient coast. The South Bay Salt Pond Restoration Project is the largest tidal wetland restoration project on the West Coast. When complete, the restoration will convert 15,100 acres of former salt evaporation ponds at the south end of San Francisco Bay to a mix of tidal marsh, mudflat and other wetland habitats. In addition to restoring and enhancing wetland habitat, the project also aims to provide wildlife-oriented public access and recreation as well as flood management in the South Bay that will increase resilience to sea level rise. The project is a partnership between the US Fish and Wildlife Service, California Department of Fish and Wildlife, the State Coastal Conservancy, and other federal, state and local agencies. The first phase of projects, which restored or enhanced 3,750 acres, was completed in May 2016. The second phase of projects (3,335 acres) will break ground in 2018.

Images provided by Cris Benton.

B-1 | Strengthen the climate adaptation component of conservation planning efforts at multiple scales.

State agencies must continue to incorporate the latest climate science, projected and observed impact information for fish and wildlife, and adaptation principles into conservation planning efforts to ensure climate-smart actions are taken at the local, regional and state-wide scales. This means going beyond a general recitation of climate projections and basic impacts to biodiversity by incorporating climate vulnerability information for species and habitats, using that information to inform conservation priorities and actions, and developing robust adaptation strategies is necessary to meaningfully address climate risks in conservation planning efforts.

Candidates for this type of work include planning efforts such as Natural Community Conservation Plans (NCCPs), Habitat Conservation Plans (HCPs), Joint-Venture Implementation Plans, Endangered Species Recovery Plans, regional advance mitigation planning, Regional Conservation Investment Strategies, California EcoRestore, and many more. Many of these conservation planning exercises are aimed at preserving biodiversity, protecting federally or state listed species, aiding in species recovery, promoting habitat connectivity, and finding multi-benefit conservation solutions through integration with agriculture and working landscapes. Some of these efforts may also provide the opportunity to promote the use of natural infrastructure to benefit wildlife while pursuing a separate objective. Incorporating climate change will only strengthen each plan's ability to achieve these goals in the long-term.

Capacity to integrate climate science and to implement conservation plans varies among agencies, partners, and stakeholders. Leveraging resources and information will be essential.

NEXT STEPS

B-1.1. Continue to implement current natural resources plans with climate adaptation measures, and utilize opportunities to ensure climate change is well represented in upcoming planning efforts (e.g. the development of NCCPs, HCPs, new Conceptual Area Protection Plans (CAPP), updates to State Wildlife Conservation Board Strategic Plan, and updates to the State Wildlife Action Plan).

B-1.2. Identify the best available climate science to use in conservation planning efforts at different scales (e.g. refugia data, landscape resiliency, connectivity, etc.)

B-1.3. Develop specific guidance on how to use best available science in various conservation planning applications.

B-1.4. Engage and support local and tribal communities in their planning processes where significant ecological resources are concerned.

ONGOING ACTIONS

- Climate change adaptation is addressed in several NCCPs that are either completed or in progress.
- The California Department of Fish and Wildlife developed general guidance for incorporating climate change into NCCPs, available on a website.

- A number of city and county general plan and regional sustainable community strategies integrate climate change into their guidance.
- California Department of Parks and Recreation continues to refine tools that will enable the department to integrate climate change adaptation into general plans and other planning documents.
- Climate change was thoroughly integrated into the Department of Fish and Wildlife's 2015 State Wildlife Action Plan update process, final document and associated Companion Plans.
- Climate change adaptation is integrated in the Department of Fish and Wildlife's 2017-2050 Delta Conservation Framework that lays out goals and strategies with focus on the long-term conservation of ecosystem processes in the Sacramento-San Joaquin Delta to protect, restore, or enhance ecological function.
- The Delta Stewardship Council is embarking on an amendment to the ecosystem chapter of the Delta Plan that will incorporate the latest climate change science in the Plan policies or recommendations for actions to protect, restore, and enhance the Delta ecosystem.
- The Climate Science Alliance – South Coast is developing a "State of the Science" project to explore the vulnerability of diverse Southern California ecosystems to climate change. The project aims to determine what conservation planning methods will best suit Southern California species in the face of a changing climate. The final report will be part of the State's Fourth Climate Assessment.
- The multi-agency Southern California Wetland Recovery Project is completing and adopting an updated regional strategy and integrates climate change considerations into quantified regional objectives.
- The Coastal Conservancy is conducting a statewide coastal habitat climate vulnerability assessment with the Nature Conservancy to identify priorities for future conservation.
- State agencies and other partners are continuing to implement the San Francisco Bay Ecosystem Habitat Goals Report's recommendations, which serve as a guide for conserving important habitat.

B-2 | Enhance habitat connectivity and protect climate refugia through strategic acquisition and protection activities.

A well-connected system of habitat reserves is essential to protect species as current habitats change and new habitats develop. In the terrestrial environment, connectivity can provide stable pathways for native species and increase overall permeability of the landscape, which is increasingly important in the face of habitat fragmentation and other barriers to species movement. Connectivity is equally important in the aquatic environment, especially establishing linkages between areas of cold water refugia, where species can survive through habitat disruptions. Acquisitions through fee title and conservation easements are tools that can be used to preserve critical wildlife corridors and areas of potential refuge or high resiliency in the face of climate change.

Connectivity is already a basic consideration in most land acquisition efforts, and habitat connectivity in California has been mapped at the state-wide scale, such as the California Essential Habitat Connectivity Project mapped by the Department of Fish and Wildlife and Caltrans, and at finer scales in some regions of the state. This recommendation is intended to move beyond business-as-usual connectivity planning and promote the development of connectivity and reserve designs that might be different in the context of climate change and as land uses change over time. In general, striving for diversity in corridor attributes and redundancy in corridor placement (i.e. expanding the area covered by corridors) may be necessary tactics. Connections that are likely to remain viable under a range of future climate scenarios should be prioritized.

Enhancing connectivity, especially when informed by climate change information, will allow for dynamic changes on the landscape and will likely benefit a multitude of species. This is one of the most foundational and potentially most beneficial adaptation strategies we can undertake to address climate change in the biodiversity and habitat sector.

NEXT STEPS

B-2.1. Identify areas within the state that may serve as possible refugia under climate change.

B-2.2. Evaluate potential resiliency of the natural landscape in California to climate change to support planning at a broader, landscape scale.

B-2.3. Identify and prioritize climate-smart corridors at multiple scales for incorporation into land acquisition decisions. Include a valuation of corridors based on ecosystem services provided and co-benefits for other sectors, where possible.

B-2.4. Determine how best to define and evaluate connectivity at various scales, so that it may be monitored over time.

ONGOING ACTIONS

- A state assessment on climate connectivity is being carried out by UC Berkeley as part of the state's Fourth Climate Change Assessment.
- The Sierra Nevada Foothills Connectivity Project, a regional connectivity analysis, was completed in 2015.

- Connectivity to existing protected habitat and to other lands proposed for conservation is an existing consideration in the guidance and format for land acquisition proposals.
- A robust and innovative scientific methodology is being developed to evaluate and plan for current and future landscape connectivity under projected climate and land use conditions in the South Coast. This project was designed collaboratively by Department of Fish and Wildlife Region 5 staff and local scientists from San Diego State University as part of the Climate Science Alliance-South Coast.
- In 2016, the Department of Fish and Wildlife created a new Regional Conservation Investment Strategies Program in response to Assembly Bill 2087 (Levine). The program went into effect on January 1, 2017 and encourages a voluntary, non-regulatory regional planning process intended to result in higher-quality conservation outcomes and includes an advance mitigation tool. The Program uses a science-based approach to identify conservation and enhancement opportunities that, if implemented, will help California's declining and vulnerable species by protecting, creating, restoring, and reconnecting habitat and may contribute to species climate change adaptation and resiliency.

B-3 | Increase restoration and enhancement activities to increase climate resiliency of natural and working lands.

Restoration and enhancement can be used to increase resilience of degraded systems and reduce vulnerability to climate change. Restoration refers to activities to re-establish critical ecosystem functions, and enhancement refers to activities to improve degraded ecosystems. Climate-smart restoration refers to conducting restoration in a manner that prepares the system for the impacts of climate change. Restoring lost and degraded habitats can improve their capacity to support a diversity of species assemblages and re-establish or improve ecological processes (e.g. sediment deposition, water filtration, etc.). Restoration and enhancement can also support wildlife corridor usage as restored systems may better support wildlife movement, and provide food, water, and cover.

We can better utilize the abundance of climate vulnerability information that has been generated for fish, wildlife, and plants in California to help target some of our restoration and enhancement efforts. Activities such as invasive species detection and removal can help to reduce existing non-climate stressors to support ecosystem function and structure and reduce potential vulnerabilities to climate change. Invasive species can significantly contribute to habitat degradation and decrease resiliency.

State agencies should continue to work with partner organizations and the broader conservation community to clearly define climate-smart restoration and enhancement, describe what they looks like in various ecosystem types, and differentiate between climate-smart restoration and business-as-usual restoration.

NEXT STEPS

B-3.1. Support the development of climate-smart restoration/enhancement tools and training for state agency staff.

B-3.2. Prioritize restoration or enhancement of areas with highly or moderately vulnerable ecosystems and with appropriate species and genetic stock to increase the likelihood of population persistence into the future.

B-3.3. Develop standards and processes for determining success of restoration efforts in relation to climate adaptation (e.g. have our actions have increased resiliency?), and explore long-term funding options to evaluate adaptation success.

ONGOING ACTIONS

- The Watershed Restoration Grants Branch at the Department of Fish and Wildlife funded 44 restoration planning and implementation projects through Proposition 1 funding in fiscal year 2016-2017, supporting California's EcoRestore initiative. These projects included both aquatic and terrestrial habitat restoration. CDFW plans to release the next Prop 1 solicitation in late spring or early summer 2017.
- All State departments that were provided with funds under the "Protecting Rivers, Lakes, Streams, Coastal Waters, and Watersheds" chapter of Proposition 1 are coordinating to provide ecosystem benefits at the watershed and regional level.

B-4 | Increase biodiversity monitoring efforts to better understand baseline conditions and make possible the early detection of climate impacts.

Monitoring current conditions on the landscape is necessary for being able to identify climate impacts to fish, wildlife and plants, and their responses to those impacts. Examples of information that could be monitored include population data, such as distribution and abundance data for species in aquatic, terrestrial, and marine ecosystems; behavioral observations such as changes in geographic distribution or migration patterns; wildlife health such as disease occurrence and impact; and other factors such as impacts to food availability and habitat alteration or degradation due to invasive species or other stressors.

This recommendation is aimed at continuing and expanding existing efforts to map and monitor species in California, as well as determining whether or not observed changes such as those in species populations, behavioral patterns, and disease events are tied to changes in climate (e.g. changes in precipitation, temperature, sea level rise, altered hydrologic regimes, etc.). Species and ecosystems can be impacted by a number of different factors, but understanding when, where, and to what extent climate is the cause of those changes will help state agencies determine how best to respond.

Monitoring every species across California is not reasonable or resource-efficient; instead, identifying areas or specific locations that might exhibit early signs of change, or even key species that might be harbingers of change would be a pragmatic way to monitor and detect climate-related impacts to fish, wildlife, and plants (i.e. key indicator species). In particular, vegetation mapping and monitoring can be extremely useful and pragmatic, as vegetation is often considered to be the best single surrogate for habitats and ecosystems. Fine-resolution vegetation data and mapping can inform not only conservation efforts, but also infrastructure and land-use planning. This may be a strategic place to focus initial expansion of monitoring efforts and attempts to discover connections to climate change. Tracking invasive species, with consideration of potential proliferation under changing temperature and precipitation regimes, will also be important.

Strong coordination between state agencies and other organizations conducting ecosystem monitoring will be crucial, especially when similar protocols or methods are being implemented; building upon or supplementing existing data sets and monitoring efforts where possible will be a more efficient use of limited resources.

NEXT STEPS

B-4.1. Continue fine-scale vegetation mapping efforts for California.

B-4.2. Select previously mapped areas of vegetation that could be re-visited and monitored to detect whether any changes have occurred.

B-4.3. Identify indicator species and appropriate metrics to monitor (e.g. the most critical flora and fauna, keystone species, etc.).

B-4.4. Expand the Department of Fish and Wildlife Resource Assessment Program to include additional at-risk ecoregions and species.

ONGOING ACTIONS

- Ongoing statewide fine-resolution vegetation mapping is conducted in compliance with the Department of Fish and Wildlife's Survey of California Vegetation standards.
- The Department of Fish and Wildlife has begun time-series monitoring that will yield importance climate change adaptation information on a few key species.

B-5 | Continue incorporating climate considerations into state investment decision processes related to fish and wildlife conservation.

Explicitly including climate change language in grant program priorities and project solicitations can achieve multiple benefits such as communicating climate-related expectations to project proponents and emphasizing the importance of the climate component; increasing the probability of receiving high quality proposals from the climate perspective; increasing the likelihood that the proposed project will contain forward-looking actions to benefit fish and wildlife; and reducing the likelihood that the project benefits to fish and wildlife and the investment itself will be overturned by climate impacts in the future. This recommendation also extends to investments in science and the allocation of funds to climate impact or vulnerability studies for fish, wildlife, and ecosystems.

State agencies have already made significant strides in accordance with Assembly Bill 1482 (Gordon, 2015), which requires consideration of climate impacts and use of climate adaptation strategies to inform State planning and investments, but need to continue making progress. For any state grant programs that do not yet consider climate change, language should be added to reflect climate impacts to fish and wildlife as appropriate. Grant programs or project solicitations that already include a climate component could be re-visited to see how climate was incorporated and if there is room for improvement in order to maximize climate co-benefits. Critical gaps in climate science related to biodiversity should be identified and filled.

NEXT STEPS

B-5.1. Develop guidelines for grant programs to include impactful climate adaptation criteria.

B-5.2. Revisit grant programs that already include climate considerations and evaluate the significance of the inclusion (i.e. is the climate component meaningful? What impact does it have to the funding decision, if any?).

B-5.3. Develop and provide training to likely authors of land acquisition planning documents on how to address climate change.

B-5.4. Identify, and direct funds to fill, gaps in scientific knowledge related to climate impacts to fish, wildlife, and habitat.

ONGOING ACTIONS

- Climate change adaptation is included in many state agency grant programs, including those at the Natural Resources Agency, Wildlife Conservation Board, Department of Fish and Wildlife and all State conservancies.
- Climate change is represented in several state agency strategic plans, including the Tahoe Conservancy, Sierra Nevada Conservancy, and Coastal Conservancy.
- Department of Fish and Wildlife staff are working to strengthen the climate component in the guidance document used by authors of land acquisition proposals.

- The Department of Fish and Wildlife recently funded two climate science projects:
  - A climate vulnerability assessment for vegetation communities statewide, carried out by researchers at UC Davis as part of the 2015 State Wildlife Action Plan revision.
  - A climate vulnerability assessment for a subset of mammals in California, also being conducted by researchers at UC Davis.

B-6 | Provide educational opportunities to the public and state agency staff regarding climate impacts and adaptation options for ecosystems, fish, wildlife, and plants.

Disseminating climate science, adaptation, and biodiversity impact information to the public furthers an understanding of why it is necessary to safeguard species and natural resources in California, thereby garnering necessary support and input from constituents.

Resource managers and conservation practitioners need easy access to adaptation strategies for planning purposes and climate-smart restoration techniques and tools to apply. Existing efforts to make this sort of information available include California Climate Commons and Point Blue Conservation Science's Climate-Smart Restoration Toolkit.

State agencies need to ensure that these resources are being utilized by staff where appropriate. Agencies should focus on sharing resources that are easily digestible and can be directly assimilated into state agency projects and programs. Where possible, agencies should identify and track how strategies can be applied across various ecosystem and project types. Encouraging feedback from state agency staff on information delivery and potential information gaps is also essential.

NEXT STEPS

B-6.1. Continue existing climate education initiatives such as Climate Science Alliance South-Coast Climate Kids initiative and the Department of Fish and Wildlife's internal Climate Course for its employees.

B-6.2. Develop an ongoing informational component related to climate risks to species and ecosystems in the Department of Fish and Wildlife's Office of Communications, Education, and Outreach program.

B-6.3. Promote, support, or develop opportunities for on-the-ground climate action courses for State agency staff.

ONGOING ACTIONS

- In 2016, 73 Department of Fish and Wildlife employees completed an internal Climate Course that includes materials designed by UC Davis faculty.
- Climate Kids, an initiative of the Climate Science Alliance – South Coast, is working with partners across the region and in Baja to engage students on climate change through art, storytelling, and science. To date, the program has reached more than 5,000 students in San Diego County and 4,000 students in Baja including opportunities for bi-national exchange events and field trips to coastal areas.
- In fall of 2016, the Department of Fish and Wildlife updated its climate change website. This website is the main tool for communicating with the public on the department's climate science and adaptation work. The website now includes more up-to-date information and improved resources.

Forests

Healthy, resilient forests provide critical ecosystem services that are essential to climate adaptation in California. Forested lands make up roughly one third of our state, covering nearly 32 million acres. Because of the broad variety of climate zones, soils, and elevations they encompass, healthy California host an exceptional diversity of plant and animal species. Their ecosystems are part of a global biodiversity hotspot[1] that provides essential habitat for native wildlife, stores carbon, and filters drinking water. Forest products and forest-based recreation support rural communities and the state economy. Nearly two-thirds of California's developed water supply originates from the streams and rivers of the Southern Cascades and Sierra Nevada mountain regions, tying healthy forests to the well-being of most the state's population, over 25 million residents. The urban tree canopy covers 15 percent of California's urban areas, providing public health benefits to 95 percent of Californians who live in cities.

- California's forests cover 33% of the state.
- Two-thirds of Californians rely on water from the state's headwater forests.
- 15% of California's urban areas are covered by urban forests.
- 102,000,000 trees have been devastated by California's ongoing tree mortality crisis since 2010.

However, many of California's forests are currently degraded as a result of fire suppression, the loss of older trees, simplified forest structure, fragmentation, and climate change. While California forests were historically shaped by low-intensity, frequent fire,[2] overgrown forests that have missed their natural fire cycles are less resilient to stresses exacerbated by climate change such as drought, large and severe wildfires,[3] and disease. Severe drought and warmer temperatures have intensified the current tree mortality crisis associated with bark beetles, which has devastated 102 million trees since 2010.

Degraded forests fall short of providing the full range of carbon and water storage benefits that could help the State mitigate and adapt to climate change. In overgrown forests with higher densities of small trees and fewer large trees, competition for scarce resources can stunt individual tree growth rates, and therefore, carbon sequestration. Fragmented and degraded forests detriment habitat for wildlife and make it more challenging for species to migrate in response to a changing climate. And while management of the state's forests is divided between the federal government (58 percent), State and local governments (3.4 percent), and private landowners (39 percent), disturbances such as disease and wildfire do not adhere to ownership boundaries. Conversely, differences in cultural norms and legal restrictions do place ownership boundary-based limitations on forest management actions.

1 Conservation International. "Biodiversity Hotspots." http://www.cnrs.fr/inee/recherche/fichiers/Biodiversite_hotspots.pdf.

2 Stephens, Scott et al. "Prehistoric fire area and emissions from California's forests, woodlands, shrublands, and grasslands." Forest Ecology and Management. 2007.

3 Mallek, Chris, Safford, Hugh, Viers, Joshua, & Miller, Jay. "Modern departures in fire severity and area vary by forest type, Sierra Nevada and southern Cascades, California, USA." Ecosphere. 2013.

FORESTS

Given the variety of wildland and urban forest ecosystems and land ownership patterns in California and the challenges brought on by climate change, there is no single prescription that will restore forest health on its own, but investing in a number of activities can significantly improve forest resilience.[4] The strategies in this chapter fall under a framework of: *restoring and protecting* forest ecosystem function by reintroducing fire and improving management, protecting California's forest base, and enhancing watershed health; *supporting community resilience* by rebuilding California's forest management workforce, expanding the extent and health of California's urban tree canopy, and advancing fire preparedness; and *fostering creative solutions* to sustainably utilize biomass from fuels reduction activities and to better understand climate trends in forests via research and monitoring. While providing a structure for improving the resilience of forest in a changing climate, this chapter recognizes the need for strategies that work across State, federal, tribal, nonprofit, and private management partners and are tailored to address regional needs and ecosystem conditions.

4 North, Malcolm et al. "Reform forest fire management." Science. 2015

KING FIRE WATERSHED REHABILITATION AND REFORESTATION

The King Fire Watershed Rehabilitation and Reforestation project will begin the process of reversing the ecological, economic, environmental, aesthetic and social impacts resulting from 1,300 acres burned in the King Fire in the Fall of 2014. The California Department of Forestry and Fire Protection partnered with the USDA Forest Service, Georgetown Divide Resource Conservation District and UC Cooperative Extensive to plant approximately 390,000 trees, thereby reducing over 169,671 tons of greenhouse gases over the next 60 years. With funding from the Forest Health Program and Greenhouse Gas Reduction Fund's California Climate Investments, the project aims to rally landowners within the King Fire perimeter to the cause of reforestation through educational and financial support to foster healthier forests. The improved health and re-established cover of forested lands will increase potential carbon sequestration and reduce the greenhouse gas emissions on the burned areas, benefitting not only local habitat, but also protecting watershed values and water quality in areas that are important sources of domestic water supply. Accumulated debris and dead trees removed from the affected lands not only improve the growth potential of future vegetation, but also reduce the risk of wildfire, making the forests more resilient to future drought and extreme heat brought on by climate change.

Images provided by the Georgetown Divide Resource Conservation District.

F-1 | Restore fire as a core ecological process, complemented by fuels reduction, working forests, and thinning to enhance forest health, resilience, and long-term carbon stability.

While forests naturally experience fire in regular cycles, called fire return intervals, forests have missed fire cycles due to fire suppression in the past several decades. Without fire, dead material has built up in the forests, fire-adverse species have moved in, and forests have become dominated by smaller trees. When fire does return to many of these forests, it is increasingly severe, compared to historic levels. The combination of fire suppression and historic logging has resulted in the removal of many larger old growth species from the landscape. Overly dense and homogenous forests with small trees competing for sunlight and water are more prone to large and severe wildfires and the spread of pest and disease, have reduced habitat quality, and store less carbon than ancestral forest regimes.[5]

Without significant efforts to restore forest structure and function (to lower densities, larger and more fire resistant trees, and reduced fuel loads), the accelerated climate stresses of warmer temperatures and more frequent drought will continue to make California's forests more vulnerable to disturbance such as severe, large wildfires and pest outbreaks. By 2085, most of the forested areas in Northern California are predicted to experience a growth in burned area of over 100 percent above 1975 reference levels.[6] Although large areas of forest burned annually in California prehistorically (pre 1800)[7] compared to 1975, the proportion of acres burned in severe fire and the size of severe fire patches has significantly increased in the past several decades and is expected to continue to increase.[8]

No single activity is going to solve the wide range of threats and climate stressors to California's forests. Given the certainty of an uncertain future climate, it is important to deploy a balanced approach of a wide range of management activities, and to adapt management strategies to changing ecological conditions. The adaptation strategies within this recommendation align with objectives for climate mitigation to secure California's forested lands as a long-term net carbon sink, as delineated in the State Forest Carbon Plan. While making forests more resilient to climate impacts, they will also help re-establish critical ecosystem functions.

NEXT STEPS

F-1.1. Increase the pace and scale of management activities such as prescribed and managed fire, fuels reduction, working forests, and thinning.

F-1.2. Expand the use of Good Neighbor Authority where appropriate to advance cooperative State projects that thin overstocked and degraded National Forest System lands, leveraging national landscape conservation networks, landscape mitigation strategies, and vegetation treatments such as managed and prescribed fire.

5 Stephenson, Nathan et al. "Rate of tree carbon accumulation increases continuously with tree size." Nature. 2014.

6 Westerling, Anthony "Climate change and growth scenarios in California Wildfire." Climatic Change. 2011. https://www.fs.fed.us/psw/publications/preisler/psw_2011_preisler002_westerling.pdf.

7 Stephens, Scott et al., "Prehistoric fire area and emissions from California's forests, woodlands, shrublands, and grasslands." Forest Ecol. Manage. 2007. http://www.sciencedirect.com/science/article/pii/S0378112707004379.

8 McKelvey, Kevin et al. "An overview of fire in the Sierra Nevada." Sierra Nevada ecosystem project: final report to Congress Vol. 2. 1996.

F-1.3. Increase partnerships and collaboratives between state agencies and conservancies, federal, local and tribal governments, nonprofits, and private landowners to apply prescribed and managed fire in priority areas and manage forests at an ecologically meaningful scale.

F-1.4. Empower state conservancies or alternative local leadership to implement the Forest Carbon Plan on a regional scale, identifying sources of funding to support regional forest management activities.

F-1.5. Partner with California Native American Tribes (Tribes) to learn from Traditional Ecological Knowledge of prescribed fire and forest activities and form cooperative agreements to facilitate the application of indigenous knowledge.

F-1.6. Build local capacity to increase the use of prescribed and managed fire to restore natural fire regimes and forest health.

F-1.7. Connect small and non-industrialized private forest landowners to funding and cost-share programs for fuels reduction and forest management and increase education and outreach efforts tailored to these landowners.

F-1.8. Expand grants and cost share agreements with Tribes, public agencies, nonprofit organizations, and landowners for selectively removing hazardous wildlife fuels.

F-1.9. Develop agreements between State and federal air quality regulatory agencies as needed to facilitate an increase in the use of prescribed fire.

ONGOING ACTIONS

- Ongoing enforcement and monitoring of AB 1504 (Skinner) ensures that Board of Forestry regulations for logging on privately-owned lands meet the State's greenhouse gas reduction goals. AB 1504 requires that BOF regulations ensure maximum sustained production of timber while providing benefits such as carbon sequestration, recreation, water resources, habitat, and economic sustainability. The first AB 1504 Inventory Report was released in fall 2017, and the second inventory is expected by early 2018.
- CAL FIRE Fuel Reduction Project Grants offer funding for California Tribes, public agencies, and nonprofit organizations for removal and utilization of vegetation to reduce wildfire hazards.
- The State Forest Carbon Plan presents actions for managing our forest landscapes in a changing climate, and sets the stage for implementation at the landscape level.
- California's Forest Improvement Program offers cost-share opportunities to reimburse individual landowners with land management planning, conservation practices to enhance wildlife habitat, and practices to enhance the productivity of the land. Timber Regulation and Forest Restoration Fund Revenues have enabled the California Forest Improvement Program to facilitate 183 projects across 52,200 acres statewide in FY 2015-2016 and 2016-2017.
- The USDA Forest Service provides funding for management on National Forest System Lands.
- The Brown Administration's Tree Mortality Task Force coordinates an ongoing response to the current tree mortality crisis with agencies, utilities, and other stakeholders.

- The California Greenhouse Gas Reduction Fund finances projects to proactively restore forest health for multiple benefits through CAL FIRE Forest Health Grants.
- The Natural Resources Agency's Timber Regulation and Forest Restoration Program works with State agencies and industry to increase efficiencies and effectiveness for timber harvest planning and permitting processes and forest restoration.

F-2 | Increase reforestation efforts on wildfire and pest-impacted areas and protect forested lands from conversion to non-forest uses.

CAL FIRE estimated in 2010 that 2.3 million acres of California's forested lands are high priority for restoration due to wildfire and disease impacts – a number that will increase due to the current tree mortality crisis that is estimated to impact 7.7 million acres statewide.[9] Progress has been made to reestablish new forests, yet, given the effects of each year's new fires, 613,781 acres could be in need of reforestation treatments within National Forests alone.

In the absence of reforestation, natural succession in areas impacted by severe wildfire may result in an effective type conversion from forest to grasslands or shrub dominated communities. Accumulating evidence that climate change is resulting in warmer and drier conditions with more severe fires in the West promises to exacerbate this conversion,[10] and makes it imperative to eliminate the current backlog of reforestation in mortality-impacted areas. Additionally, researchers are already seeing a shift in distributions of vegetation types in forests and other ecosystems, such as vegetation moving upslope, as climate change progresses. While increasing the pace and scale of reforestation, these activities must also be informed by expected future changes in climate conditions and anticipated species shifts.

Additionally, although the expanse of California's forested land base has been relatively stable over the past three decades at approximately 32 million acres, regional development pressures threaten to convert forests to non-forest land uses, which is usually irreversible. Some forests are being fragmented or fully converted to other commercial land uses, such as vineyards, cannabis farms, and residential development. Development can deforest and fragment forest lands, degrade forest health, disrupt wildlife habitat, and increase risk of wildfire, even if the development footprint itself is small relative to total forest acreage. Land protection targeted to conserve and steward large, relatively intact forests, can help ensure that forestlands continue to provide essential ecosystem services long-term.

NEXT STEPS

F-2.1. Increase the area of State and private lands reforested with a diverse mix of native species, and ensure that the species mix considers future climate conditions.

F-2.2. Work with the USDA Forest Service to eliminate the current reforestation treatment backlog and sustain future treatments at a level where annual additions are matched by treatments.

F-2.3. Provide funding to maintain and expand seed banks, revive State tree nurseries, and support programs for collection, propagation, and dissemination of tree species and genotypes that are better adapted to shifting regional climate conditions.

F-2.4. Increase the acreage of forestland protected by conservation easements paired with stewardship plans, with a focus on large, relatively intact landscapes that can provide habitat for diverse species and prevent future development.

9 USDA Forest Service. "Aerial Detection Survey – South Sierra Foothills July 6th-10th, 2015." *Forest Health Protection Survey*. 2015.

10 Coppoletta, Michelle, Merriam, Kyle, & Collins, Brandon. "Post-fire vegetation and fuel development influences fire severity patterns in reburns." *Ecological Applications*. 2016.

F-2.5. Provide support and technical assistance for counties, cities and regions to integrate preventing the conservation of forest and timberland production zones into regional planning and development documents and county-level zoning ordinances, drawing from existing General Plan Guidelines, Natural Community Conservation Plans, habitat conservation plans, and the State Wildlife Action Plan.

F-2.6. Provide private landowners with incentives for forest protection through easements and working forests that can return revenue from timber harvesting to cover taxes and other expenses of maintaining forest lands, thereby preventing land fragmentation and conversion to non-forest land uses.

ONGOING ACTIONS

- The federal Forest Legacy Program and California Forest Legacy Program help incentivize conservation easements to protect environmentally important private forestlands.
- The Wildlife Conservation Board's land acquisition program acquires real property or rights in real property on behalf of the California Department of Fish and Wildlife for protection and restoration of wildlife habitat.
- USDA Forest Service State and Private Forestry Grants provide technical and financial assistance to landowners and resource managers to help sustain the nation's forests.
- Seedbank and nursery support is provided through the Los Angeles Moran Reforestation Center, which catalogues and stores approximately 42,000 pounds of primarily native conifer seeds available for replanting forest stands after fires, insect or disease outbreaks, or other catastrophic events.
- The ongoing Reforestation Seedling Distribution Project, administered by the El Dorado County and Georgetown Divide Resource Conservation Districts (RCDs), allows for large-scale propagation and sales from the USDA Forest Service Placerville Nursery to private landowners for forest management and reforestation. This role fills a gap that has existed since the CAL FIRE nurseries ceased operations.

F-3 | Manage forests to support statewide water infrastructure and to protect forested source watersheds.

Investment in forest watersheds, the source of nearly two-thirds of the state's developed water supply, helps ensure high-quality water downstream. Forested watersheds help anchor soil, absorb rain and snowmelt, and lessen the severity of flooding and landslides. In addition, healthy forests help regulate the timing and magnitude of water runoff and water flows, delaying and buffering the timing of spring melt while improving water quality.

Supplementing the forest health challenges described in Recommendation F-1, approximately half of the 191,000 acres of meadows in the Sierra Nevada are known or likely to be degraded. Eroded meadows lose their capacity to store groundwater, an ecosystem service that will be more important under warmer and dryer climate scenarios.[11] Restoration activities can improve meadow habitat and hydrologic function.[12] Meadow and forest restoration activities to enhance watershed health will be increasingly important as climate change continues to reduce snowpack and cause temporal changes in snowmelt and spring runoff that can lead to longer dry periods, reducing available moisture for forest plants and aquatic species.

Soil loss following high severity fire negatively affects tree growth and can also be detrimental to watershed health. High sediment loads, conveyed during the high-flow events typical of California's precipitation regime, typically follow large, high-severity fires for a number of years. This sediment and debris can reduce reservoir capacity, increase water turbidity, interfere with other critical infrastructure, and negatively affect riparian habitat. Post-fire reforestation and forest health activities, such as commercial timber harvesting and thinning, can improve watershed health and benefit water resources. Forest management helps to reduce the need to remove silt and debris from reservoirs and recharge basins, make more space for water supply storage and hydropower generation capacity, and increase the economic value of these activities.

NEXT STEPS

F-3.1. Invest in research and monitoring to quantify water quality and quantity benefits of fuel reduction and forest restoration.

F-3.2. Better communicate the connection between water infrastructure, restoration actions in upper forest watersheds, and the avoided costs of investing in restoring these ecosystem services.

F-3.3. Develop financing mechanisms to account for the full value of healthy watersheds, including the multiple beneficiaries of the ecosystem services they provide, encouraging investments by downstream commercial water users such as drinking water suppliers, breweries, and canneries.

F-3.4. Support watershed-level collaboratives for forest management through multi-party funding mechanisms and existing cost-share programs that engage federal agencies, state conservancies, local governments, Tribes, nongovernmental organizations, and private landowners.

11 Sierra Meadows Partnership. "Sierra Meadows Strategy." 2016. https://meadows.ucdavis.edu/files/Sierra_Meadow_Strategy_4pager_shareable20161118.pdf.

12 California Department of Water Resources. "Chapter 23: Forest Management." *California Water Plan Update* 2013, Volume 3– *Resource Management Strategies*. 2013. http://www.water.ca.gov/waterplan/docs/cwpu2013/Final/Vol3_Ch23_Forest-Mgmt.pdf.

F-3.5. Work with the USDA Forest Service and other federal agencies to identify and prioritize forest health and fuels reduction activities that maximize benefits to water supply watersheds.

F-3.6. Restore 10,000 acres of mountain meadow habitat on non-federal lands in key locations.

F-3.7. Work with the USDA Forest Service to restore mountain meadow habitat on federally managed lands.

ONGOING ACTIONS

- The *Mokelumne Watershed Avoided Cost Analysis,* conducted by the Sierra Nevada Conservancy in coordination with the USDA Forest Service and The Nature Conservancy, evaluates the benefits and avoided costs of increased fuels reduction treatments in the Mokelumne Watershed. This analysis is intended to inform future watershed planning, as well as public and private investment.
- The State Water Board Timber Grant Program funds $2 million in projects per year that demonstrate water quality improvement through the application of Forest Management Measures such as stream restoration, road stabilization, post-fire recovery, and fuels reduction.
- A chapter on Forest Management within the Department of Water Resources' California Water Plan Update provides guidance on actions to improve forest health.
- State Board of Forestry regulations guide protection of the beneficial uses of water and riparian functions.
- Assembly Bill 2480 (Bloom, 2016) identifies watersheds as part of California's water infrastructure.
- Greenhouse Gas Reduction Funds provide funding for forest-related watershed reforestation and restoration projects.
- Large-scale collaborative efforts such as the Sierra Nevada Conservancy's Watershed Improvement Program bring stakeholders together to protect watersheds at an ecologically meaningful scale
- Proposition 1 Restoration Grant Programs fund watershed protection and ecosystem restoration projects of statewide importance outside of the Sacramento-San Joaquin Delta.

F-4 | Elevate biodiversity considerations in forest restoration and conservation planning efforts.

California's forests are home to a vast array of plants, fish, and wildlife. Old forest habitats, which include a layered vegetative structure, large-diameter trees, snags, and fallen logs, are particularly important for maintaining diverse and abundant wildlife populations. Altered forest systems in California, largely due to fire suppression practices over the past century and historic logging, have negatively impacted species that depend on old-growth forest habitat. Declines in mammals, birds, and other vertebrates in the Sierra, Cascades, and Modoc regions have been attributed to the loss and degradation of riparian areas, foothill woodlands, and diverse old forest habitats. The degradation of mountain meadows and loss of quaking aspen, willow, and other woody riparian wood vegetation has affected the State endangered willow flycatcher and other species that have similar habitat requirements. Aquatic and riparian systems are believed to be two of the most altered and impaired habitats of the Sierra Nevada, negatively affecting many of the state's fish and amphibians.

To support the persistence of robust fish and wildlife populations as well as associated recreational opportunities they provide (e.g. bird watching, hunting, and fishing), it is important to actively and deliberately consider wildlife within state agency forest management activities. We must continue to take action to protect and restore the full range of forest ecosystem functions and processes to increase resilience to climate change and accommodate transitioning communities of plants and animals. Actions to address species and habitat vulnerability through forest and watershed management in the other recommendations of this chapter are largely consistent with actions designed to improve forest health, and will help to achieve a multitude of climate change adaptation and mitigation co-benefits.

NEXT STEPS

F-4.1. Prioritize the protection of potential climate refugia in forests or highly resilient landscapes, and those habitats which support species that are highly vulnerable to climate change (as identified in the 2015 State Wildlife Action Plan and numerous other publications) through state agency efforts, where possible.

F-4.2. Protect relatively intact forest landscapes and maintain and enhance connectivity among them to support species movement in response to changing climate conditions.

F-4.3. Increase the scale of invasive species removal and management to maintain healthy ecosystems that are more resilient to changes in climate, disease, and pest outbreaks, and better able to support native wildlife communities.

F-4.4. Expand acres of high priority forest habitat in accordance with the goals of the State Wildlife Action Plan.

F-4.5. Focus restoration and enhancement efforts on moderately to highly vulnerable or highly exposed habitat types where possible, which have already been identified and mapped for the State, including alpine vegetation, mountain riparian scrub and wet meadow, subalpine forests and pine woodlands, and wet mountain meadow, among others.[13]

ONGOING ACTIONS

- The State Wildlife Action Plan outlines strategies for conserving California's fish and wildlife resources in ecosystems including forest.
- The Wildlife Conservation Board's Forest Conservation Program aims to promote the ecological integrity and economic stability of California's diverse native forests for all their public benefits through forest conservation, preservation and restoration of forestlands, including the conservation of water resources and natural habitat for native fish and wildlife and plants found on these lands.

13 Thorne, James, Boynton, Ryan, Holguin, Andrew, Stewart, Joseph, & Bjorkman, Jacquelyn. "A climate change vulnerability assessment of California's terrestrial vegetation." California Department of Fish and Wildlife (CDFW), Sacramento, CA. 2016. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=116208&inline.

F-5 | Continue investing in urban forestry to enhance the health of current urban forests and expand urban tree canopy statewide.

Covering over 791,725 acres, the urban tree canopy occupies approximately 15 percent of all urban areas in California. Urban forests benefit the 35 million Californians living in urban areas, or 95 percent of the population. However, the density and extent of urban canopy has room to grow, as the stocking rate of urban forests is just over a third of its potential statewide. An expanded urban tree canopy could provide a variety of environmental and public health benefits, especially to low income urban areas, which generally have less access to urban parks and green spaces.[14] Meanwhile, existing urban forests are being impacted by climate change, drought, and pest outbreaks. Investment in managing the urban tree canopy to be more resilient to climate impacts will allow urban forests to continue to provide important climate adaptation benefits.

Expanding urban tree canopy cover and using vegetation where feasible can help reduce heat island effects by providing natural cooling. Urban heat islands are created by the concentration of dark pavement and roofing that absorb heat, engines and generators that produce heat, and the absence of vegetation in urban areas. The urban heat island effect can lead to daytime temperatures in urban areas on average one to six degrees Fahrenheit higher than in rural areas, and nighttime temperatures as much as 22 degrees Fahrenheit higher as the heat is gradually released from buildings and pavement.[15] By mitigating these effects, canopy shading by urban forests saves $568 million annually in reduced energy costs.[16]

In addition to cooling, urban forests offer a variety of other co-benefits that enhance climate resilience. Trees and vegetation support water infrastructure through rainfall interception, reduced water pollution, and reduced flood risk. They can filter air and mitigate public health impacts of criteria pollution in urban areas. Additionally, urban greenspace provides public health and community benefits such as strengthened social cohesion, support for cognitive functioning and place attachment, and increased physical activity.[17] Trees in gardens, orchards, farms, and schools provide food for communities. Urban forests offer significant economic benefits as well—in 2009, they generated over $3 billion in direct revenues and nearly 60,000 jobs.

NEXT STEPS

F-5.1. Establish local tree canopy cover goals (locally and regionally) and work towards the Forest Carbon Plan's objective of increasing total urban tree canopy statewide by one-third above current levels, to 20 percent coverage of urban areas by 2030.

14 Wen, Ming et al. "Spatial Disparities in the Distribution of Parks and Green Spaces in the USA." *Annals of behavioral medicine: a publication of the Society of Behavioral Medicine*. 2013. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3590901/.

15 CalEPA & CDPH. "Preparing California for Extreme Heat: Guidance and Recommendations." Heat Adaptation Working Group, Public Health Workgroup, California Climate Action Team. 2013. http://www.climatechange.ca.gov/climate_action_team/reports/Preparing_California_for_Extreme_Heat.pdf.

16 McPherson, E. Gregory, van Doorn, Natalie, & de Goede, John. "Structure, function, and value of street trees in California, USA." *Urban Forestry & Urban Greening*. 2016. https://www.fs.fed.us/psw/publications/mcpherson/psw_2016_mcpherson004.pdf.

17 Sullivan, William, Kuo, Frances, & DePooter, Stephen. "The Fruit of Urban Nature: Vital Neighborhood Spaces." *Environment & Behavior*. 2004.

F-5.2. Help local governments identify optimal locations for green infrastructure and increased tree canopy cover in the 372 communities identified in CAL FIRE's 2010 Forest and Rangeland Assessment as high-priority areas for urban tree planting in order to conserve energy and improve air quality.

F-5.3. Assist local governments and community organizations with establishing policies and management plans to develop urban forests and incentivize the use of best practices for the long-term maintenance and preservation of urban trees.

F-5.4. Develop guidance on how all urban forestry-related projects can support biodiversity goals through thoughtful and climate-smart plant palette selection, and promote the exclusive use of native plants or non-invasive plants in landscaping where possible.

F-5.5. Work with federal, research, and other entities to assist local governments and others in controlling the introduction and threat of pests and pathogens to urban forests.

F-5.6. Obtain and share tree canopy coverage data with local governments on a periodic basis and support adoption of long-term comprehensive urban forest management plans, including relevant tree inventories.

F-5.7. Develop urban forestry protocols to ensure that communities are engaged in site choice and project development from the onset of planning.

F-5.8. Support the creation of jobs, training programs, and workforce development in urban forest management, tree planting, and green infrastructure development to provide sustained economic benefit and ensure long-term capacity for maintenance.

F-5.9. Fund urban tree planting and green infrastructure projects where they yield multiple benefits such as energy reduction, storm water capture, or job creation.

F-5.10. Improve and expand the use of urban biomass to avoid traditional waste streams.

ONGOING ACTIONS

- The Urban and Community Forestry Grant Program has funded projects for urban forest expansion, improvement, and management as well as urban wood and biomass utilization through the Greenhouse Gas Reduction Fund.
- CAL FIRE Regional Urban Forestry Advisors offer technical assistance on urban forest management.
- The California Natural Resources Agency Urban Greening Grant Program, funded through the Greenhouse Gas Reduction Fund, will help to preserve, enhance, increase or establish community green areas such as urban forests, open spaces, parks and other community spaces.
- State, federal, and local forest health entities continue to provide research, information, and support to monitor and control pest and pathogen threats to California's urban tree canopy.

IMPERIAL VALLEY URBAN FOREST EXPANSION

The California Department of Forestry and Fire Protection, in partnership with the City of Brawley, Brawley High School District, the City of Imperial, the City of Calexico, and the City of Holtville, led the planting of 1,400 trees in predominantly disadvantaged communities in the Imperial Valley. Funded by the USDA Forest Service's Urban and Community Forestry Program and California Climate Investments from the Greenhouse Gas Reduction Fund, the project offers job training, community involvement, and young tree establishment care as a means of expanding the urban canopy, particularly in disadvantaged communities. Improving the urban forest inventory is an effective low-cost means of adapting to changing climate. The increased urban shade will help to save energy by reducing the urban heat island effect and offer protection to the public during extreme heat events. The expanded canopy will have significant public health benefits as it filters polluted air and stormwater in the Imperial Valley. During this 40-year project, not only will an estimated 5,622 tons of greenhouse gases be reduced, but also the expanded urban forest will help the area develop a stronger resiliency to the impacts of climate change.

F-6 | Promote wood products markets, particularly innovative utilization of thinned material and other biomass, to support forest-dependent economies and ongoing forest management activities.

The sale of forest biomass and wood products can support climate resilience by helping to pay for forest restoration and sustainable management activities. A core challenge to implementing forest management activities, however, is the lack of economically sustainable demand for smaller diameter trees, dead trees, and other woody biomass that may be removed through restoration. There is a significant amount of woody biomass that comes out of California's overstocked forests, an amount which will increase if management activities are scaled up in accordance with the strategies within this chapter. In many regions landowners struggle to find financially sustainable pathways for biomass. Transportation costs remain high and insufficient workforce capacity prevents proper removal of small-diameter trees, dead trees, and biomass. The lack of viable markets and infrastructure to convert the biomass and other woody materials to higher value products such as electricity, durable wood products, compost, and other soil amendments often results in this wood being left in the forest, where it can increase the risk of wildfire, or in many cases, is open-pile burned. Both of these activities undermine the objectives of greenhouse gas emission reduction goals and can have negative implications for human health. These economic challenges make it challenging to achieve the climate adaptation goals for forests within this chapter and contribute to sub-optimal forest management.

There is a need to both expand forest management and associated wood processing and biomass utilization infrastructure across the state and to invest in the human capacity necessary to carry out management activities. California imports over 75 percent of its wood for consumption despite being the third largest producer of timber in the nation, providing a significant opportunity to increase in-state utilization of California timber products. The State can also help identify and support potential new markets for wood products such as engineered mass timber and wood-based composite panel products for construction, biochar and other soil amendments, and liquid biofuels that can be made from traditionally low-value biomass.

In addition to biomass utilization, forests can support rural economic development through non-timber products, recreation, and tourism. Recreation and tourism benefits augment support for forest conservation efforts while contributing to regional economies: one of the strongest predictive factors that determine public endorsement of forest restoration projects is whether the project is perceived to improve access to recreational opportunities. More information on recreational resources and climate change is provided in the Parks, Recreation, and California Culture chapter.

NEXT STEPS

F-6.1. Provide assistance to navigate legal, permitting, and financial barriers to redevelopment of former sawmill and other previous industrial sites to new wood products facilities.

F-6.2. Create an information clearinghouse of existing State financial resources and incentives applicable to wood products industries, and address resource gaps as needed.

F-6.3. Work with Tribes to protect access to non-timber forest products and traditional activities such as cultural burns and activities related to subsistence in forests such as hunting, fishing, and trapping.

F-6.4. Encourage the use of mass timber and wood products in construction by engaging local and county planning offices, developers, and architects in outreach on building codes; developing and using life cycle assessment of building materials; and encouraging low-carbon building for State facilities.

F-6.5. Promote innovation in the wood products industry by strengthening academic partnerships and supporting applied research and development.

F-6.6. Encourage the siting of complementary wood products manufacturing facilities and small-scale bioenergy businesses to create regional economic hubs.

F-6.7. Train individuals to enter wood products-related jobs by expanding related community college, youth, and apprenticeship programs.

F-6.8. Support California-grown and California-manufactured wood products.

F-6.9. Provide community representation in decision-making for biomass facility siting and ensure that air quality impacts to local communities are considered in project siting and development.

F-6.10. Develop and support the generation of and markets for compost from forest biomass for agricultural, rangeland, municipal, and residential soil amendments.

ONGOING ACTIONS

- The Natural Resources Agency's Wood Products Working Group established through Senate Bill 859 (Committee on Budget and Fiscal Review) has developed recommendations to expand wood products markets in California.
- In 2016, the California Energy Commission released an Electric Program Investment Charge solicitation for efficient, sustainable and lower-cost bioenergy projects. Awards for six projects totaling more than $16 million were announced in March 2017.
- The National Disaster Resilience Competition funded a $22 million grant for a biomass facility and wood products campus in Tuolumne County through the California Department of Housing and Community Development.
- The California Energy Commission continues to support research into the potential for conversion of woody biomass to transportation fuels both statewide and regionally.
- Contracts approved by the Public Utility Commission to fulfill mandates for biomass energy provided by statute through Senate Bill 1122 (Rubio, 2012) or Governor Executive Order 10-30-2015 will continue to be implemented.

F-7 | Foster fire-adapted communities through local planning and fire preparedness.

Although natural wildfire supports and is critical to forest ecosystem health, ongoing research predicts that climate change will exacerbate the risk of uncharacteristically large and severe wildfires that put many forested communities in danger. Additionally, while adaptation strategies within the previous recommendations will help enhance forest health and reduce the risk of catastrophic wildfire, some fires will inevitably continue to escape control efforts. As a result, we must prepare homes and communities to withstand and recover from fires, develop policies and procedures to promote public safety, and educate the public regarding the natural role of wildfire in California's landscape. Engaging individual landowners, homeowners, and communities in fire protection responsibilities with federal, State, and local fire protection agencies is an ever-increasingly important climate adaptation strategy.

Communities within California's 6.7-million-acre wildland urban interface, the geographic transition zone between human-inhabited structures and wildland, are especially susceptible to damage from catastrophic wildfire. Development and population growth in this zone puts human lives and homes at risk during wildfires and degrades and fragments wildlife habitat. Increasing wildfire risk has put a financial strain on these communities due to increased cost and decreased availability of home insurance. Creating fire-adapted communities will require the integration of local land use planning with proactive fire prevention, pre-disaster planning, and emergency management activities.

NEXT STEPS

F-7.1. Integrate climate change considerations in the update to the Strategic Fire Plan for California, the State's roadmap for reducing wildfire risk, drafted by CAL FIRE and the Board of Forestry.

F-7.2. Balance irregularities between fire service and fire prevention budgets.

F-7.3. Provide State guidance and financial support for local and tribal governments, public agencies, and communities to implement fuel breaks, fire safe landscaping, removal of hazardous vegetation, inspections for fire safe clearance around homes, forest health treatment, fire prevention, and fire safe building standards that reduce human loss and property damage from wildland fires.

F-7.4. Assist local and tribal governments in integrating policies within general plans and other local planning documents that discourage development in the wildland urban interface to avoid putting more people at risk of extreme fire.

F-7.5. Develop county and regional fire readiness plans with input and engagement from fire safe councils, fire and land management agencies, Tribes, and individual community members; include provisions for local emergency response through cooperative fire protection agreements with local, State, and federal partners.

F-7.6. Further support landowner-initiated hazardous fuels reduction through grants, cost-share agreements, and streamlined permitting for hazardous fuels reduction activities. Make these grants available and publicized to California Native American Tribes.

F-7.7. Leverage regulatory authority to improve compliance with defensible space laws by increasing the number and effectiveness of defensible space inspections and applying building standards for fire safety uniformly.

F-7.8. Use science-based approaches to understand how climate change will affect the risks wildland fire hazards pose to lives, homes, and critical infrastructure.

F-7.9. Increase public education on the link between fire risk and the elevated importance of preventative fuels treatment projects, the responsibilities of living in the wildland, and necessary prevention measures.

F-7.10. Educate firefighting services on new challenges resulting from climate conditions.

F-7.11. Address post-fire responsibilities for community revival and natural resource recovery.

F-7.11a. Conduct rapid post-fire assessments and project implementation to protect access and functional needs and other communities, to minimize flooding, protect water quality, limit sediment flows, and to reduce other risks.

F-7.11b. Engage landowners and land management agencies in designing and implementing salvage and reforestation activities and vegetation treatment plans to restore ecosystem function to burned areas.

ONGOING ACTIONS

- The 2010 Strategic Fire Plan for California, a cooperative effort to reduce firefighting costs and property losses, increase firefighter safety, and contribute to ecosystem health, is being updated.
- CAL FIRE conducts monitoring of vegetation clearing in the wildland urban interface and conducts defensible space inspections in State Responsibility Area communities across the state.
- The California State Board of Forestry and Fire Protection's Vegetation Treatment Program aims to lower the risk of catastrophic wildfires on nonfederal lands through hazardous fuels reduction.
- CAL FIRE Fire Prevention Education reaches audiences statewide through a new mobile app, social media campaigns, school programs, fair exhibits, posters, flyers and other printed materials, radio and television spots, internet communications, community meetings, and one-on-one contacts with those who live, work, and recreate in wildland areas.

F-8 | Ensure that forest monitoring and applied research activities match decision-making needs.

The forest sector has a long tradition of applied research and monitoring. Given recent trends of climate change, drought, wildfire occurrence and tree mortality, however, there is a need to revisit key research priorities to ensure the continual employment of science-based, cost-effective strategies for forest management and monitoring. This should include collaboration among federal, State, and private funding entities to identify a comprehensive set of research priorities. Studies in progress include a resource economics study by UC Berkeley for the Forest Climate Action Team; research to support the Natural Resources Agency's Fourth Climate Change Assessment; and research by Lawrence Berkeley National Laboratory for the natural and working lands component of the Air Resources Board's 2030 Target Scoping Plan.

Linked to research activities, ongoing data collection and monitoring of forest conditions will provide baseline information for adaptive management and understanding the effects of climate change on forest ecosystems. For example, the Board of Forestry and Fire Protection will report monitoring of the carbon stored in forests for the Air Resources Board's Natural and Working Lands Inventory. Other existing tools that support resource management and assessment, conservation planning, and ecological analysis in landscapes such as forests include the California Environmental Data Exchange Network and CDFW's Biogeographic Information and Observation System (BIOS). Data sharing and integration of these platforms across agencies will help facilitate a better understand the range of climate impacts to California's forests. Other databases such as CalMAPPER, used by CAL FIRE to record fuel reduction efforts and Miradi, used by CDFW to track State Wildlife Action Plan implementation, will help visualize progress towards conservation goals outlined in this chapter.

NEXT STEPS

F-8.1. Create an interdisciplinary committee consisting of researchers and funding entities to develop a priority climate and forest research agenda in coordination with the University of California, the California State University system, and the Research Working Group for the California Climate Action Team.

F-8.2. Complete a standardized greenhouse gas inventory to track carbon sequestration and greenhouse gas emissions on working forestlands.

F-8.3. Sharpen forest carbon accounting methods by improving forest inventory data collection and incorporating remote sensing where possible.

F-8.4. Develop a centralized database to track implementation of forest restoration and management activities across State, federal, and local entities and private landowners.

F-8.5. Research forest restoration and protection best practices and apply them in an adaptive management context.

F-8.6. Initiate and continue research relating to appropriate restoration efforts in areas affected by uncharacteristic wildfire and tree mortality, including incorporation of climate change modeling.

F-8.7. Use CAL FIRE's Demonstration State Forests to better understand how management activities such as thinning and prescribed burns impact fire risks, carbon storage, and various co-benefits in forests.

F-8.8. Gain a better understanding of genetic and species selection of tree planting stock that can best thrive under changing climate conditions.

F-8.9. Maintain consistent, detailed, and regularly updated vegetation and fuels maps and CAL FIRE Very High Fire Hazard Severity Zone maps and improve sharing of data across ownerships to ensure communities understand local fire risks.

F-8.10. Perform full greenhouse gas and carbon lifecycle analyses for wood products and biomass utilization pathways, including those imported from out of state.

ONGOING ACTIONS

- CAL FIRE's Demonstration State Forests, the U.S. Forest Service Pacific Southwest Research Station, the University of California, and other landowners have research reserves, studies, and demonstrations across geographic and elevation gradients to inform our understanding of climate change in California's forests.
- The California Air Resources Board is developing a Natural and Working Lands Greenhouse Gas Inventory to assess net greenhouse gas emissions from forests.
- CAL FIRE is required by statute to produce periodic assessments of the forests and rangelands of California. Draft indicators are being developed for the next Forests and Rangelands Assessment.
- The Board of Forestry and Fire Protection is implementing a monitoring and reporting process for annual forest carbon stocks using Forest Inventory and Analysis data, as required by Assembly Bill 1504 (Skinner, 2010).
- The Fourth Climate Change Assessment includes research projects on the impact of changing wildfire risk on the California homeowners' insurance market, fuel treatment for forest resilience and climate mitigation, and innovations in measuring and managing forest carbon stocks in California.
- Through research with the Lawrence Berkeley National Laboratory, the Natural Resources Agency is investing in the California Natural and Working Lands Carbon Model, an inventory that will quantify and compare the changes in landscape carbon due to different management options for the entire California landscape.

Ocean and Coast

Nearly 75 percent of California's population lives in coastal counties and along over 1,200 miles of the state's iconic shoreline.[1] The ocean and coast contributed $41.1 billion to the state's GDP, provided $19.3 billion in wages and salaries, and supplied 502,073 jobs in 2013. These figures demonstrate how much the people and economy of California rely on the coastline and the ocean. The short- and long-term risks from climate change, such as sea level rise, coastal erosion and beach loss, and ocean acidification will continue to affect a vast number of people and industries. California is one of the world leaders in both addressing climate change and protecting our coastal and ocean habitats and resources. Because of the ever-growing value of California's coastal areas and our dependence on the coast and ocean for recreation, food, and critical infrastructure such as ports, airports, and power plants, it is important to assess how climate change will impact our ocean and coasts and how to best anticipate, plan, and prepare for these changing ocean conditions.

> Sea levels are rising along California's iconic 1,200 miles of coasts and shores.

Globally, the ocean absorbs about a third of the Carbon Dioxide (CO_2) that society releases into the atmosphere every year, significantly reducing the amount of this greenhouse gas in the atmosphere and dampening climate change related stressors and impacts. The CO_2 emissions that the ocean absorbs are fundamentally changing the chemistry of our ocean, decreasing its pH and thereby making it more acidic. An increase in ocean acidity was first felt along the U.S. West Coast, characterized by the upwelling of cold, CO_2-rich water into shallower coastal areas where key species develop, grow, and live.[2] Ocean acidification makes it harder for many of these organisms to develop, thrive, and protect themselves. Damage to shelled organisms and shellfish industries has already been documented as calcium carbonate which is needed for shelled organisms to build their shells is less available when atmospheric CO_2 is absorbed by and interacts with seawater.

In addition to changes in ocean acidity, increasing sea surface temperature and ocean heat content are melting glaciers and ice sheets. Coupled with the thermal expansion of seawater, these changes are causing sea levels to rise. Ocean warming also contributes to increased storm activity and will eventually trigger profound changes in ocean circulation. Episodic and extreme events such as storm surges and high tides combined with sea level rise and land subsidence directly affect Californians living in coastal and inland delta counties, increasing floods that disrupt services and infrastructure systems. It is critically important to understand the range of sea level rise projections over several timescales as well as their uncertainties and regional impacts so that jurisdictions and decision-makers can prepare for future impacts and minimize risks.

1 Kildow, Judith, Colgan, Charles, and Johnston, Pat. "Coastal and Ocean Economic Summaries of the Coastal States - Update 2016" National Ocean Economics Program, Center for the Blue Economy, Middlebury Institute of International Studies at Monterey. 2016. http://centerfortheblueeconomy.org/2016-noep-report.

2 Kelly, Ryan and Caldwell, Margaret. "Why Ocean Acidification Matters to California, and What California Can Do About It: A Report on the Power of California's State Government to Address Ocean Acidification in State Waters." 2012. Stanford Woods Institute for the Environment. https://woods.stanford.edu/sites/default/files/files/OceanAcidification.pdf.

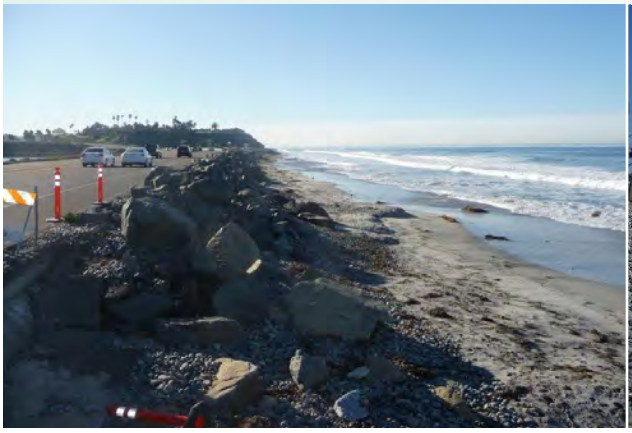
OCEAN AND COAST

Marine fisheries and fishing communities, whose livelihoods are dependent on a stable stream of income generated by California's marine resources, are also increasingly impacted by climate change – specifically through ocean acidification, ocean warming, increased frequency of extreme events, and exacerbation of natural phenomena, such as increased duration of harmful algal blooms.

California's state agencies with jurisdiction along the coast and inland delta are taking action to assess the risks and reduce the anticipated short and long-term impacts of climate change. State agencies continue to work to understand climate impacts and to enhance the health and resilience of coastal systems through collective efforts on high priority issues, such as sea level rise, ocean acidification, and hypoxia. These issues impact coastal and marine ecosystems, livelihoods and economies, public access to the coast, recreation, and the well-being and safety of coastal communities. The ocean and coast sector, by focusing on the cumulative impacts of various stressors linked to climate change, continues to foster multi-agency collaboration to ensure that effective adaptation strategies are identified and implemented statewide in California. The sector relies on and supports the development of the best available science to guide these adaptation efforts, and recognizes that resilience in the face of climate change will require commensurate financial resources and political capital.

CARDIFF BEACH LIVING SHORELINE

Development has had a heavy impact on the condition of coastal dunes. In an effort to restore habitat and provide nature-based sea-level rise adaptation along the Cardiff Beach, the State Coastal Conservancy, in partnership with California State Parks, Ocean Protection Council, California Coastal Commission, City of Encinitas, San Elijo Lagoon Conservancy and the University of California Los Angeles, is implementing a dune restoration project. This nature-based sea-level rise adaptation strategy will reconfigure bottom layers of cobble and stone beneath a top layer of imported sand and introduce native seeds collected from nearby lagoons to protect the 2,900 feet of vulnerable Pacific Coast Highway along the beach. This living shoreline approach will produce four acres native dune habitat and enhance the public's access to the coast. Physical and biological monitoring will be conducted before and after the project construction to provide information on how and why dune topography changes over time and which native plants and planting methods are best suited for dune restoration in the region. The planning and design processes have recently been completed and current implementation and monitoring efforts will help ensure that the shoreline will maintain viable habitat and natural barriers against the impacts of sea-level rise in the near future.



Images provided by the State Coastal Conservancy.

O-1 | Support planning and adaptation to reduce hazards and to increase the resilience of coastal communities, infrastructure, development, and other resources.

Climate risks and impacts need to be fully integrated into existing and planned management activities on the coast. This entails incorporating anticipated climate impacts into infrastructure assessments, planning, and design along the coast as well as considering risks that may arise from policies and plans that affect how the coast and ocean is managed and used. State agencies must continue to work with federal, local, regional, and tribal governments along the coast to be flexible, transparent, and capable of translating policies and actions in order to smartly plan, prepare, and adapt.

Additionally, to ensure resilient communities, coastal and ocean planning must consider the differential impact of climate risks when evaluating whether disadvantaged communities face unequal burdens from climate risks or inadequate resources to respond to these risks. An explicit effort must be made to build capacity and fill resource gaps for adaptation in these communities.

NEXT STEPS

O-1.1. Allocate additional assistance grants for updating and certifying Local Coastal Programs to address climate change and sea level rise in all 76 local coastal jurisdictions.

O-1.2. Provide technical assistance and guidelines to plan for sea level rise within local and regional jurisdictions and provide funding so that local entities can build capacity necessary to utilize these planning resources.

O-1.3. Provide guidance and technical assistance so that privately-owned entities can begin planning to adapt critical infrastructure at risk from sea level rise, including necessary commercial and recreational fishing infrastructure.

O-1.4. Facilitate planning and implementation of adaptation measures in communities with unequal burdens from climate risks or insufficient resources to respond to these risks, and incorporate environmental equity into various grants for local adaptation.

O-1.5. Continue integrating climate considerations into state agency planning, investment, and funding decisions along the coast.

O-1.6. As much as feasible, avoid new development and the expansion of existing structures in at-risk coastal locations.

O-1.7. Where expanded or new water-dependent infrastructure (e.g., at ports and harbors) cannot be avoided, encourage the development and incorporation of innovative design elements that minimize ecological impacts while providing sea level rise protection.

O-1.8. Use regulatory authority to reduce risk to existing property impacted by sea level rise and plan to adapt publically-owned critical infrastructure at risk from sea level rise such as highways, wastewater treatment plants, airports, ports, pipelines, and transmission lines:

- **O-1.8a.** Invest in engineering and cost feasibility studies to move all vulnerable infrastructure that can be relocated to a higher or more protected area.
- **O-1.8b**. Reinforce non-moveable infrastructure at risk of sea level rise and storm surge.
- **O-1.8c.** Regularly monitor all at-risk coastal infrastructure.

O-1.9. When feasible, use phased retreat or buyout of vulnerable property and develop incentive programs to relocate existing at-risk development.

O-1.10. Prioritize the remediation of hazardous material cleanup sites on the coast and in high flood risk areas so that they do not spread contamination later due to flooding.

O-1.11. Assess and plan for relocation, retrofit, inland migration, or replacement of coastal public access points, coastal recreation, and the landward migration of public trust lands so that the loss of beaches does not disproportionately burden the public, especially inland and underserved populations.

O-1.12. Safeguard cultural and archeological resources threatened by sea level rise and ensure California Native American tribes and other affected groups have a leadership role in planning efforts to address these impacts.

ONGOING ACTIONS

- The Ocean Protection Council is updating the State of California Sea-level Rise Guidance Document to ensure the best available science is incorporated into specific policy guidance for state and local decision-makers.
- Local Coastal Program Grant Programs, which provide support for updating Local Coastal Programs consistent with the California Coastal Act, have requirements for addressing sea level rise and climate change impacts, furthering coastal resilience.
- Coastal Development Permits address the impacts of sea level rise on new development and integrate adaptation triggers for at-risk development through their permit process.
- BCDC is expanding and completing the Adapting to Rising Tides community-based planning program along the entire San Francisco Bay shoreline.
- Assembly Bill 2516 (Gordon) requires the Ocean Protection Council to update the Sea-level Rise Planning Database and to support a related project on improving the State's sea level rise planning resources.
- Coastal regulatory agencies such as the State Lands Commission develop lease terms that address hazard liability and protect resources from climate impacts and work with lessees to adapt existing and future facilities to climate change impacts.
- Assembly Bill 691 (Muratsuchi) requires local trustees of granted public trust lands to prepare and submit assessments to the State Lands Commission on how the local trustee proposes to address sea level rise, including protection of manmade and natural resources and facilities, on its trust lands.

- Policy guidance and model ordinance language for resilient residential shoreline developments was created through the Coastal Commission's Managing the Coastal Squeeze Project.
- The Office of Planning and Research has released updated General Plan Guidelines with updated information on incorporating sea level rise into local general plans.
- Starting in 2017, Senate Bill 379 (Jackson) requires local jurisdictions to provide climate change vulnerability assessments within local hazard mitigation plans to fulfill statutory requirements of the General Plan Safety Element and to plan for climate change impacts such as sea level rise.
- The Delta Stewardship Council takes sea level rise into account in its Delta Levees Investment Strategy.
- The San Pedro Bay Ports Clean Air Action Plan is being implemented with the State Lands Commission as a partner.
- The State Coastal Conservancy's Climate Ready grant program provides funds and technical assistance to local communities to assess climate impacts and plan for adaptation. The 2017 grant round is focused on providing assistance to vulnerable communities.
- Senate Bill 1066 (Lieu) gave the State Coastal Conservancy explicit authority to prepare for and adapt to the effects of climate change and take action against its causes.
- The California Climate Resilience Account was created to accept and provide funds for climate adaptation work by the state's coastal management agencies.

O-2 | Design and implement nature-based projects to protect and enhance the adaptive capacity of coastal and marine ecosystems, including beaches and wetlands.

Decades of coastal development and efforts to stabilize beaches have transformed California's iconic coastline. Eighty percent of the California coastline is actively eroding, and the risk of beach loss is increasing.[3] Projected impacts of climate change will accelerate sea level rise and coastal erosion, and likely make storms more frequent and powerful. Historically, California has responded to coastal erosion and storms through beach replenishment projects and by building seawalls, bulkheads, revetments, and other armoring structures along the coast. While these structures intend to safeguard coastal communities, they offer only temporary protection, eventually accelerating long-term erosion and leaving homes and property at risk. When put on an eroding or retreating beach, these structures prevent coastal ecosystems from migrating inward, impede the shoreline from carrying out natural processes, reduce habitat for coastal species, and will eventually cause the beach to narrow and disappear.[4, 5]

Rising sea levels will further alter the fundamental physical and ecological processes within coastal and inland estuarine wetlands, lagoons, and other critical habitats, potentially causing them to face inundation and erode. Wetland habitats would need an estimated 150 square miles of open space for inland migration to be maintained for 5 feet of sea level rise.[6] Sea level rise will also result in the change of some freshwater marshes into estuarine or marine tidal marshes due to seawater intrusion. Already, as much as 91 percent of the wetland acreage in California has been drained, filled, and converted to other uses.[7] Wetlands not only provide habitat for fish, birds, and other species, but also help improve water quality, water supply, and flood control, and sequester carbon from the atmosphere. Thus, protecting wetlands and the benefits they offer will help reduce climate risks. The natural functions of wetlands and other coastal ecosystems support and add value to state, regional, and local economies, public health, and culture. The function and consequent benefits of wetlands are increasingly threatened by climate change and coastal squeeze, so their protection is imperative.

California must look to nature-based infrastructure adaptation measures to ameliorate the climate risks related to coastal erosion, sea level rise, and ecosystem degradation, as highlighted in Governor Brown's Executive Order B-30-15. Living shorelines can stabilize the shore using a variety of structural and organic materials such as wetland plants, submerged aquatic vegetation, oyster reefs, sand fill, fiber, and stone. While stabilizing the shoreline and protecting public access to coastal resources, living shorelines offer benefits including the protection of surrounding riparian and intertidal environment, the filtration of runoff and improvement of water quality, the creation of habitat for coastal

3 Griggs, Gary. "California's Coastline: El Niño, Erosion and Protection, in California's Coastal Natural Hazards." Living with the Changing California Coast. 1998.

4 Loughney Melius, Molly and Caldwell, Margaret. "2015 California Coastal Armoring Report: Managing Coastal Armoring and Climate Change Adaptation in the 21st Century." Environmental and Natural Resources Law & Policy Program, Stanford Law School. http://law.stanford.edu/wp-content/uploads/2015/07/CalCoastArmor-FULL-REPORT-6.17.15.pdf.

5 National Oceanic and Atmospheric Administration (NOAA). "Guidance for Considering the Use of Living Shorelines." 2015. http://www.habitat.noaa.gov/restoration/techniques/livingshorelines.html.

6 Heberger, Matthew, Cooley, Heather, Herrera, Pablo, Gleick, Peter, and Moore, Eli. "The Impacts of Sea-Level Rise on the California Coast." California Climate Change Center, Pacific Institute. 2009. http://pacinst.org/publication/the-impacts-of-sea-level-rise-on-the-california-coast/.

7 Yuhas, Roberta. "Loss of Wetlands in the Southwestern United States." United States Geological Survey Water Supply Paper 2425. https://geochange.er.usgs.gov/sw/impacts/hydrology/wetlands/.

species, and long-term cost savings.[8] Beaches can be made more resilient through regional sediment management (RSM) plans and by reducing the hard armoring (e.g. rip-rap, seawalls) that contributes to beach erosion/narrowing and coastal squeeze. Coastal dune, wetland, and lagoon enhancement and restoration can help protect shoreline communities from wave energy, storm surges, and flood pulses from upstream watersheds. Finally, the adaptive capacity of coastal ecosystems can be improved by protecting adjacent floodplains and uplands from development, so that these ecosystems can move upslope with rising sea levels.

NEXT STEPS

O-2.1. Advance and develop adequate funding for the research and implementation of nature-based infrastructure projects, including living shorelines, managed retreat, wetland restoration, and related strategies.

O-2.2. Develop goals and success criteria for nature-based infrastructure projects, commit to project monitoring, and disseminate findings to improve design approaches and our understanding of the benefits of nature-based infrastructure.

O-2.3. Where possible, remove existing shoreline protective devices to allow coastal lands and habitats including beaches, dunes, and wetlands to migrate landward over time as the mean high tide line and public trust boundary moves landward with sea level rise.

O-2.4. When removal of shoreline protective devices isn't possible, encourage modifying the structure to have more ecological and protective benefits; for example, consider hybrid structures (e.g. Boring pores/making seawalls to also support marine life; removable seawalls to protect natural infrastructure until they're mature enough to withstand storms; managed realignment) when removal is too expensive or not feasible.

O-2.5. Support regional and ecosystem-level projects to restore coastal habitats and natural physical and ecological processes.

O-2.6. Analyze the economic costs and co-benefits of managed retreat and nature-based infrastructure projects in comparison to grey alternatives, such as reduced flood risk and stormwater runoff; include market and non-market values (e.g. ecosystem services) in these evaluations.

O-2.7. Work with regulating entities to manage, enhance, and restore natural systems such as wetlands to reduce flood risk and treat stormwater runoff.

O-2.8. Use soft or nature-based solutions as a preferred alternative to hard armoring within the planning and regulatory processes outlined in Recommendation O-1, and, when possible, provide local governments with guidelines and streamlined and simplified permitting to facilitate the use of nature-based infrastructure.

O-2.9. Support and encourage the implementation of management strategies aimed at beach preservation, including beach nourishment projects and managed retreat efforts that maximize the beach's ecological and recreational values.

8 NOAA. "Guidance for Considering the Use of Living Shorelines." 2015. http://www.habitat.noaa.gov/restoration/techniques/livingshorelines.html.

O-2.10. Prioritize funding to acquire and preserve undeveloped open space and critical areas of habitat at risk along the coast.

O-2.11. Where nature-based shoreline protection is not feasible, allow for alternative solutions such as mitigation banks and regional advanced mitigation plans to address sea level rise and flooding on a larger scale.

O-2.12. Research and explore the extent to which Marine Protected Areas (MPAs) buffer marine resources against the negative impacts of climate change and consider climate impacts in MPA management; explore applications of California MPAs in monitoring and management planning that directly support marine fisheries ecological resilience and assist managers in decision-making; and continue to ensure adequate enforcement of MPA regulations.

ONGOING ACTIONS

- Across several agencies like State Coastal Conservancy and Department of Parks and Recreation, green infrastructure and coastal restoration and rehabilitation projects are underway to restore and rehabilitate important coastal habitats (i.e., dune restoration and coastal bluff rehabilitation).
- When complete, the South Bay Salt Pond Restoration Project – led by the State Coastal Conservancy – will restore 15,100 acres of industrial salt ponds to a rich mosaic of tidal wetlands and other habitats.
- Estuarine habitat restoration projects are in progress through the California Coastal Estuarine Land Conservation Program.
- Sediment-related projects at Department of Parks and Recreation will help support coastal restoration and protection and engage on coastal sediment management.
- Living Shorelines Projects are being planned and implemented in Arcata, San Francisco, Newport, and San Diego by the State Coastal Conservancy.
- Development of the State's Sediment Master Plan through the Coastal Sediment Management Workgroup features twelve Coastal Regional Sediment Management Plans to mitigate adverse impacts of coastal erosion and excess sedimentation on coastal habitats.
- The Southern California Wetlands Recovery Project Regional Strategy is being updated.
- Implementation of Senate Bill 1363 (Monning) is restoring and protecting eelgrass habitat for its multiple benefits including potentially mitigating local ocean acidification and hypoxia and sequestering carbon dioxide.
- The Green Shoreline Infrastructure help desk at BCDC aims to connect projects with technical experts and is developing a comprehensive multi-agency permit application and approval process for projects that place fill in the Bay to accelerate the region's resilience.
- The Ocean Protection Council supported the development of the document, *Readying California Fisheries for Climate Change*, which was authored by a working group of the Ocean Protection Council Science Advisory Team and the California Ocean Science Trust. This project was developed for consideration by the California Department of Fish and Wildlife to help inform the state's process to amend the Marine Life Management Act Master Plan for Fisheries.

- Current projects to better integrate the Marine Life Management Act and the Marine Life Protection Act will provide direct mechanisms to utilize MPAs in the type of nimble, fisheries management required under changing ocean conditions from climate change.
- The San Francisco Bay Regional Water Quality Control Board is partnering with the San Francisco Estuary Institute's Resilient Landscapes Program to develop sea level rise adaptation strategies for the San Francisco Bay shoreline, with an emphasis on nature-based infrastructure and multi-benefit projects.
- The San Francisco Bay Joint Venture is updating its Implementation Strategy and accompanying Habitat Goals to address the long-term conservation and restoration of a broad variety of SF Bay and Pacific Coast habitats, including estuarine wetlands and upland transition zones, in a changing climate.
- The San Francisco Estuary Partnership's recently revised Comprehensive Conservation and Management Plan (CCMP) establishes goals (through 2050) and actions (through 2021) to demonstrate and promote the use of natural habitats and nature-based infrastructure to improve the resiliency of SF Estuary habitats.

O-3 | Develop actionable science that reflects the latest and evolving trends over a range of spatial and temporal scales.

California has a long history of drawing on the scientific community to inform coastal and ocean policy, planning, and management. Monitoring, data gathering, and research can enhance scientific understanding of the impacts of climate change in coastal and ocean areas and the ability of the sector to anticipate emerging issues. In order to incorporate climate-relevant decision making into management practices, the latest climate science needs to be reflected, used, and continually advanced.

Climate science is a field that is rapidly informed by new data and peer-reviewed studies as we learn and better understand how changes in one part of the planet or global carbon cycle reverberate and cascade to other regions. In order to comprehensively reflect the latest trends, we will need integrated models and measurements to develop information and tools for appropriate scales and to bound change over different timescales depending on the decision and choice that is being made. *Safeguarding California* prioritizes continued modeling and continued support and investment in monitoring regarding climate impacts on the ocean and coast. This 2018 update will add to and enhance these priorities.

NEXT STEPS

O-3.1. Identify and research evolving trends to anticipate climate impacts and proactively prepare for a range of potential scenarios.

O-3.2. Translate science findings across decision-making venues and to key end-users to ensure best available science in swiftly integrated into policy and management.

O-3.3. Secure and leverage funding for research and monitoring related to climate impacts on the ocean and coast.

ONGOING ACTIONS

- California participates in the Pacific Coast Collaborative Subcommittee on Ocean Acidification and the Federal Interagency Working Group on Ocean Acidification (IWG-OA) Monitoring Task Force which is collecting and compiling ocean acidification and hypoxia monitoring data across the West Coast to assess information gaps, track changes in ocean chemistry, and inform future investments.
- The Ocean Protection Council is supporting a West Coast wide ocean acidification model developed by a team of scientists from NOAA, University of Washington, and the Southern California Coastal Water Research Project and led by UCLA to predict ocean chemistry changes throughout the California Current.
- The Ocean Protection Council is supporting the Coastal Storm Modeling System (CoSMos), which makes detailed predictions of coastal inundation, storm-induced coastal flooding, erosion, and cliff failures over large geographic scales and can be used for to analyze future climate scenarios (sea level rise and storms). The State Coastal Conservancy is leveraging the Ocean Protection Council's investment in CoSMoS by supporting outreach workshops for local communities through the USC Sea Grant program.

- The State is incorporating sea level rise and climate change modeling for the Sacramento-San Joaquin River Delta through the Department of Water Resources' 2017 Central Valley Flood Protection Plan Update and the Delta Stewardship Council's Delta Levee Investment Strategy; stage-frequency curves were developed for the Delta providing a link between tides and Delta inflow as well as the impacts of climate change.
- Coastal site surveys for cultural resources are being conducted by the Society for California Archaeology in partnership with the Department of Parks and Recreation.
- The California Department of Fish and Wildlife and partners are working with California Native American Tribes and constituents to update the Marine Life Management Act Master Plan for fisheries, through considering tools and recommendations developed through information gathering projects.
- The Ocean Protection Council is supporting the following information gathering projects: a Climate Change and Fisheries working group, a peer review for Fishery Management Plans, Productivity and Susceptibility Analysis (PSA) and Ecological Risk Assessment (ERA); and the development of socioeconomic guidance for fisheries management.
- The Southern California Coastal Ocean Observing System and Central and Northern California Ocean Observing System provide and disseminate scientific data and knowledge needed to inform decision-making and better understand the changing conditions of California's coastal ocean, in partnership with state agencies such as the State Water Resources Control Board and the California State Coastal Conservancy.
- California is completing historical hourly tide data to develop hourly sea level rise and storm surge datasets.
- Long-term temperature and salinity measurements are provided by the Shore Stations Program at 10 locations along the coast. The California State Parks' Division of Boating and Waterways Oceanography Program funds the Shore Stations Program.
- UC San Diego's Coastal Data Information Program (CDIP) provides ongoing beach change measurements and wave research, with funding contributed by California State Parks' Division of Boating and Waterways Oceanography Program. CDIP includes research projects on sea level rise facilities vulnerability and flood modeling, beach and cliff erosion, and tide, sea level, and coastal storm surge variability.
- State and federal government agencies fund research on atmospheric rivers and coastal landslides.
- The State Coastal Conservancy leads research on saltwater intrusion into groundwater.
- The State is assisting Bay Area efforts to define, identify, and fund one or more regional data repositories to collect and share data in ways that best inform rising sea levels strategies and actions.
- The State is developing indicators for tracking climate change in the Marine Protected Area statewide monitoring program to address multiple state priorities such as climate change.
- USC Sea Grant and California Sea Grant fund relevant scientific research on ocean and coastal topics with facilitation through the Resources Agency Sea Grant Sea Grant Advisory Panel (RASGAP) to ensure the science is relevant to the issues addressed by State agencies.

O-4 | Continue to assess community and ecosystem vulnerability to climate impacts.

Effective adaptation requires understanding climate change vulnerabilities and impacts at appropriate scales. Because there is no one-size-fits-all solution to reduce threats, it is important to assess vulnerabilities and risks through a suite of decision-support tools, analyses and strategies. In doing so, we will be more equipped to investigate options and prioritize actions that are most suitable to a given community or environment. Through visualization tools, mapping, and robust analyses, we can continue to understand climate change vulnerabilities in order to build more resilient communities and ecosystems. The state is committed to communicating tools and mapping based on the best available science so that communities are equipped to assess vulnerability and prioritize appropriate action and response at a range of scales.

NEXT STEPS

O-4.1. Provide continual grants and funding for community-based vulnerability assessments.

O-4.2. Incorporate input into vulnerability assessments from residents, beach users, local businesses, and other stakeholders affected through workshops and community events, and ensure that these workshops are accessible to the most vulnerable stakeholders.

O-4.3. Continue to identify and map coastal infrastructure and vulnerable assets, such as water and wastewater infrastructure, energy infrastructure, ports, tourism, and fishing sites.

O-4.4. Assess the vulnerability of archaeological and historic sites and cultural resources to sea level rise in coordination with California Native American tribes and the California Office of Historic Preservation.

O-4.5. Identify critical areas of habitat at risk of climate change impacts including northward species shifts, lower productivity and food, exotic species, reduced coastal water quality, toxic algae blooms, health hazards, and inundation.

O-4.6. Identify vulnerability of coastal beaches and wetlands and priority upland transition sites.

O-4.7. Assess the statewide vulnerability of coastal lagoon ecosystems (bar-built estuaries), dependent fish & wildlife communities (especially coastal salmonids), and adjacent infrastructure (particularly wastewater treatment plants) to climate change, and develop strategies and funding to improve the resiliency and adaptive capacity of these habitats.

O-4.8. Conduct integrated social-ecological climate vulnerability assessments on the impacts of ocean acidification and increased temperatures on California's marine and estuarine fisheries, fishing communities, and food supply and integrate results into climate-ready management strategies.

ONGOING ACTIONS

- The State provides support for vulnerability assessments through resources including:
  - Decision support tools for coastal storm surge in a changing climate;
  - Cal-Adapt sea level rise maps;
  - FEMA Flood Risk Reduction Project identification; and
  - The Adapting to Rising Tides Program.
- The State Coastal Conservancy is partnering with the Nature Conservancy to conduct a statewide coastal habitat vulnerability assessment.
- The Ocean Protection Council's Local Coastal Program Grant Program supports the development detailed local sea level rise vulnerability assessments and adaptation plans.
- The State Lands Commission maps existing and proposed coastal infrastructure leases and legacy coastal hazards, and it identifies sites that are vulnerable to climate change impacts.
- California coastal zone management agencies are undertaking many related assessments including:
  - a Coastal Commission synthesis of sea level rise vulnerability assessments and information by county and statewide summary report;
  - a complete multi-sector, county scale rising sea level vulnerability assessments for all nine counties that touch San Francisco Bay by BCDC;
  - an assessment of sand resources on the California outer continental shelf; and
  - finalized vulnerability assessments, including sea level rise, of all Department of Water Resources facilities.

O-5 | Provide pathways for meaningful community engagement (such as education and outreach) in coastal decision-making processes.

Ongoing outreach and engagement is needed to raise awareness and to improve understanding of the impacts of climate stressors on valuable coastal and ocean communities and resources. There are a variety of tools to facilitate implementing successful implementation strategies, such as policy guidance documents, models, and tools that demonstrate where areas may be impacted by climate stressors such as sea level rise or ocean acidification. In addition to engaging the public from the onset of tool development, once these tools are finalized, agencies work to communicate how to use these resources and why and how they are applicable to local or regional jurisdictions, such as cities, counties, and California Native American Tribes. Agencies should also advance and expand outreach, engagement, and education efforts and climate-related training activities to ensure that vulnerable communities have a seat at the table in coastal decision-making processes and are prepared to effectively plan for the impacts of climate change.

NEXT STEPS

O-5.1. Develop best practices for seeking inclusive participation in planning decisions related to sea level rise and climate change along the coast, such as: using targeted, culturally-sensitive communication to engage underserved, low income, and linguistically isolated communities and communities of color, providing interpreters, offering a variety of venues for public comment, and locating community meetings so that they are accessible to public transportation and closest to communities most affected by climate impacts.

O-5.2. Ensure that those most vulnerable to the impacts of sea level rise and coastal climate change have equity and agency in the decision-making process for coastal planning within their communities.

O-5.3. Conduct relevant outreach directly with specific marine resource users and sector communities, like fishers and seafood industry, who may be impacted by climate change.

O-5.4. Engage communities and increase education opportunities through citizen and community science projects that further our understanding of climate impacts.

O-5.5. Employ community-based habitat restoration, involving individuals, organizations, and academic institutions, in helping to improve and restore coastal habitat in their communities.

O-5.6. Expand existing public awareness programs like the California King Tides website and the Whale Tail Program.

O-5.7. Conduct outreach and communication on impacts to beaches, dunes, and wetlands from "coastal squeeze," when shoreline protection and other development prevent the inland migration of shoreline habitats, leading to inundation of that land area and loss of habitat/beach area. Communicate best practices for avoiding, minimizing, and/or managing coastal squeeze, such as ecosystem restoration and nature-based infrastructure.

O-5.8. Continue outreach and training of local officials regarding implementing adaptation options through updates to Local Coastal Programs, Hazard Mitigation Plans, General Plans, and other relevant planning documents.

ONGOING ACTIONS

- The Integrated Climate Adaptation and Resilience Program at the Governor's Office of Planning and Research coordinates regional and local efforts with state actions to adapt to sea level rise and other climate impacts. It emphasizes climate equity considerations across sectors and regions and strategies that benefit both greenhouse gas emissions reductions and adaptation efforts in order to facilitate the development of holistic, complementary strategies for adapting to climate change impacts.
- A California Department of Fish and Wildlife Climate College climate education course focused on climate science and adaptation issues in the marine environment for California Department of Fish and Wildlife staff and partners, and lecture materials are archived online.
- The Marine Life Management Act (MLMA) Master Plan Amendment discussions for interested stakeholders, webinars, and meetings are led by the California Department of Fish & Wildlife.
- Climate Ready Webinars are hosted regularly through the State Coastal Conservancy.
- The Whale Tail Grant Program educates children and the public on marine and coastal issues while supporting beach maintenance and habitat restoration projects.
- The California King Tides Project is a citizen science initiative that works in partnership with federal, state and local organizations to help validate coastal inundation models.
- The Quick Guide Coastal Appendix provided through the Department of Water Resources gives guidance for communities to consider when integrating climate change adaptation into their coastal planning for the Federal Emergency Management Agency's National Flood Insurance Program. This supports National Flood Insurance Program Community Assistance Visit Workshops across the state to aid communities in maintaining their National Flood Insurance Program eligibility.

- Other engagement, education, and outreach efforts that the State supports include:
  - the Adapting to Rising Tides Program;
  - the Policies for a Rising Bay Project;
  - Bay Plan Climate Policies;
  - training and presentations on the California Coastal Commission's Sea Level Rise Policy Guidance;
  - Coastal Commission reports and website updates, including creation of a web tool, to communicate coastal county and statewide vulnerabilities as well as case studies on Local Coastal Program update efforts;
  - the engagement strategy around the update to the State of California Sea-level Rise Guidance Document;
  - the International Alliance to Combat Ocean Acidification (OA Alliance) and creation of an action plan to address ocean acidification in California; and
  - a climate change and sea level rise training program for State Lands Commission staff, which includes a GIS-based sea level rise decision support tool and training on how to incorporate sea level rise analyses into lease conditions.

O-6 | Coordinate across agencies and external partners to ensure efficient problem solving and widely communicate resources for ocean and coastal adaptation strategies.

State agencies that work on ocean and coastal issues are continuously collaborating and exchanging information to address changing conditions due to climate change. Because ocean currents and resources are not bounded by traditional jurisdictional lines, it is critical that agencies – local, state, regional, federal, and tribal – collaborate across their jurisdictions in order to safeguard the health of our ocean, coastal ecosystems and resources, and vulnerable coastal populations. Impacts such as sea level rise, ocean acidification and hypoxia, and storm surge and severe storm events vary in severity along the California coastline, and require effective coordination and planning to ensure successful adaptation of our coastal communities, ecosystems and economies. A number of multi-partner working groups and task forces are targeting specific climate change issues in order to address related risks to our ocean and coastal ecosystems, resources, and communities, and to ensure successful adaptation.

NEXT STEPS

O-6.1. Continue collaborating across agencies to ensure a nimble, sustained, and efficient response to emerging climate change impacts on the ocean and coastal regions.

O-6.2. Work with external partners, champions, and boundary organizations to ensure that robust science, policy and outreach is conducted, and that state resources and guidance are widely and strategically communicated across California.

O-6.3. Engage regional partners such as ARCCA (Alliance of Regional Collaboratives for Climate Adaptation) to gather input on state policy, coordinate local and state adaptation projects, and disseminate tools and research regionally and locally to strengthen the state's capacity to adapt.

ONGOING ACTIONS

- California's extensive coastline will be affected in many ways by sea level rise and other climate change impacts, so state government is undertaking extensive efforts to coordinate and collaborate on adaptation actions. Coordinating bodies for these efforts include, but are not limited to:
  - the Safeguarding and Adaption Working Group of the Climate Action Team (SafeCAT);
  - the Research Working Group of the Climate Action Team (Research-CAT);
  - the Coastal and Ocean Working Group of the Climate Action Team (CO-CAT);
  - the State Coastal Leadership Group on Sea-level Rise;
  - the Coastal Sediment Management Working Group;
  - the Sea-level Rise and Floodplain Management Focus Group;

- the Bureau of Ocean Energy Management (BOEM) Intergovernmental Renewable Energy Task Force;
- the Pacific Coast Collaborative Subcommittee on Ocean Acidification;
- the International Alliance to Combat Ocean Acidification (OA Alliance);
- Marine Protected Area Statewide Leadership Team;
- the San Francisco Bay Regional CHARG (Coastal Hazards Adaptation Resiliency Group);
- the Office of Planning and Research's Technical Advisory Council within the Integrated Climate Adaptation and Resilience Program;
- West Coast Ocean Partnership and West Coast Regional Planning Body; and
- the Pacific Marine and Estuarine Fish Habitat Partnership and its studies of key species' use of estuarine habitats as nursery areas.

- Critically, State government aligns sea level rise adaptation planning with State and local Hazard Mitigation Planning to achieve coastal community resilience.
- The Bay Area Resilient by Design initiative has launched a design challenge to create innovative solutions that make the Bay Area's most vulnerable bayfront communities, ecological systems, and infrastructure more resilient to climate risks. Funded in part by the California State Coastal Conservancy, the challenge received applications from 51 multidisciplinary teams composed of architects, engineers, horticulturists, artists, students, and academics, and more. The process includes a 3-month period in which teams will work with community members and local leaders to learn about challenges and vulnerabilities and subsequently tailor their projects to these needs. In May 2018, 10 innovative solutions will be revealed after the yearlong challenge is complete.

Water

The data are irrefutable: California's hydrology is already changing due to global climate shifts. The vulnerability of the water sector to climate change stems from a modified hydrology that affects the frequency, magnitude, and duration of extreme events, which, in turn, affect water quantity, quality, and infrastructure. Changes in hydrology include declining snowpack, earlier snow melt, more precipitation as rain than snow, more frequent and longer droughts, more frequent and more severe flooding, changes in the timing and volume of peak runoff, and consequent impacts on water quality and water availability.[1] Vulnerabilities of water resources include changes to water supplies, land subsidence, increased water pollution, erosion, flooding, and related risks to water infrastructure and operations, degradation of watersheds, alteration of ecosystems and loss of habitat, multiple impacts in coastal areas, and ocean acidification. Additionally, rising sea level will produce higher storm surges during coastal storms, and climate impacts are reducing the percentage of annual precipitation that falls as snow.

Drinking water for more than **25 million** Californians flows through the Delta, which is threatened by climate impacts such as sea level rise.

California is preparing for and addressing impacts of climate change comprehensively across all components of the water cycle, from protecting and restoring upper watersheds, to resource recovery from wastewater (renewable energy, nutrients, and water), and everything in-between. Continued progress will require maintaining efforts to coordinate among federal, state, and local resource managers and to present key actions and tangible next steps in the State's adaptation strategy. This update builds consistency and alignment with the most up-to-date information, and past adaptation work and roadmaps within the water sector, such as the California Water Action Plan.

The Department of Water Resources (DWR) and the State Water Resources Control Board (Water Board), along with other agencies, have updated their recommendations on how to make water systems more integrated, more resilient, and able to adapt to impacts of climate change. There is a great deal of work to be done, but California has a solid foundation to continue to safeguard its people, environment, and economy into the future.

1 California Department of Water Resources. Hydroclimate Report. 2016. http://www.water.ca.gov/climatechange/docs/2017/DWR_Hydroclimate_Report_2016.pdf

DROUGHT RESILIENCE IN TULARE COUNTY

California's five-year drought left Tulare County particularly vulnerable. The unincorporated community of East Porterville, in the heart of Tulare County, is considered "ground zero" of the drought. Hundreds of households lost access to clean, running water as a result of dry wells, or faced deteriorating water quality from increasing nitrate contamination. Residents were relying on deliveries of bottled drinking water and non-potable water before the State Water Resources Control Board, Department of Water Resources, and the California Office of Emergency Services, and the governments of Tulare County and the City of Porterville collaborated to provide a more permanent, safe, and reliable solution. Together, through Proposition 1 grants and loan forgiveness, the state agencies fully funded the connection to public water system. When the project is complete at the end of 2017, approximately 1,100 properties will be connected and have access to clean and reliable source of drinking water. Already, the project is enabling Tulare County residents to be prepared for the worsening effects and frequency of drought. As climate change makes a mark on California's natural environment, these collaborative efforts to safeguard communities against the effects of drought and other extreme events are critical to maintaining a resilient future.

Project in the unincorporated community of Monson

W-1 | Vigorously prepare California for flooding.

More than seven million Californians and $580 billion in assets are exposed to the hazards of flooding.[2] Flooding occurs in nearly every part of California, and has cost hundreds of lives and billions of dollars in damage.[3] Climate change heightens the threat of high stream flow levels due to increases in frequency and magnitude of extreme precipitation in a warmer climate. New climate change analysis in the San Joaquin River Basin found that climate change is projected to increase flood volumes by 60 to 80% over the next 50 years. Over the next 30 years, between $17 and $21 billion is needed in flood investments to safeguard Californians in the Central Valley from flooding, which is a much higher level than existing funding levels.[4] While the Department of Water Resources will continue to invest hundreds of millions of voter-approved dollars into multi-benefit flood management projects, more must be done to reduce flood risk, especially in the context of climate change.

NEXT STEPS

W-1.1. DWR will work with the U.S. Army Corps of Engineers to determine the potential for updating reservoir Water Control Manuals that include reservoir Flood Control Rule Curves and spillway operating rules. The Water Control Manuals guide reservoir operators to ensure flood safety to reflect current science and engineering methodologies and climate-induced changing hydrology.

W-1.2. DWR shall classify the public safety risk of all state jurisdiction dams, based on downstream hazard potential and reviews of critical appurtenant structures.

W-1.3. For high hazard dams under state jurisdiction, DWR will review, provide comments, and when complete, approve dam failure inundation maps prepared by dam owners for the dam's failure under various failure scenarios unique to the dam and the critical appurtenant structures of the dam. DWR shall provide the completed and approved dam failure inundation maps to the California Office of Emergency Services.

W-1.4. DWR shall make approved dam failure inundation maps publicly available.

W-1.5. For all dams under state jurisdiction that are not low hazard dams, DWR has the authority to require Emergency Action Plans. DWR shall review and approve the dam failure inundation map and the California Office of Emergency shall review and approve the Emergency Action Plan based on the approved dam inundation map(s) prepared by the dam owner.

2 California Department of Water Resources. "California's Flood Future: Recommendations for managing the State's Flood Risk". 2013. http://www.water.ca.gov/SFMP/resources/California_Flood_Future.pdf

3 California Legislative Analyst's Office. "Managing Floods in California". 2017. http://www.lao.ca.gov/reports/2017/3571/managing-floods-032217.pdf

4 Department of Water Resources. "Central Valley Flood Protection Plan: 2017 Update." August 2017. http://cvfpb.ca.gov/docs/2017CVFPPUpdateFinal/2017CVFPPUpdate-Final-20170828.pdf

W-1.6. DWR will work to develop flood inundation maps for major stream systems that consider future projections of hydrology in cooperation with the Federal Emergency Management Agency and the U.S. Army Corps of Engineers.

W-1.7. DWR will support collaboration and communication of flood models that incorporate climate impacts in the Regional Flood Management Plans.

W-1.8. DWR will update grant guidelines and proposal solicitations for its Small Community Flood Risk Reduction and Urban Flood Risk Reduction programs to include consideration of future projections of flood flows and to support climate change adaptation in future rounds of funding.

W-1.9. DWR will incorporate future climate extremes and variability in its Flood Investment Strategy included in the Statewide Flood Management Planning Program, which works with organizations across the state to develop flood management policies and guide financial investments to protect people and property.

W-1.10. The Water Board will evaluate permits and regulatory requirements necessary to reduce vulnerability of water and wastewater infrastructure to flooding, increased wet weather flows, storm surge, and rising sea level.

W-1.11. DWR and the Water Board will collaborate with federal, State and local agencies as well as research and academic communities to assess the adverse impacts to human health and safety, industries, water and other physical infrastructures, communities and ecosystems of floods and related extreme events.

W-1.12. DWR will ensure collaboration with federal agencies including the National Oceanic and Atmospheric Administration and the National Aeronautics and Space Administration, as well as the research community, on improving both monitoring and scientific understanding of the role of the climate system in extreme precipitation events in order to better inform water management during extreme events and changing snowpack. The following areas of collaboration for research should continue to be prioritized:

- **W-1.12a.** Atmospheric rivers
- **W-1.12b.** Rain and snow trends
- **W-1.12c.** Upland watershed monitoring
- **W-1.12d.** Seasonal winter outlooks
- **W-1.12e.** Sea-level rise
- **W-1.12f.** Paleohydrology

ONGOING ACTIONS

- The Central Valley Flood Protection Board's 2017 Central Valley Flood Protection Plan Update incorporates climate change in order to assess the true costs of managing flood waters to protect the State Plan of Flood Control facilities for the design life of structural and non-structural investments.
- The Central Valley Flood Protection Board is undertaking ongoing efforts to incorporate and prepare for future climate extremes and variability in its Flood Investment Strategy, included in the Central Valley Flood Protection Plan.
- DWR will continue its close collaboration with the Governor's Office of Emergency Services (Cal OES) in the preparation of the State's 2018 Hazard Mitigation Plan.
- DWR collaborates closely with Cal OES during regional and statewide flood emergencies, and disaster emergency response plans include emergency support function decision support matrices that require coordination among the department, Cal OES and the Federal Emergency Management Agency. Strengthening these activities helps support climate change adaptation because increased flood risk is projected to occur in the future.
- The Water Board, DWR, and other state and local land use agencies continue collaboration to prioritize storm water capture and infiltration.
- The Water Board is funding up to $186 million in storm water capture and infiltration projects through Proposition 1 that provide multiple benefits including attenuation of flood flows and increased groundwater recharge.
- The Water Board is implementing the 2016 Strategy to Optimize Resource Management of Storm Water (Storm Water Strategy), a high-level planning effort that will, in addition to capturing and treating storm water, result in local and regional storm water management that produces multiple benefits, including reduced or attenuated flooding of downstream utilities, facilities, and water bodies, and increased coordination and cooperation among wastewater, storm water, flood management, transportation, and drinking water agencies.
- Municipal Separate Storm Sewer System permits include provisions that result in multiple benefits, including reductions in flooding.
- The Water Board will continue to promote low-impact development strategies to manage storm water and attenuate localized flooding.

W-2 | Support regional groundwater management for drought resiliency.

During a typical year, approximately 40 percent of the state's total water supply comes from groundwater.[5] During dry years, groundwater provides 60 percent (or more) of the state's total supply, and serves as a critical buffer against the impacts of drought and climate change.[6] With the 2014 enactment of the Sustainable Groundwater Management Act (SGMA), which provides new authorities for local agencies to directly manage groundwater resources, the State is making progress on the recommendation to support regional groundwater management for sustainability and drought resiliency. Moving forward, state government needs to further its work to support the formation of groundwater sustainability agencies and implementation of groundwater sustainability plans in coordination with other flood and water management plans.

NEXT STEPS

W-2.1. DWR will provide water budget and climate change datasets, tools and guidance to support groundwater sustainability agencies in their evaluation of potential climate change impacts in groundwater sustainability plans by the January 2020 or 2022 deadlines.

W-2.2. DWR will update its groundwater basin prioritization to include assessment of adverse impact on local habitat and local streamflow and also use the best available statewide data sets for analysis.

W-2.3. DWR will provide technical and financial assistance from Proposition 1 to local agencies to support groundwater sustainability plan development.

W-2.4. The Water Board will prepare for the possibility of state intervention to ensure groundwater resources can be protected in the event that local groundwater management efforts are not successful. Preparation includes development of a fee schedule and the capacity to collect groundwater extraction data.

W-2.5. DWR will evaluate the groundwater sustainability plans and alternative plans according to adopted regulations, and will coordinate with the Water Board to ensure state intervention is effective and appropriate.

W-2.6. In January 2017, DWR released a draft Water Available for Replenishment (WAFR) report, as required by SGMA. The report presents the department's estimate of WAFR for each of the State's hydrologic regions. In addition, the report provides a framework and guidance that may be used by Groundwater Sustainability Agencies (GSA) as they do local planning of water available for recharge, which is required in their Groundwater Sustainability Plans (GSP). Finally, the report presents reliability and

5 California Department of Water Resources. Groundwater Information Center Website. http://www.water.ca.gov/groundwater/gwinfo/index.cfm
6 California Department of Water Resources. Groundwater Basin Prioritization Website. http://www.water.ca.gov/groundwater/casgem/basin_prioritization.cfm

potential availability from the SWP and CVP, including the effects of climate change. Throughout the report, GSAs are encouraged to consider the effects of climate change in their planning and are required to consider climate change in their GSPs.

W-2.7. DWR will work with federal, state and regional partners and land use agencies to explore and implement easements and projects for temporary storage of floodwaters on agricultural lands to increase groundwater replenishment during periods of high water.

ONGOING ACTIONS

- DWR provides facilitation services to support the local agencies in forming groundwater sustainability agencies to meet the SGMA formation deadline and to support development of groundwater sustainability plans.
- DWR published its initial Draft Report of Water Available for Replenishment in January 2017 and will periodically update the analysis and report to provide planning guidance to groundwater sustainability agencies, and to provide information on interregional groundwater interaction, groundwater dependent ecosystems, and stream-aquifer connections.
- DWR developed and adopted regulations for Basin Boundary Modification that were implemented in 2016 and will be the basis for future periodic basin boundary updates.
- DWR published best management practices and selected guidance documents in December 2016 to help groundwater sustainability agencies and other stakeholders develop groundwater sustainability plans. These documents will be updated periodically as better information becomes available.
- DWR will continue to improve and build new tools to support groundwater sustainability agencies and local agencies to report information and data and to support their water management efforts.
- DWR will include progress on achieving sustainable groundwater management by local agencies through periodic updates of Bulletin 118, California's official compendium on the occurrence and nature of groundwater statewide.
- The Water Board's permits for Aquifer Storage and Recovery projects support groundwater replenishment with treated drinking water during times when water is available. The Water Board will continue its efforts to ensure an effective permitting process.
- The Water Board continues to evaluate the issuance of temporary water right permits that allow for underground storage of flood flows and continue to evaluate how processes for capturing flood flows can be efficiently permitted.
- With $744 million in Proposition 1 grants, the Water Board is funding projects that clean up and prevent contamination of groundwater that serves as a source of drinking water.

W-3 | Diversify local supplies and increase water conservation and use efficiency.

California faces the threat of greater scarcity of water supplies, increased water demand, and limited water supply reliability. State government needs to promote and incentivize regional self-reliance, diversified local water supply portfolios, maximized water conservation, and water use efficiency, as well as improved storm water management for groundwater recharge. Recognizing unique local conditions and differences, the state should encourage communities to identify a suitable a mix of conservation, efficiency, and alternative sources, commensurate with local needs and goals.

NEXT STEPS

W-3.1. DWR, the State Water Board, and other agencies will work together to develop methodology and standards for urban water suppliers to set targets for indoor use, outdoor irrigation, commercial, industrial, and institutional water use.

W-3.2. DWR and the Water Board will continue to develop and implement actions to minimize water system leaks and set performance standards for water loss.

W-3.3. The Water Board will develop conservation regulations and rules that permanently prohibit water waste.

W-3.4. The Public Utilities Commission and the California Energy Commission will certify innovative technologies for water conservation and efficiency.

W-3.5. The Water Board will initiate Phase II projects of its Storm Water Strategy supporting the objective to increase storm water capture and use through regulatory and non-regulatory approaches.

W-3.6. The Water Board will work to address knowledge gaps and conduct additional research related to the protection of public health and direct potable reuse of recycled water, and to draft regulations for direct potable reuse of recycled water.

W-3.7. DWR and the California Department of Food and Agriculture will strengthen and expand the requirements for Agricultural Water Management Plans to include water budgets, measures to increase water use efficiency, and drought contingency plans, and to require such plans by a greater number of water suppliers.

ONGOING ACTIONS

- DWR and the Water Board manage many grants and programs to increase regional planning and coordination in order to improve self-reliance, diversify local water supplies, and increase water use efficiency.
- The Water Board's Storm Water Strategy incentivizes statewide use and redefines storm water as a resource results in local storm water management that produces multiple benefits that will contribute to diversification of local supplies through strategies including but not limited to: replenishment of depleted groundwater aquifers,

increased storm water use for local irrigation and non-potable water demands, increased flows in local streams and rivers, incentives for regionalization of local utilities, increased regional and local community partnering, and joint-involvement in regional and local water resource management. In addition to increased water supply, the resulting multiple benefits for California communities include improved water quality, increased space for public recreation, increased tree canopy, restoration of natural hydrograph, and enhanced stream and riparian habitat area.

- Statewide water conservation requirements and prohibition of wasteful water use practices will continue to be implemented under the Water Board's forthcoming long-term water conservation regulation.
- The Water Board adopted a General Order for recycled water use to streamline permitting of non-potable recycled water projects statewide, and encourage recycled water projects by acknowledging recycled water as a resource, and allowing recycled water programs that are implemented in multiple Regional Water Board boundaries to be permitted by the Water Board. These actions support the state goal of increasing the use of recycled water in California by 200,000 acre-feet per year by 2020 and by an additional 300,000 acre-feet per year by 2030.
- The Water Board is developing the Surface Water Augmentation regulation that will provide guidance on how to safely use recycled water to augment a drinking water surface reservoir.
- DWR's Integrated Regional Water Management grant program contributes to the state's climate change efforts through the establishment of standards that address climate change and must be used to evaluate projects included in plans or updates. The implementation grant program funds projects that include greenhouse gas reduction or climate change adaptability as a primary or secondary benefit.
- As part of DWR's Integrated Regional Water Management approach, it released a report titled "Stakeholder Perspectives, Recommendations for Sustaining and Strengthening Integrated Regional Water Management," which recommends that the State continue to work with regional groups to provide technical support services for climate change analyses.

W-4 | Reduce Sacramento-San Joaquin Delta climate change vulnerability.

At the confluence of the Sacramento and San Joaquin Rivers, the Delta is home to a half million people, farms and businesses, and a diversity of ecosystems, while at the same time is vitally important to statewide water management and other infrastructure. Nearly half of the landmass of California drains to San Francisco Bay through the Sacramento-San Joaquin Delta (Delta). The largest estuary on the West Coast, the Delta is a critical element of California's water system. Drinking water for two-thirds of the state's population and millions of acres of productive farmland flows through the Delta annually.[7] The Delta also serves as an important corridor for Chinook salmon and provides habitat for abundant wildlife, including threatened and endangered species. Once a mosaic of habitats that included vast wetlands, the Delta has been drained and diked into dozens of farmed islands ringed by levees. As the Delta's dried, tilled peat soil oxidizes, many of the islands are sinking – some are already 15 to 20 feet below sea level.[8] The Delta's more than 1,000 miles of levees are vulnerable to collapse from earthquakes and the climate change effects of sea-level rise and more severe storms.[9] The failure of multiple levees could cause saltwater to rush inland and contaminate the drinking water source for 25 million people.[10] The State needs to further its work in reducing vulnerability of Delta levees, restoring lost habitat, and reducing reliance by water districts around the state on the Delta for water supply.

NEXT STEPS

W-4.1. The Water Board is in the process of a phased process to update and implement the San Francisco Bay/Sacramento-San Joaquin Delta Water Quality Control Plan (Bay-Delta Plan), which sets water quality and flow standards designed to protect the many beneficial uses of Delta water. Phase 1 involves updates of lower San Joaquin River flow requirements, and southern Delta salinity requirements. Phase 2 involves updates to Delta outflow, Sacramento River tributary and Delta eastside tributary inflow, coldwater habitat and interior Delta flow requirements. The updates to the Bay-Delta Plan and its implementation will include adaptive management provisions to address and respond to scientific advances, changing environmental conditions including climate change, and habitat restoration actions, and changes in water supply infrastructure.

W-4.2. The Natural Resources Agency will coordinate and advance at least 30,000 acres of critical habitat restoration in the Delta during the next four years through California EcoRestore program.

W-4.3. The Department of Fish and Wildlife will develop the Delta Conservation Framework to guide Delta conservation planning and investment until 2050.

7 United States Environmental Protection Agency. "About the Watershed." https://www.epa.gov/sfbay-delta/about-watershed

8 United States Geological Survey. "Delta Subsidence in California: The sinking heart of the state". 2000. https://pubs.usgs.gov/fs/2000/fs00500/pdf/fs00500.pdf

9 Central Valley Flood Protection Board. "Central Valley Flood Protection Plan". 2012. http://www.water.ca.gov/cvfmp/docs/2012%20CVFPP_June.pdf

10 California Department of Water Resources. "Delta Risk Management Strategy Phase 2 Report". 2011. http://www.water.ca.gov/floodsafe/fessro/levees/drms/phase2_information.cfm

ONGOING ACTIONS

- DWR and the U.S. Bureau of Reclamation finalized the environmental analysis for WaterFix and are pursuing permits from the Water Board, National Marine Fisheries Service, U.S. Fish and Wildlife Service and other agencies. WaterFix would install new intakes in the northern Delta and carry water underground to the existing federal and state water project pumping plants in the southern Delta. WaterFix would safeguard water supplies from levee collapse and salinity intrusion and allow for more natural flow patterns in the Delta.
- DWR continues its work to convert marginal farmland on Sherman and Twitchell islands in the western Delta into wetlands and demonstration plots for alternative farming practices. The pilot study and proof of concept will support larger-scale projects that reduce and reverse subsidence, sequester greenhouse gases, and improve water and air quality on Delta peatlands.
- The Delta Conservancy is working with a large partnership of agencies, landowners, and academics to promote carbon management practices in the Delta by getting landowners to "grow" carbon through wetlands for profit by utilizing a newly approved California Wetland Carbon voluntary protocol that allows those carbon savings to be sold in international markets.
- California EcoRestore continues to pursue habitat restoration projects to address aquatic and terrestrial ecosystem needs in order to improve the overall health of the Delta.
- The Delta Stewardship Council is in the process of amending the Delta Plan to promote options for water conveyance, storage, and the operations of both. The draft amendment language includes recommendations for considering potential climate change effects in both design and operations of new and existing facilities.
- The Delta Stewardship Council is providing funding to the Bay Conservation and Development Commission to conduct a sea level rise vulnerability assessment and adaptation planning effort for communities and unincorporated areas that may be affected by sea level rise in eastern Contra Costa County.

W-5 | Prepare California for hotter and drier conditions and improve water storage capacity.

California faces the threat of a hotter and drier climate. In addition to increased groundwater recharge, surface storage, and conjunctive use water management, strategies to increase resilience under such conditions include flood and storm water management for augmenting water supply, water recycling, conservation and efficiency, watershed and meadow restoration to enhance natural "above the dam" storage, and groundwater replenishment and sustainable management. The State is poised to make its biggest new water storage investment in a generation as the California Water Commission administers $2.7 billion from Proposition 1 to pay for the public benefits of new groundwater or surface storage projects. Through a competitive process, the Water Commission expects to award funds as soon as 2018.

NEXT STEPS

W-5.1. The Water Commission, working with other state water and wildlife agencies, will complete review of applications submitted to its $2.7 billion Water Storage Investment Program, ensuring that all projects are evaluated for performance under changing future conditions.

W-5.2. DWR will develop and maintain research partnerships relevant to the observation, prediction, and management of atmospheric rivers including changes in atmospheric river characteristics associated with climate change.

W-5.3. DWR will help produce scientific research to explore and develop probabilistic estimates of drought vulnerability in California under future climate conditions.

W-5.4. DWR and the Water Board will continue to develop partnerships that foster scientific research to provide additional relevant information to support policy and operations.

W-5.5. Under its Drought Contingency Plan, DWR will coordinate climate change adaptation activities with drought preparedness.

W-5.6. DWR will work with other state, federal and local agencies to evaluate the potential effects of reoperating the state's flood management and water supply systems in the context of climate change as part of its System Reoperation Study.

W-5.7. DWR will support urban water suppliers in the development of more consistent and substantive water shortage contingency plans that include a five-year drought risk assessment and annual water budget forecasts, and will work with communities to develop drought response actions.

ONGOING ACTIONS

- Proposition 1, the $7.5 billion water bond passed overwhelmingly by California voters in 2014, includes $2.7 billion for investments in water storage projects. The Water Storage Investment Program will fund the public benefits of project throughout the state that provide measurable benefits to the Delta ecosystem or its tributaries. The California Water Commission adopted regulations in December 2016 to guide the investment of public benefits associated with new storage projects. Projects must evaluate performance under changing future conditions.
- The California Department of Water Resources will participate in and collaborate with science partnerships such as the U.S. Global Change Research Program Water Management Indicators Work Group and NASA's Western Water Applications Office to further develop water management related science objectives that could be used in climate change tracking and the development and refinement of adaptation strategies.
- The State Water Board administers drought-related emergency grants and loans for drinking water, and assists in identifying and permitting alternative water supplies for public water systems anticipating severe shortages or water outages, with funding approach prioritizing disadvantaged communities and low-income households.

W-6 | Address water-related impacts of climate change on vulnerable and disadvantaged populations and cultural resources.

Under California's Human Right to Water Policy, "every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption." However, for millions of Californians, the costs of drinking water are unaffordable, and many of the state's residents do not have access to clean and reliable drinking water.[11] Disadvantaged communities that already have problems in securing safe water and sanitation are unlikely to have the capacity to deal with additional challenges to water quality and quantity climate change could cause to drinking water and wastewater infrastructure. The State must support the resilience of communities to withstand, recover, and learn from the impacts of climate change. The State must prioritize aid to disadvantaged communities facing public health risks.

NEXT STEPS

W-6.1. The State will ensure disadvantaged communities receive an equitable and timely distribution of benefits from State processes and technical and financial assistance programs, and assist communities with climate change information about where climate change might pose undue burden.

W-6.2. The Water Board will work to develop and provide information and public outreach on potential climate change impacts to water quality, and options and funding opportunities for adapting to those impacts, including protecting source watersheds, drinking water and wastewater treatment infrastructure.

W-6.3. The Water Board will increase outreach to environmental justice and disadvantaged communities and Native American tribes in collaboration with non-governmental organizations.

W-6.4. DWR will award grants to small communities protected by facilities of the State Plan of Flood Control to complete feasibility studies that have the goal of increasing small community flood protection to the 100-year level. Improving the level of flood protection should include climate change projections.

W-6.5. The Water Board will develop funding guidelines for a new $9.5 million grant program that will improve access to clean drinking water in public schools and prioritize funding small disadvantaged communities.

W-6.6. The Water Board and the Office of Environmental Health Hazard Assessment will identify communities most vulnerable to climate change impacts to ensure access to information and technical assistance.

11 State Water Resources Control Board. *Communities That Rely on a Contaminated Groundwater Source for Drinking Water*, Final Report to the Legislature. 2013. http://www.waterboards.ca.gov/water_issues/programs/gama/ab2222/docs/ab2222.pdf

W-6.7. The Water Board will work to provide technical assistance and financial support to protect drinking water systems that are highly vulnerable to climate change impacts, with emphasis on disadvantaged communities and vulnerable populations.[12]

ONGOING ACTIONS

- The Water Board has launched the Human Right to Water Portal with information on state efforts to assist local communities in addressing contamination problems and improving access to safe, affordable drinking water.
- The Water Board's Household and Small Water System Drought Assistance Program, administered by three not-for-profit organizations, provides grants and loans to small water systems and individual households to address drought-related drinking water emergencies, with funding approach prioritizing disadvantaged communities and low-income households.
- Financial and technical assistance for permanent and sustainable solutions for provision of safe, clean, affordable, and reliable drinking water, and for wastewater treatment services, particularly for small systems and disadvantaged communities, are provided through the Water Board's Office of Sustainable Water Solutions.
- The Water Board's Cleanup and Abatement Account administers grant funding to address drinking water emergencies and urgent drinking water needs, including improvements to water quality and water supply, with a funding approach that prioritizes disadvantaged communities.
- Proposition 1 allocates $260 million to the Clean Water State Revolving Fund Program's Small Community Wastewater Grant Fund to assist small disadvantaged communities in addressing their wastewater needs.
- The Drinking Water State Revolving Fund Program provides low-interest loan and grant agreements for planning and infrastructure improvements and related actions to meet safe drinking water standards, ensure affordable drinking water, or both. Proposition 1 funding is only available for projects benefiting small, disadvantaged communities.
- The Water Board priority is to facilitate and fund the consolidation of small drinking water systems serving disadvantaged communities through coordination with funding partners, and stakeholders, as identified in the 2015 Safe Drinking Water Plan for California report.
- DWR prioritizes disadvantaged communities in all Water-Energy grant programs, funded through the Greenhouse Gas Reduction Fund.
- California Conservation Corp crews work in vulnerable and disadvantaged communities on climate-related projects such as turf removal, irrigation retrofits, plumbing retrofits, erosion control on riverbanks, flood preparedness, and flood fighting.
- DWR conducts climate change coordination activities with Native American tribes, collaborating with regard to climate change tracking, impacts, and adaptation.

12 State Water Resources Control Board. Comprehensive Response to Climate Change. 2017. https://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2017/rs2017_0012.pdf

W-7 | Continue to mainstream climate considerations into water management through improved understanding of climate risks and tool development.

Warmer temperatures, reduced snowpack, extreme precipitation events and more severe droughts all severely impact water management. California plays a leadership role in supporting and using downscaled climate change models. State government can build on improved scientific understanding of the causes, impacts and risks of climate change to state water resources by developing tools and outreach for water managers for coordinated adaptation actions.

NEXT STEPS

W-7.1. DWR will complete and disseminate results from the Vulnerability Assessment and Adaptation Plan from its Climate Action Plan. The primary water system analyzed is the State Water Project, but the tools used can be applicable to local water management agencies.

W-7.2. The Public Utilities Commission will develop a new urban water resilience modeling tool to assess water system capability resilience metrics such as the ability to respond to and recover from a disturbance.

W-7.3. DWR will revise its Economic Analysis Guidebook to include economic analyses that consider a broader accounting of costs and benefits, valuation of ecosystem services, and sustainability indicators and metrics.

W-7.4. DWR will work with the Energy Commission and the Natural Resources Agency to continually incorporate the best available water-related climate data on Cal-Adapt.org, including updated projections for precipitation and snowpack for local climate change planning data.

W-7.5. DWR will employ advanced techniques for decision making under deep uncertainty to assess the vulnerability of activities and assets under State control that face the greatest climate change threats and the adaptation strategies that can be employed to minimize or mitigate those threats under a wide range of future risk scenarios.

W-7.6. The Water Board will incorporate climate change considerations consistently across all activities, and one of the first steps is to obtain access to relevant data and model outputs.

ONGOING ACTIONS

- As part of DWR's Climate Action Plan: Phase II, climate change scenario selection is being coordinated and standardized across all of the department's programs and for local water management, including legislatively mandated programs such as SGMA and Proposition 1 Water Storage Investment Program. This activity builds on a three-year collaboration with DWR's Climate Change Technical Advisory Group and activities by other state agencies and the State's Fourth Climate Change Assessment to draw from a consistent set of potential future climate change projections.

- DWR is developing new methodologies to estimate the water content of the Sierra Nevada snowpack using aerial and satellite based technology.
- In partnership with the Federal Emergency Management Agency and the U.S. Army Corps of Engineers, DWR is updating flood inundation maps for the National Flood Insurance Program and for community risk awareness. It will utilize new methodologies to conduct flood risk assessment across the full spectrum of return period flood events and will not limit analysis to the 100-year return period flood.
- Baseline data collection is ongoing through the Water Board's Surface Water Ambient Monitoring Program and the Groundwater Ambient Monitoring and Assessment, which will inform adaptive management in response to climate change stressors.
- DWR and the State Climatologist's Office is now publishing an Annual Hydroclimate Report that includes a broad range of climate-related metrics, a discussion of climate signal detection, and possible approaches to improve knowledge of climate impacts.
- DWR is working in partnership with the National Weather Service to coordinate volunteer participation in citizen science activities such as the Community Collaborative Rain Hail and Snow (CoCoRAHS) Observation Network. This data will support climate change assessments of potential precipitation changes in the state.
- Cross-cutting risks are addressed through DWR's white paper "Connecting the Dots between Water, Energy, Food, and Ecosystems Issues for Integrated Water Management in a Changing Climate."
- DWR collaborates with the University of California on a number of water-related climate science studies and with other federal agencies on studies, tools, and observations that improve our understanding and increase our capacity to respond to water management risks impacted by climate change.
- DWR will continue to engage water agencies and support public understanding of climate change by sharing data and science on observations, impacts and climate change projections for water supply, educational training, and guidance materials.
- The 2017-2021 Science Action Agenda produced by the Delta Stewardship Council's Delta Science Program, prioritizes modernizing monitoring, modelling, and data management efforts to better understand how climate change will influence the state's coequal goals of achieving water supply reliability for California and enhancing the Delta ecosystem.

W-8 | Utilize low-impact development and other methods in state and regional storm water permits to restore the natural hydrograph.

The State is well on its way in making progress to fulfill this policy recommendation through the adoption of the statewide Strategy to Optimize Resource Management of Storm Water (Storm Water Strategy), which provides a vision, mission, goals, objectives, and specific projects to establish the value of storm water as a resource in California. Storm Water Strategy projects will evaluate existing programs, incentivize integrated water management and storm water capture and use, and emphasize low impact development. The resulting multiple benefits for California communities include improved water quality, increased water supply, and increased space for public recreation, increased tree canopy, and enhanced stream and riparian habitat area. This action area supports actions for greening and reduction of urban heat island effects and water resources for important ecosystems.

NEXT STEPS

W-8.1. The Water Board will initiate Phase II projects of the Storm Water Strategy supporting the objective to increase storm water capture and use through regulatory and non-regulatory approaches.

W-8.2. The Water Board will develop technical guidance and permitting tools to promote statewide implementation of post-construction requirements based on watershed processes.

W-8.3. The Water Board will incorporate Storm Water Strategy elements/products in regulatory permits.

ONGOING ACTIONS

- Green infrastructure and low-impact development designs are being facilitated through permits.
- Implementation of the Water Board's Storm Water Strategy offers multiple benefits, including improved water quality, more diversified water supply, increased space for public recreation, increased tree canopy, restoration of natural hydrograph, and enhanced stream and riparian habitat area.
- The Water Board will continue to collaborate with the Natural Resources Agency on the Urban Greening Grant Program to support the combined benefits of storm water capture and groundwater recharge with greenhouse gas reduction.
- The Water Board Storm Water Grant Program promotes the beneficial use of storm water and dry weather runoff by providing financial assistance for projects that provide multiple benefits while improving water quality.
- State funding and local assistance programs such as DWR's IRWM Grant Program and Strategic Growth Council and State Coastal Conservancy grant programs support the facilitation of natural infrastructure projects.

W-9 | Require closer collaboration and coordination of land use and water planning activities to ensure that each reinforces sustainable development that is resilient to climate changes.

California faces the threat of increasing scarcity of water resources and must foster sustainable development that minimizes water use and is resilient to climate change. The state should also strengthen alignment of land use planning and integrated water management, as described in the California Water Plan Update 2013, to facilitate stronger collaboration between land use and water planners.

NEXT STEPS

W-9.1. OPR will support the integration of water resource and land use planning in the update of OPR's General Plan Guidelines.

W-9.2. DWR will implement SGMA's requirement for water and land use agencies to share information and develop consistent water and land use plans. When fully implemented, SGMA is expected to drive substantial improvements in collaboration and cooperation between land use and water agencies as groundwater sustainability agencies work to align their long-term water supplies and water demands and propose management actions to achieve sustainable groundwater management.

W-9.3. DWR will support the integration of water resource and land use planning considerations as part of climate resilience strategies in partnership with the U.S. Bureau of Reclamation on various watershed basin studies.

W-9.4. State agencies will use a common approach to incorporate agricultural land stewardship strategies in their programs and projects that consider multiple uses of the land, including production, flood management, groundwater recharge, habitat conservation and water supply benefits.

ONGOING ACTIONS

- California Landscape Conservation Cooperative efforts to incorporate climate change planning in land use and water resources planning (such as the Central Valley Landscape Conservation Project resources and recommendations) are supported by State initiatives.
- DWR and Sonoma State University's Center for Sustainable Communities developed an integrated water and land management tool for comparing development outcomes of different residential land cover and infrastructure choices.
- State and Regional Water Boards continue to integrate statewide and regional policies, plans, and permits to incentivize:
  - The unification of planning efforts for drinking water, storm water, and wastewater with local land-use and climate change planning efforts; and
  - The regionalization of local utilities to address regional water and land-use objectives and goals.

- DWR released a Technical Methods Manual on how to amend/modify a Federal Emergency Management Agency Coastal Flood Insurance Rate Map to incorporate sea level rise. In response to an increased flood risk due to climate change, DWR will provide technical assistance to urban and urbanizing communities in the Central Valley to develop 200-year flood inundation maps that will guide sustainable development in accordance with the requirements of Senate Bill 5 (Machado, 2007).

W-10 | Protect and restore water resources for important ecosystems.

California faces the threat of losing or degrading critical habitats and ecosystem services. State government must advance its protection of aquatic and terrestrial ecosystem resilience in the face of climate change. This recommendation is tightly linked to the actions to protect and enhance the Delta ecosystem, and the source watersheds in the Sierra Nevada.

NEXT STEPS

W-10.1. DWR will complete ecosystem services valuation and economic analysis for the next update of California Water Plan.

W-10.2. The Natural Resources Agency will continue to be a key partner in restoring wetlands habitat, minimizing air pollution and protecting against environmental degradation around the Salton Sea through its Salton Sea Management Program.

W-10.3. The Water Board and the Department of Fish and Wildlife will implement a suite of actions to enhance flows statewide in at least five stream systems that support critical habitat for anadromous fish, as identified in the California Water Action Plan released in 2014 and updated in 2016.

W-10.4. The Water Board will update plans, permits, and policies; coordinate with other agencies to enhance ecosystem resilience to the impacts of climate change; and work with relevant agencies to restore and maintain healthy watersheds, reduce vulnerability to catastrophic fires, and support resilience in recovery efforts.[13]

W-10.5. The Water Board will identify actions to minimize impacts associated with ocean acidification, hypoxia, increasing temperature and nutrients, and to support resilient ocean and coastal ecosystems.

W-10.6. DWR and the Water Boards will emphasize, whenever possible, the benefits of protection and restoration (e.g. forest management and meadow restoration) of source watersheds to increase water supply and protect ecosystem services (e.g. fisheries), benefitting water users throughout the entire watershed.

W-10.7. Depending on the scale, forest thinning could increase mean annual streamflow by up to 6%.[14] DWR will continue to work to implement the forest health management strategy in the California Water Plan Update 2013.

13 Podolak, K., D. Edelson, S. Kruse, B. Aylward, M. Zimring, and N. Wobbrock. "Estimating the Water Supply Benefits from Forest Restoration in the Northern Sierra Nevada". An unpublished report of The Nature Conservancy prepared with Ecosystem Economics. 2015.San Francisco, CA. https://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/california/forest-restoration-northern-sierras.pdf

14 State Water Resources Control Board. Comprehensive Response to Climate Change. 2017. https://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2017/rs2017_0012.pdf

ONGOING ACTIONS

- State and Regional Water Boards provide ongoing support for aquatic ecosystem restoration through funding, permits, monitoring, and technical assistance on case-by-case basis.
- The Water Board continues to issue water shortage notices in water bodies where available water supply cannot satisfy the demand of senior water rights, or the flow needed for instream beneficial uses.
- The Water Board is developing models and associated tools to support its instream flow related work. These models will assist the Water Board in determining water availability and water demand in priority watersheds throughout the state and help to evaluate potential water supply effects from alternative management and climate change scenarios.
- The Water Board is integrating adaptive strategies in municipal and industrial permits to protect and restore the chemical, physical, and biological integrity of the state's surface and ground waters to ensure continued efficacy of regulatory programs during times such as drought.

Parks, Recreation, and California Culture

A range of climate change impacts is already affecting and will continue to affect public parks, recreation, and cultural resources in California and how Californians interact with the outdoors. Safeguarding these resources while accommodating the desire for increased access to parks and recreation can instill a sense of place and shared identity by connecting Californians to their environment and state history; provide places for gathering to increase social cohesion; yield public health benefits such as cooling, clean air, and space for exercise; and create opportunities to educate the public about climate change to motivate subsequent action. Access to parks and other natural areas can be particularly beneficial for children, supporting sensory development, encouraging creativity, improving concentration, and helping rehabilitate illness.[1] In addition, outdoor recreation contributes significantly to the economic well-being of communities, directly providing almost 700,000 jobs in the state.[2,3] Due to the importance of recreational and cultural resources to California's social fabric, economy, and well-being, several State laws codify protection of these resources including the California Coastal Act and the National Historic Preservation Act.

Access to parks and other natural areas can be particularly beneficial for children, supporting sensory development, encouraging creativity, improving concentration, and helping rehabilitate illness.

Climate impacts to parks and recreation will affect the 56% of California residents that participate in outdoor recreation in mountains, forests, and other landscapes each year,[4] plus millions of others who visit neighborhood parks, beaches, and other public lands. Impacts related to sea level rise and increased coastal erosion will affect public access to beaches and State Parks along the coast, and may inundate trails, parking lots, buildings, piers, campgrounds, and immovable cultural resources. Large and severe wildfires and hazardous trees due to growing tree mortality deter hikers and bikers, forcing the closure of campgrounds, parks, roads, and trails. Drought reduces water availability at campsites and has the potential to lower water levels, exposing cultural resources to unprotected conditions while also impacting freshwater recreation such as boating and fishing. Warming of freshwater lakes can result in the growth of toxic algal blooms, often making these areas dangerous for freshwater recreation. Reduced snowpack shortens the season for winter sports and threatens the loss of recreation-dependent jobs in rural economies.

Meanwhile,demand will increase for accessing beaches, mountains, urban parks, and other cool recreation areas that serve as refuge during extreme heat days. Extreme heat will make inland areas and unshaded trails and bike paths less desirable for recreation; high temperatures could also make these areas potentially dangerous for children, the

1 Louv, Richard. *Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder*. 2005.

2 Morgan, Todd, Brandt, Jason, Songster, Kathleen, Keegan Charles, & Christensen, Glenn. "California's forest products industry and timber harvest" (pg. 48). U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR. 2006.

3 "California." Outdoor Industry Association. 2017. https://outdoorindustry.org/wp-content/uploads/2017/07/OIA_RecEcoState_CA.pdf

4 "California." Outdoor Industry Association. 2017. https://outdoorindustry.org/wp-content/uploads/2017/07/OIA_RecEcoState_CA.pdf

elderly, and people with certain disabilities. Flooding can wash out trails and roads causing closures, thereby cutting off access to parks and recreation facilities. Declines in native fisheries will continue to detriment traditional cultural practices for communities including a number of California Native American tribes. Increases in mosquitos and ticks may contribute to the spread of vector-borne diseases and impact enjoyment of outdoor resources.

This chapter presents strategies for preparing for and responding to climate impacts to parks, recreation, and areas of important cultural significance along the coast and in inland, mountain, and urban areas so that they can provide accessible and enriching opportunities for all Californians. The chapter recognizes that recreational play, family vacations and daytrips, educational opportunities within parks and historic sites, and routine interactions with neighborhood playgrounds and community spaces bring people together around treasured places that are a vital part of California's culture. Although climate change adds to the challenges of managing these resources, actions by State agencies and in coordination with diverse partners can help ensure that parks, recreation, and cultural resources can be enjoyed by future generations.

PC-1 | Augment public access to the coast and coastal recreation while protecting beaches and coastal areas consistent with resource conservation priorities.

Climate change will affect our coast and beaches, which are among California's most treasured natural resources. Coastal climate impacts such as sea level rise and storm surges can inundate parking lots, parks, public access points, trails, camps, and lodging. These climate impacts exacerbate existing challenges associated with the erosion of beaches, a shortage of affordable coastal accommodations, and lack of transportation options for travelling to cooler coastal areas.

As sea levels continue to rise, State agencies with coastal jurisdiction will need to invest in coordinated responses with federal, local, tribal, and community partners, to ensure that the coast is equally accessible to all Californians now and in the future. The California Coastal Act tasks the California Coastal Commission, in partnership with other State agencies and local governments, with maximizing public access to and along the coast and public recreational opportunities in the coastal zone. Submerged lands and tidelands, the land covered and uncovered by the ebb and flow of the tides, are held in trust and managed by the State Lands Commission for the benefit of the people of California.[5] As the sea egresses landward due to climate change, management will have to shift accordingly to ensure Californians' access rights to these public trust lands and their uses. With 114 coastal park units under its management, California State Parks oversees nearly a quarter of the coastline. State Parks plays a leadership role in managing its own facilities for climate impacts while engaging with stakeholders on landscape-level projects that promote coastal resiliency. The State Coastal Conservancy supports State and local partners in protecting coastal lands, constructing and repairing trails, building recreational facilities, expanding affordable overnight accommodations, and restoring coastal resources.

NEXT STEPS

PC-1.1. Assess vulnerability to inundation, flooding, and erosion for all new State Parks projects, including capital outlay and deferred maintenance, acquisitions, environmental restoration, and other applicable planning, projects, and associated grants.

PC-1.2. Forecast changes in visitor demand resulting from nearby narrowing beaches and increasing inland temperatures and plan regionally and cross-jurisdictionally to ensure public access in spite of those changes.

PC-1.3. Complete the inventory of coastal cultural resources at risk from Sea Level Rise and littoral erosion on public lands in coordination with appropriate coastal tribal representatives and historical societies.

PC-1.4. Develop specific management plans to protect existing State Park infrastructure, including parking lots and visitor facilities, and vulnerable natural resources, including beaches, dunes and wetlands, to sea level rise.

5 "The Public Trust Doctrine." State Lands Commission. 2015. http://www.slc.ca.gov/About/Public_Trust.html

PC-1.5. Protect existing open space adjacent to the coast and restore dunes to increase the resilience of coastal habitats and beaches.

PC-1.6. Encourage where appropriate managed retreat, or removal of development that is threatened by sea level rise, so that coastal lands, habitats, and beaches can move inland over time.

PC-1.7. Use soft or natural solutions as preferred approached for protecting structures likely to face flooding or inundation and require mitigation for the public access impacts of shoreline protective devices if they are used.

PC-1.8. Develop coordinated plans between agencies at the park and regional level to replace the loss of visitor-serving accommodations, maximizing continued provision of affordable options and an appropriate mix of accommodations over time.

PC-1.9. Plan and locate new coastal recreation and work to make existing public access points to be safe from hazards without requiring hard protection.

PC-1.10. Where allowed, design and engineer shoreline protective devices and monitor existing devices so that they do not result in the loss of Public Trust lands and their uses for navigation, commerce, and fisheries without permission of an appropriate trustee agency.

PC-1.11. Design, build, retrofit or relocate recreation and visitor-serving facilities, coastal accessways, and sections of the Coastal Trail to be resilient to inundation, flooding, and erosion.

PC-1.12. Incorporate educational elements into coastal adaptation projects to teach the public about the risks of sea level rise and options for adaptation.

PC-1.13. Maximize opportunities for the public to participate in and inform coastal planning processes that affect recreational resources, including both residents of coastal communities and those who visit the coast to recreate, such as inland communities.

ONGOING ACTIONS

- California State Parks requires the evaluation of potential impacts from sea level rise, coastal storm surge, and extreme events on all new projects, facilities, and resource protection efforts in low-lying or susceptible areas of coastal State Park units.
- California State Parks managers refer to a "Sea Level Rise and Extreme Event" guidance document for all new State Parks projects, including capital outlay and deferred maintenance projects, new land acquisitions, environmental restoration and enhancement projects, general plans, and other applicable planning and projects.
- California State Parks is working collaboratively with the California Coastal Conservancy on the preparation of a vulnerability assessment and online tool to assess potential sea level rise and extreme event impacts to many existing State Park facilities in coastal park units.

- Potential climate change impacts have been considered in more than 20 of the most recently completed State Park General Plans. These include the General Plans for Cuyamaca Rancho (2015), Big Basin Redwoods (2013), Topanga State Parks (2012), and San Luis Reservoir State Recreation Area (2013).
- In 2017, the California Conservation Corps is being contracted by State Parks to restore and broaden access to over a dozen coastal trails in Torrey Pines State Natural Reserve, Pfeiffer Big Sur State Park, Mount Tamalpais State Park, and other iconic landscapes.
- The State Coastal Conservancy is implementing dune restoration and managed retreat projects along the coast to enhance shoreline resilience and preserve beaches into the future and using rolling easements and other strategies to develop a coastal trail and public access amenities that will be resilient to sea level rise.
- The California Coastal Commission's 2015 Sea Level Rise Policy Guidance provides guidance on protecting public access, recreation, and cultural resources from the impacts of sea level rise.
- The California Coastal Commission's LCP Local Assistance Grant Program has awarded $5 million to local governments to support sea level rise vulnerability assessments and updates to Local Coastal Programs, which include measures to protect coastal recreational and cultural resources at the local level, among other topics.
- The California Coastal Commission's ongoing regulatory actions on coastal development permit applications implement the California Coastal Act's requirements to maximize public access to and along the coast as well as public recreational opportunities.
- The State Lands Commission reviews all project proposals on its land for sea level rise vulnerability and other climate change impacts and assists local trustees of granted sovereign lands with AB 691 compliance (sea level rise vulnerability assessments).

PC-2 | Increase and improve access to climate-resilient recreation opportunities in inland, mountain, and freshwater regions.

Inland, mountain, and freshwater landscapes provide refuge for nearby urban centers and opportunities for a diverse range of outdoor activities from hiking and biking to horseback riding, swimming, boating, fishing, camping, snowsports, and rock climbing. Temperature already significantly impacts decision-making around how users choose to enjoy these outdoor resources and studies from other states and countries indicate that temperature increase from climate change is likely to shift tourism patterns towards higher latitudes and altitudes and to cooler regions.[6,7] Temperature increases of a few degrees also increase demand for freshwater lakes and reservoirs.[8,9] As the number of visitors to inland, mountain, and freshwater recreation areas increases due to population growth and extreme heat, management of these natural resources will have to adjust to embrace new capacities.

Meanwhile, wildfire, flooding, drought, algal blooms and other climate extremes will continue to pose challenges to the management of inland, mountain, and freshwater recreation resources. Sustainable funding mechanisms will be needed for managers to maintain outdoor recreation despite these challenges. Funding to adapt to these challenges is especially pertinent given the mismatch between the population of many of California's rural communities near mountain and forest recreation and the number of visitors they serve; for example, Mammoth Lakes, a region with 8,234 residents, serves an average of 2.8 million visitors a year.[10]

NEXT STEPS

PC-2.1. Better track climate impacts and their effects on visitation rates and usage of California State Parks and other state-managed recreation areas through increased research and monitoring.

PC-2.2. Learn from the prehistory and history of California to better evaluate conditions that lead to population movements, cultural adaptation and migration that may mirror behavior and cultural choices during environmental change.

PC-2.3. Secure sustainable funding for robust trail maintenance to prevent and respond to damage from rain, flooding, and storm impacts.

PC-2.4. Consider shading and usability of resources on hot days when designing inland trails, parks, and freshwater recreation areas and when acquiring new land for recreation.

PC-2.5. Expand availability of affordable accommodations and lodging for overnight visitors to inland, mountain, and freshwater regions.

6 Hamilton, J.M., D.J. Maddison, and R.S.J. Tol. Climate Change and International Tourism: A Simulation Study. Global Environmental Change 15: 253–266. 2005.

7 Although tourism is linked to recreation, the difference between tourism and recreation is that the former includes at least one overnight stay away from home.

8 Hamilton, Jacqueline M., and Richard SJ Tol. "The impact of climate change on tourism and recreation." *Human-induced climate change: an interdisciplinary assessment*. Cambridge University Press, Cambridge, UK. 2007.

9 Boyer, Tracy A., Richard T. Melstrom, and Larry D. Sanders. "Effects of climate variation and water levels on reservoir recreation." *Lake and Reservoir Management*. 2017.

10 "Mammoth Lakes Facts." Mammoth Lakes Tourism. 2017. http://www.visitmammoth.com/mammoth-lakes-facts

PC-2.6. Support public access on waterways, lakes, and rivers; improved and strategically located access points on public land; and affordable equipment rentals and staging areas.

PC-2.7. Promote water safety with robust public education, free life vests, and other safety measures.

PC-2.8. Work across federal, state, and local agencies to provide affordable parking, accessible and convenient transportation options, and shuttles to make inland, mountain, and freshwater recreation areas easier to reach and to minimize the impact of increased private vehicle use.

PC-2.9. Investigate sustainable funding measures to support visitor services in rural areas that experience a high volume of recreation-based tourists.

PC-2.10. Work with land management agencies to integrate awareness of impacts of changing climates into management plans and decisions.

ONGOING ACTIONS

- The Sierra Nevada Conservancy continues to implement its Watershed Improvement Program (WIP) through strategic partnerships with federal land management agencies and stakeholders to restore and protect the health of California's primary watershed and yield recreational co-beneifts through increased investment and policy changes.
- The Coachella Valley Mountains Conservancy has a trails project now being implemented that will add four trails in the Northern Coachella Valley, providing new recreational and educational options for economically disadvantaged communities where such amenities are lacking and establishing trail connections between the Valley and Joshua Tree National Park for the first time.
- The Wildlife Conservation Board's Public Access Program Solicitation 2017 includes climate change and enhanced access to nature and wildlife for youth, disadvantaged communities, and urban-focused populations as criteria for grant guidelines.

PC-3 | Maximize opportunities to connect urban populations to natural spaces through urban parks, wetlands, and river parkways.

For urban communities that lack access to further away wildland recreation, urban parks can provide a local opportunity to share a common identity, build community, learn about nature, spend time with family and friends, and find shade on a hot day. However, low-income urban communities and communities of color are generally park-poor relative to other urban areas.[11,12,13] Because of the social and environmental benefits of urban parks, climate change provides an impetus to rethink urban design with an emphasis on public space, equitable access to parks, and green infrastructure. Shaded urban parks, trees and vegetation can help moderate the effects of the urban heat island, protecting people from extreme heat, reducing air temperatures, and decreasing energy demand.[14] Trees and vegetation offer air quality benefits by filtering pollutants and also store carbon.[15] Walking trails and green alleys can increase connectivity between residents, community parks, and other destinations while providing carbon-free transportation options for all residents. Urban parks and green space can be designed to reduce stormwater runoff and flooding, recharge drinking water supplies, and save energy used for water treatment.[16] In coastal cities, wetlands, shoreline parks, and natural areas can buffer low-lying urban centers from the impact of rising seas, storms, and flooding. Gardens, parks, and trees provide natural habitat for birds and insects.

In addition to environmental quality benefits offered by urban green space, nature in cities and towns can improve public health and social well-being, providing a place to bring neighbors together and strengthen relationships between them.[17] Urban residents have been shown to spend more time outdoors in common areas with trees and vegetation. Adults with more exposure to common green spaces report a stronger sense of unity among neighbors and belonging to the neighborhood.[18] Urban green space supports healthy child development and children with daily exposure to greener spaces engage in more physical activity.[19] Community gardening and urban agriculture can increase access to healthy food while teaching individuals about their food system.[20] Providing opportunities within urban green space for visitors to see and interpret the history around them increases opportunities for public engagement and allows visitors to reflect on the past, creating a sense of place and optimism about the future.[21]

11 García, Robert & White, Aubrey. "Healthy Parks, Schools, and Communities: Mapping Green Access and Equity for the Los Angeles Region." *The City Project*. 2006.

12 "Parks & Recreation in Underserved Areas: A Public Health Perspective." National Recreation and Park Association. http://www.lchc.org/wp-content/uploads/02_LCHC_ParksRec.pdf.

13 "A New Vision for California State Parks: Recommendations of the Parks Forward Initiative" *Parks Forward Initiative*. 2015. http://www.parksforward.com/.

14 Akbari, Hashem, Melvin Pomerantz, & Haider Taha. "Cool surfaces and shade trees to reduce energy use and improve air quality in urban areas." *Solar energy*. 2001.

15 "How cities use parks for climate change management." *City Parks Forum Briefing Papers*. American Planning Association. 2007. https://planning-org-uploaded-media.s3.amazonaws.com/legacy_resources/cityparks/briefingpapers/pdf/climatechangemanagement.pdf

16 The Trust for Public Land. "Climate Smart Cities." https://www.tpl.org/how-we-work/climate-smart-cities#sm.000any26h1d8ddnas2z24t2k8bzxj

17 Sullivan, W., Kuo, F., and DePooter, S. The Fruit of Urban Nature: Vital Neighborhood Spaces." *Environment and Behavior*. 2004. http://www.willsull.net/resources/Sullivan-papers/SullivanKuoDePooter.pdf

18 Wolf, Kathleen & Rozance, Mary Ann. "Social Strengths - A Literature Review." *Green Cities: Good Health*. 2013. http://depts.washington.edu/hhwb/

19 Almanza, Estela. "A study of community design, greenness, and physical activity in children using satellite, GPS and accelerometer data." *Health and Place*. 2012.

20 Lyson, Thomas & Raymer, Annalisa. "Stalking the wily multinational: Power and control in the U.S. food system." *Agriculture and Human Values*. 2000.

21 Hilton, Steven. "Golden Landscapes: Cultural Resources Management at Empire Mine State Historic Park." *Master Thesis Sonoma State University*. 2013.

PARKS, RECREATION, AND CALIFORNIA CULTURE

By drawing people together to relax, exercise, and gather with friends and family, public green spaces contribute substantially to public health outcomes, community resilience, trust, and connectedness.[22] These benefits of urban investments bolster resilience to climate impacts by making city environments cooler, healthier, and more connected.

NEXT STEPS

PC-3.1. Identify park-poor communities and ensure that new urban parks and trail systems are within walking distance to underserved populations and are connected to high-density infill, homes and offices.

PC-3.2. Involve communities and stakeholders from the onset of urban park planning through robust outreach, feedback and consultation, and consensus seeking.

PC-3.3. Ensure that communities have ownership of their neighborhood parks by integrating local cultural assets such as stories, public art, cultural activities, artists, and traditions into park design.

PC-3.4. Create job, training, and internship opportunities in urban forestry and park development, planting, and maintenance to ensure their upkeep long-term and to benefit local economies.

PC-3.5. Provide large trees to shade existing park recreation areas and trails in urban areas.

PC-3.6. Create new park designs that offer a variety of land cover including dense trees, scattered trees, and lawn to provide recreation opportunities and shading.

PC-3.7. Build trail connections to urban parks and green spaces to form a network of biking, walking, and equestrian options that increase the reach of parks.

PC-3.8. Retrofit existing facilities and underutilized spaces for parks when aligned with the community's vision for sites: consider converting vacant lots to community gardens, eliminating or consolidating parking lots, beautifying levees, remediating and reclaiming brownfields and vacant waterfronts, utilizing abandoned rail lines, and adding parks to decking over freeways or rooftops.[23]

PC-3.9. Use climate-smart landscaping and native plants where possible to restore native habitat and decrease water use.

PC-3.10. Design new parks and retrofit existing parks to include green infrastructure stormwater management techniques.

PC-3.11. Invest in data to identify costs and benefits of green infrastructure.

PC-3.12. Ensure that appropriate safety measures are added as needed as recreation is pushed to later in the evening or earlier in the morning to avoid high heat.

PC-3.13. Interpret the cultural resources within urban parks to increase inclusivity and highlight elements of history that are important to the current community.

22 Wolf & Rozance. 2013.

23 Welle, Ben. "Connecting City Parks to Global Warming." *City Parks Blog*. 2009. https://cityparksblog.org/2009/12/10/connecting-city-parks-to-global-warming/

ONGOING ACTIONS

- On April 22, 2017, California State Parks celebrated the grand opening of the Los Angeles State Historic Park which currently provides recreational and educational opportunities for visitors. The park unit is 32 acres of open space with walkways and views that is located in the heart of Los Angeles.
- A blueprint to revitalize the lower section of the LA River to improve recreational access and is being developed with technical assistance from the San Gabriel and Lower LA Rivers and Mountains Conservancy and the LA County Department of Public Works. Projects in the plan include trail, park, and wetland restoration, connected bike paths, and storm water solutions. Youth and family group bike rides and trail usage education training sessions are being held to engage residents concurrent to public meetings for the development of the plan which will be completed in February 2018.
- The California Natural Resources Agency was allocated $80 million to distribute through its Urban Greening Grant Program from the Greenhouse Gas Reduction Fund in 2016. Funded green infrastructure projects include expansion of neighborhood parks and community space and greening of public lands and structures such as schoolyards.
- California State Parks' Office of Grants and Local Services (OGALS) administers grants annually for park and recreation needs. Since 2000, OGALS has awarded nearly $3 billion in grants for local park projects. In June 2017, $16 million in grants were awarded from the 2002 Resources Bond Act (Proposition 40) alone for 25 local park projects.
- The California Natural Resources Agency awards Urban River and California River Parkway grants to restore riparian trails, waterfront paths, habitats, and ecosystem function in California's cities and towns.
- CAL FIRE's Urban and Community Forestry Program works in cooperation with nonprofits such as California ReLeaf and with seven Regional Urban Foresters to advance the development of sustainable urban and community forests in California. CAL FIRE also distributes Urban and Community Forestry Program grants through the Greenhouse Gas Reduction Fund.
- The Health in all Policies Taskforce housed under the Strategic Growth Council is working towards a goal for all California residents to have access to places to be active, including parks, green space, and healthy tree canopy.
- The Coastal Conservancy has awarded hundreds of grants for urban park and trail projects to increase accessibility to outdoor recreation, including projects to complete the Santa Ana River Parkway, the San Francisco Bay Trail and the Coastal Trail. Grants have also been awarded to plan and implement many urban greening projects that create recreational and educational opportunities, increase shade, improve walkability and reduce stormwater runoff in coastal counties.

PC-4 | Understand the scope of climate change impacts to cultural resources and integrate climate change into the management of cultural resources.

Historic and cultural resources include artifacts, archaeological sites, cultural landscapes, ethnographic resources, museum collections, buildings and structures. A number of these sacred sites, objects, and heritage sites are a critical aspect of living culture for many Californians, especially California Native American Tribes. Cultural resources are elements of cultural continuity and identity that provide a connection to the land and inspire practices today. Historic and cultural resources face many impacts from climate change, and efforts to preserve them must be interwoven with initiatives to address the effects of climate change to the built and natural environments, and communities.

NEXT STEPS

PC-4.1. Ensure that climate change strategies for all land management agencies consider cultural resources.

PC-4.2. Complete surveys to document and catalog cultural resources on public lands in order to know what resources may be at risk of climate impacts.

PC-4.3. Form a Cultural Resources Climate Change Task Force charged with developing an overall strategy for non-traditional ways to address cultural resources before they suffer irreversible effects of climate change. In line with the Paris Agreement, major sub-themes such as mitigation of greenhouse-gas emissions, net zero energy, the role of heritage in social cohesion, integration and equity, and models to value loss and damage to cultural heritage and ecosystem services are among the issues in need of further research and design.

PC-4.4. Provide guidance to State agencies on engaging with California Native American Tribes to promote Traditional Environmental Knowledge practices in climate adaptation projects to benefit indigenous peoples, enhance vegetation in natural and designed landscapes, and provide continuity of cultural identity through traditional practices.

ONGOING ACTIONS

- Led by the California State Office of Historic Preservation, the Cultural Resources Climate Change Task Force, with participation of state agencies such as State Parks, the California Energy Commission, Office of Emergency Services, State Library, State Archives, Native American Heritage Commission, and others, will create a Cultural Resources Climate Change Strategic Plan (Plan) envisioned for completion to coincide with the next update of Safeguarding California. The Plan would include information as to how to consult with appropriate California Native American Tribes and the State Historic Preservation Officer in advanced to protect cultural resources at-risk by developing non-traditional solutions to retain, and adapt or treat these resources, where possible. The Plan could include methods for local and regional sea level rise vulnerability assessments evaluate potential impacts

on cultural resources; such evaluation should occur in consultation with relevant tribes and the State Historic Preservation Officer. The Plan would recommend policies to LCPs to protect archaeological resources from sea level rise through actions such as monitoring programs, protection measures, or relocation of at-risk resources.

- California State Parks' Cultural Resources Division, through partnerships with the National Ocean and Atmospheric Administration, the National Parks Service, Native American Tribes, professional organizations like the Society for California Archaeology, and academic institutions like Sonoma State University is proposing a program of targeted coastal surveys of State Parks' most at risk coastal lands from sea level rise and littoral erosion.
- Archaeologists and Historians are investigating cultural adaptations and behavioral changes associated with climate change evident in the archaeological record. Many current studies investigate prehistoric California's inhabitants reactions to climate change during the Medieval Climactic Anomaly, a climate change evident in California from ca. 1,000 – 600 years before present.
- The Society for California Archaeology (SCA) launched a Climate Change and California Archaeology study in 2011 and has started volunteer archaeological surveys along the California coastline. California State Parks is contributing to the survey, following protocols developed for the effort and sharing reports on archaeological survey efforts through the SCAs website.
- The Native American Heritage Commission created a guide of relevant laws and cultural resources management practices for *Protecting California Native American Sites During Drought, Wild Land Fire, and Flood Emergencies*.
- Funded in part by the California Coastal Conservancy and the California Natural Resources Agency Environmental Enhancement & Mitigation Program, the Trust for Public Land purchased 688 acres on the North Coast in 2016 to establish the Kashia Coastal Reserve, restoring ownership of native coastal land to the Kashia Band of Pomo Indians of the Stewarts Point Rancheria. The reserve will serve as a demonstration forest and a place to educate and engage the public about native people in the area while extending the California Coastal Trail from Salt Point State Park through the reserve for public enjoyment.
- The State Lands Commission is developing staff trainings to provide guidance on what to do if cultural resources are found on lease or project sites.

PC-5 | Incorporate climate change in all California State Park and conservancy planning and decision-making.

The California Department of Parks and Recreation manages over 1.5 million acres of land in California consisting of 280 individual park units and including State Parks, State Beaches, State Wilderness Areas, and State Vehicular Recreation Areas. Over 67 million visitors enjoy California's state parks each year by engaging in activities such as hiking, swimming, camping, and boating in State Park units. The Department of Parks and Recreation plays an integral role in conserving, protecting and restoring natural and cultural resources while providing high-quality recreational opportunities to the public. Complementary to the Department of Parks and Recreation, 10 regional conservancies under the California Natural Resources Agency play an integral role in conservation, protecting and restoring natural and cultural resources, and providing local recreational opportunities to the public. These conservancies oversee millions of acres along the California Coast and in the Baldwin Hills, Coachella Valley, Sacramento-San Joaquin Delta, San Diego River, San Gabriel and Lower Los Angeles River, San Joaquin River, Santa Monica Mountains, Sierra Nevada, and Tahoe regions.

Managing and conserving lands for the public is a monumental task, but these agencies are committed to safeguarding California's natural and cultural resources from climate change for the lasting enjoyment of all.

NEXT STEPS

PC-5.1. Make climate considerations explicit in park General Plans, Management Plans, trail system master plans, strategic plans, and all other planning documents.

PC-5.2. Include climate considerations in the evaluation and prioritization of new state-led land acquisitions.

PC-5.3. Adopt best practices for adapting to climate change when planning and implementing State Parks' projects.

PC-5.4. Align State Parks' and conservancy efforts to focus on highest priority programs and projects in coordination with broader climate change planning efforts.

PC-5.5. Connect climate adaptation efforts in State Parks and Conservancies with efforts to sequester carbon on public lands and reduce greenhouse gas emissions.

PC-5.6. Prioritize conservation, protection and restoration of natural resources in climate change adaptation projects and planning to ensure sustainable recreational opportunities for the public.

ONGOING ACTIONS

- Potential climate change impacts have been considered in more than 20 of the most recently completed park General Plans. These include the General Plans for Cuyamaca Rancho (2015), Big Basin Redwoods (2013), and Topanga (2012) State Parks and San Luis Reservoir State Recreation Area (2013).
- California State Parks Departmental Notice No. 2014-03 requires the evaluation of potential impacts from sea level rise, coastal storm surge, and other extreme events on all new projects, facilities, and resource protection efforts in low-lying or susceptible coastal state park units.
- California State Parks created a "Sea Level Rise and Extreme Event" guidance document for all new State Parks projects, including capital outlay and deferred maintenance projects, new land acquisitions, environmental restoration and enhancement projects, general plans, and other applicable planning and projects.
- California State Parks is working collaboratively with the California Coastal Conservancy on the preparation of a vulnerability assessment and online tool to assess potential sea level rise and extreme event impacts to many existing State Park facilities in coastal park units.
- State Parks inventoried all energy and water usage reported to Energy Star Portfolio Manager, which will continue to inform conservation efforts; conservation of energy and water will make these resources more resilient to pressures resulting from climate change.
- The San Joaquin River Conservancy's draft San Joaquin River Parkway Master Plan Update includes a goal on incorporating climate adaptation and sequestration strategies in Parkway projects.
- The California Coastal Conservancy's Climate Ready Program supports planning, project implementation and multi-agency coordination to advance actions that will increase the resilience of coastal communities and ecosystems. In 2009 the Conservancy adopted a comprehensive Climate Change Policy that informs all aspects of its work and amended its Project Selection Criteria to ensure that all Conservancy projects are designed with climate change in mind. The Climate Ready Program helps natural resources and human communities along California's coast and San Francisco Bay adapt to the impacts of climate change, such as rising sea levels, beach and bluff erosion, extreme weather events, and many other climate hazards.
- The Coastal Conservancy has funded several projects that measure and increase carbon sequestration on natural lands, including redwood forests, grasslands and coastal wetlands, some of these properties also created public recreational opportunities.

PC-6 | Engage the public and foster ongoing and diverse partnerships to create a shared commitment to stewardship and to harness complementary skills, capacities, and support.

To adapt the management of resources to the effects of climate change, state agencies cannot work in isolation from a wide range of neighbors and partners. State agencies, including California State Parks, regional conservancies, the Office of Historic Preservation, the California Coastal Commission, California Coastal Conservancy, and the State Lands Commission, should leverage partnerships with federal and local governments, California Native American Tribes, civic and community groups, nonprofit organizations, businesses and volunteers, and schools to embrace new models for managing and maintaining recreational resources for climate change impacts and addressing climate justice concerns about park distribution. This recommendation builds off extensive public support that already enhances outdoor recreation and parks; in 2013, nonprofits contributed more than $12 million to California State Parks, while nearly 40,000 volunteers donated more than 1 million hours of their time.[24] Broadly engaging the public and other stakeholders helps introduce new and underserved audiences to the outdoors while increasing inclusivity and promoting cross-sector support in the management of for recreation and cultural resources.

NEXT STEPS

PC-6.1. Invest in robust outreach efforts and corroborate partnerships with non-governmental organizations to make outdoor recreation more accessible to underrepresented youth, low income communities, and communities of color and to ensure that park facilities, amenities, and programming serve the needs of a broader base of park visitors.

PC-6.2. Provide mentorship, internship, and apprenticeship opportunities for youth, students, and young adults interested in climate change and land management.

PC-6.3. Continue to develop public education and interpretation materials that support increased public understanding of climate change at State Parks, Conservancies, and other public lands through web-based resources, interpretive services, and natural classrooms.

PC-6.4. Collaborate with existing youth programs, schools, and community colleges to provide youth and young adults with place-based education on climate change.

PC-6.5. Create citizen and community science projects that engage the public in collecting monitoring of climate change conditions.

PC-6.6. Ensure pathways exist for interested volunteers to engage in environmental restoration efforts.

24 "A New Vision for California State Parks: Recommendations of the Parks Forward Initiative" Parks Forward Initiative. 2015. http://www.parksforward.com/.

PC-6.7. Identify landscape and ecosystem-level conservation goals that extend beyond individual parks with landowners including National Forests, State Parks, Conservancies, State Lands Commission, California Native American Tribes, local governments, and private landowners.

PC-6.8. Create state agency guidance for engaging communities in park planning and resource management and maintenance through outreach, information exchange, and feedback and consultation.

PC-6.9. Actively engage California's outdoor recreation industry and stakeholders in restoration, stewardship, education and outreach efforts.

ONGOING ACTIONS

- The Baldwin Hills Greenhouse Internship Program, a partnership between Los Angeles Audubon, the Baldwin Hills Conservancy, and other nonprofits engages Dorsey High School students in scientific research at Baldwin Hills Scenic Overlook State Park. This program pays and trains youth from the highly impacted inner-city schools to serve as researchers and hands-on habitat restorers.
- The Los Cerritos Wetlands Authority has an on-going Stewardship Program that takes place at the wetlands in Long Beach and Seal Beach, in partnership with several partners including the Rivers and Mountains Conservancy and Coastal Conservancy to incorporate partners that have mutually beneficial interests toward the goals of valuing, learning, restoring and education about Los Cerritos.
- California State Parks provides mentorship through Youth Programs such as Junior Rangers. State California Parks also provide opportunities for students to work side by side with managers through work experience with The California Conservation Corps and internships with the American Conservation Experience.
- California State Parks is beginning to manage natural and cultural resources as geographically larger interconnected landscapes. The landscape approach to management considers the varied interaction of people and nature to understand historic land use and adaptation, to inform land managers about future human behavior.
- The California Coastal Commission's Public Education Department supports outreach to communities on coastal management issues like climate change in a number of ways, including through student field trips, restoration and coastal cleanup events, resources and curriculum for educators, funding through the Whale Tail Grant Program, and the annual Coastal Clean Up Day event.
- The Explore the Coast grants fund programs to enable and encourage all Californians to visit and enjoy the coast. The Coastal Conservancy has awarded more than 150 of these grants that fund buses to bring central valley school children on coastal field trips, camping trips for foster children and many other programs. These programs include support for tribal organizations to educate youth about ancestral territory, traditional ecological knowledge and cultural identity.
- California State Parks partners with local and statewide organizations to better engage with diverse populations throughout the state.

Tracking Progress

The hundreds of next steps identified across dozens of high-level policy recommendations in 11 different sectors in this plan show California's commitment to preparing for ongoing and inevitable climate impacts. With hundreds of additional ongoing actions, the sheer breadth and complexity of state climate change adaptation activity can make it difficult to develop a clear understanding of the State's achievements and opportunities for further action.

While this 2018 update is built on the foundation of the *2009 California Climate Adaptation Strategy, 2014 Safeguarding California: Reducing Climate Risk* plan, and 2016 *Safeguarding California: Implementation Action Plans*, there is a clear need to transparently track the State's progress in implementing adaptation actions. By institutionalizing comprehensive reporting and update processes, the State can better ensure continuity and accountability of existing efforts.

In accordance with Assembly Bill 1482 (Gordon), the Natural Resources Agency will report annually to the Legislature on actions taken to implement the plan. Each report should include, at minimum:

- A status update on each next step identified in this 2018 update by the appropriate agency or agencies, and
- A description of any next steps or commitments not detailed in this update included with status updates under the most appropriate recommendation.

Before release of the 2018 report on the implementation of the 2018 Update to the Safeguarding California Plan, the Natural Resources Agency will conduct an analysis of all the actions identified in the 2009, 2014, and 2016 adaptation plans to document all pending and completed actions. While these documents were consulted as references and sources for this update, it will be important to show the State's progress, as well as extant opportunities and needs, ten years after California's first executive order on climate change adaptation.

Successfully adapting to climate change in California will require a steady commitment to actionable research, far-sighted reform, and increasing collaboration and grassroots action. Accountability and transparency will serve as an important part of the broader effort needed to scale up statewide comprehensive responses to growing climate change impacts.

Successfully adapting to climate change in California will require a steady commitment to actionable research, far-sighted reform, and increasing collaboration and grassroots action. State government is only part of the solution to facing the threats from a changing climate. Accountability and transparency will serve as an important part of the broader effort needed to scale up statewide comprehensive responses to growing climate change impacts.

This 2018 Update to the Safeguarding California Plan demonstrates the continued importance of incorporating consideration of climate change impacts in all policy discussions. As scientific understanding, local and regional coordination, and comprehensive strategies continue to develop, the Safeguarding California Plan will also evolve and develop new ways to measure adaptation progress. Moving forward, metrics tracking climate impacts and relevant government responses can enhance understanding of vulnerability and how to increase resilience throughout the

state. The Metrics Appendix in this 2018 update includes conceptual proposals for metrics that monitor climate impacts and the scale of state agency actions addressing those impacts.

We will be adapting to climate change for centuries.The 2018 Update to the Safeguarding California Plan provides a durable framework for organizing state agency actions to adapt to climate change, and perhaps more importantly provides a replicable base for the State to report on its actions taken. As state agencies and their partners continue to adapt existing practices, undertake new responses, and scale up their actions to make California resilient to climate change, it will be crucial that their progress is transparent and accountable.

Looking Forward

As a conclusion, the 2018 Update to the Safeguarding California Plan looks ahead to the critical progress on climate adaptation that the Brown administration will continue to make in 2018.[2]

2018

January

Sea-Level Rise Guidance Document Update: The Ocean Protection Council is providing a new document based on the best available science to address the needs of state agencies and local governments as they address sea-level rise.

August

Fourth Climate Change Assessment: As the first interagency initiative to implement California's Climate Change Research Plan, this body of research is designed to directly inform adaptation action. Using a common foundation of climate scenarios, 32 State-funded projects and 21 externally-funded projects will provide a wealth of cutting-edge information on the ways state government and others should address climate impacts. To help synthesize the foundational data and bounty of knowledge produced for the assessment, the State is working with leading climate scientists to produce nine regional reports, several topic-specific reports, and a statewide synthesis that will help communicate the new findings and other best available science.

Using a common foundation of climate scenarios, 32 State-funded projects and 21 externally-funded projects will provide a wealth of cutting-edge information on the ways state government and others should address climate impacts.

Climate-Safe Infrastructure Recommendations: Leading climate experts and engineers will make recommendations on how to safeguarding California from climate change through integrating climate science in infrastructure design as part of the Natural Resources Agency's Climate-Safe Infrastructure Working Group.

Tracking Progress on Safeguarding California: As required by AB 1482, the Natural Resources Agency will work with its many sister agencies to report on the progress made on the hundreds of next steps identified in the 2018 Update to the Safeguarding California Plan. As part of the effort to communicate the strides made in making California resilient to climate change, the Natural Resources Agency will analyze actions from the 2009, 2014, and 2016 strategies as part of this report.

California Adaptation Forum: The third statewide forum will convene hundreds of local, regional, and state leaders who are committed to addressing California's adaptation needs.

September

Global Climate Action Summit: Governor Jerry Brown is convening a summit that will demonstrate the groundswell of innovative, ambitious climate action from leaders around the world — and will highlight the economic and environmental transition already underway. In doing so, the Summit will encourage progress at a critical moment that will take place at the 2018 United Nations Climate Change Conference.

2 This timeline is also found on page 20 as part of the larger timeline of California's climate adaptation highlights.

Safeguarding California Plan: 2018 Update Appendices

APPENDIX A:
Acronyms

APPENDIX B:
Glossary of Terms

APPENDIX C:
Principles and Recommendations in the Safeguarding California Plan

APPENDIX D:
California's Fourth Climate Change Assessment Research Supporting the Safeguarding California Plan

APPENDIX E:
Metrics for Changing Climate Conditions and Resilience Outcomes

Appendix A: Acronyms

AB	State Assembly Bill
ARCCA	The Alliance of Regional Collaboratives for Climate Adaptation
BCDC	Bay Conservation and Development Commission
Cal-Adapt	Cal-Adapt.org online platform
CalBRACE	CDPH's California Building Resilience Against Climate Effects Project
CalEPA	California Environmental Protection Agency
CA/FACE	CDPH's California Fatality Assessment Control & Evaluation
CAL FIRE	California Department of Forestry and Fire Protection
Cal OES	Governor's Office of Emergency Services
Cal/OSHA	California Division of Occupational Safety and Health
CalRecycle	Department of Resources, Recycling, and Recovery
CalSTA	California State Transportation Agency
Caltrans	State Department of Transportation
CAPP	Conceptual Area Protection Plans
CARE	California Alternative Rates for Energy
CCC	California Coastal Commission
CDFA	California Department of Food and Agriculture
CDFW	California Department of Fish and Wildlife
CDPH	California Department of Public Health
CEC	California Energy Commission
CNRA	California Natural Resources Agency
CosMoS	Coastal Storm Modeling System
CPUC	California Public Utilities Commission
CSD	California Department of Community Services and Development
DPR	Department of Pesticide Regulation
DWR	Department of Water Resources
EPA	US Environmental Protection Agency
EPIC	Electric Program Investment Charge
EV	Electric vehicle
GHG	Greenhouse gas
HCP	Habitat Conservation Plan
HCD	Department of Housing and Community Development

HiAP	Health in All Policies Task Force
HSR	High-Speed Rail Authority
ICARP	Integrated Climate Adaptation and Resiliency Program
IPCC	United Nation's Intergovernmental Panel on Climate Change
ITHIM	Integrated Transportation and Health Impacts Model
IVAN	Identifying Violations Affecting Neighborhoods
LCP	Local Coastal Program
Low-Income Barriers Study	Low-Income Barriers Study, Part A: Overcoming Barriers to Energy Efficiency and Renewables for Low-Income Customers & Small Business Contracting Opportunities in Disadvantaged Communities
LIWP	Low-Income Weatherization Program
MPA	Marine Protected Areas
NCCP	Natural Community Conservation Plan
NOAA	National Oceanic and Atmospheric Administration
OAFN	Cal OES's Office of Access and Functional Needs
OEHHA	Office of Environmental Health Hazard Assessment
OHB	California Department of Public Health Occupational Health Branch
OPC	Ocean Protection Council
OPR	Governor's Office of Planning and Research
OSHPD	Office of Statewide Health Planning and Development
SB	State Senate Bill
SCC	State Coastal Conservancy
SGC	Strategic Growth Council
SGMA	Sustainable Groundwater Management Act
SLC	State Lands Commission
SLR	Sea-level rise
SWEEP	State Water Efficiency and Enhancement Program
USDA	United States Department of Agriculture
USDA Forest Service	US Department of Agriculture Forest Service
Water Board	State Water Resources Control Board
ZEV	Zero-emission vehicle

Appendix B: Glossary of Terms

ADAPTATION (CLIMATE CHANGE)

Adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.[1]

ADAPTIVE MANAGEMENT

A process of iteratively planning, implementing, and modifying strategies for managing resources in the face of uncertainty and change. Adaptive management involves adjusting approaches in response to observations of their effect and changes in the system brought on by resulting feedback effects and other variables.[2]

CLIMATE CHANGE

Climate change refers to a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use.[3]

CLIMATE SCENARIOS

A plausible and often simplified representation of the future climate, based on an internally consistent set of climatological relationships that has been constructed for explicit use in investigating the potential consequences of anthropogenic climate change, often serving as input to impact models. Climate projections often serve as the raw material for constructing climate scenarios, but climate scenarios usually require additional information such as the observed current climate.[4]

COMMUNITY-BASED ORGANIZATION

A community-based organization is a group of individuals organized by and for a particular community of people based on shared interests and/or attributes. The community could be defined geographically (e.g. a neighborhood), could contain members from diverse backgrounds, and/or could be defined on the basis of something like religious beliefs or a shared condition. Members may include various stakeholders, such as the public, elected officials, advocacy groups, and business leaders.[5]

1 United States Environmental Protection Agency. 2013. http://www.epa.gov/statelocalclimate/index.html.

2 IPCC, 2014: Annex II: Glossary. In: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change IPCC, Geneva, Switzerland. 117-130.

3 IPCC, 2014: Annex II: Glossary. In: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change IPCC, Geneva, Switzerland. 117-130.

4 IPCC, 2014: Annex II: Glossary. In: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change IPCC, Geneva, Switzerland. 117-130.

5 United States Department of Transportation. "Public Involvement Techniques." The Transportation Planning Capacity Building Program.

Appendix B
GLOSSARY OF TERMS

COMMUNITY RESILIENCE

Community resilience is the ability of communities to withstand, recover, and learn from past disasters, and to learn from past disasters to strengthen future response and recovery efforts. This can include but is not limited to physical and psychological health of the population, social and economic equity and well-being of the community, effective risk communication, integration of organizations (governmental and nongovernmental) in planning, response, and recovery, and social connectedness for resource exchange, cohesion, response, and recovery.[6]

DISADVANTAGED COMMUNITIES

Areas disproportionately affected by environmental pollution and other hazards that can lead to negative public health effects, exposure, or environmental degradation, or with concentrations of people that are of low income, high unemployment, low levels of homeownership, high rent burden, sensitive populations, or low levels of educational attainment.[7]

ENVIRONMENTAL JUSTICE

The fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation and enforcement of environmental laws, regulations, and policies.[8]

EQUITY

Equity is just and fair inclusion into a society in which all can participate, prosper, and reach their full potential.[9]

EQUITY (CLIMATE)

The central equity challenges for climate change policy involve several core issues: addressing the impacts of climate change, which are felt unequally; identifying who is responsible for causing climate change and for actions to limit its effects; and understanding the ways in which climate policy intersects with other dimensions of human development, both globally and domestically.[10]

EXTREME (CLIMATE) EVENTS

The occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable[11]

FRONTLINE COMMUNITIES

These communities experience the impacts of issues such as environmental pollution, climate change, and the economic crisis first and most severely. These communities are most often communities of color and low income.[12]

6 Los Angeles County Community Disaster Resilience. http://www.laresilience.org/.

7 California Health and Safety Code Section 39711

8 California Government Code §65040.12[e]

9 PolicyLink. http://www.policylink.org/about/equity-manifesto.

10 World Resources Institute, 2014.

11 IPCC, 2012: Glossary of terms. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA. 555-564.

12 Zimmerman, Kristen. "Dare to Change: Environmental Justice Leadership for Climate Justice, Sustainable Communities and a Deep Green Economy." Movement Strategy Center, 2010. http://movementstrategy.org/b/wp-content/uploads/2015/08/MSC-Dare_To_Change.pdf

MITIGATION (CLIMATE CHANGE)

A human intervention to reduce the human impact on the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks.[13]

MITIGATION (OF DISASTER RISK AND DISASTER)

The lessening of the potential adverse impacts of physical hazards (including those that are human-induced) through actions that reduce hazard, exposure, and vulnerability.[14]

NATURAL AND GREEN INFRASTRUCTURE

The preservation or restoration of ecological systems, or utilization of engineered systems that use ecological processes, to increase resiliency to climate change, manage other environmental hazards, or both. This may include, but is not limited to, floodplain and wetlands restoration or preservation, combining levees with restored natural systems to reduce flood risk, and urban tree planting to mitigate high heat days.[15]

RESILIENCE (CLIMATE)

"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."[16]

SEA LEVEL RISE

The worldwide average rise in mean sea level; may be due to a number of different causes, such as the thermal expansion of sea water and the addition of water to the oceans from the melting of glaciers, ice caps, and ice sheets; contrast with relative sea-level rise.[17]

URBAN HEAT ISLAND

The relative warmth of a city compared with surrounding rural areas, associated with changes in runoff, effects on heat retention, and changes in surface albedo.[18]

VULNERABLE POPULATIONS

Vulnerable populations include, but are not limited to women; racial or ethnic groups; low-income individuals and families; individuals who are incarcerated or have been incarcerated; individuals with disabilities; individuals with mental health conditions; children; youth and young adults; seniors; immigrants and refugees; individuals who are limited English proficient (LEP); and Lesbian, Gay, Bisexual, Transgender, Queer, and Questioning (LGBTQQ) communities, or combinations of these populations.[19]

13 United States Environmental Protection Agency. 2013.

14 IPCC, 2014: Annex II: Glossary. In: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change IPCC, Geneva, Switzerland. 117-130.

15 California Government Code 65302

16 Rodin, Judith. Natural Disaster Resilience Competition Summit. 2014.

17 United States Environmental Protection Agency. 2013.

18 IPCC, 2014: Annex II: Glossary. In: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change IPCC, Geneva, Switzerland. 117-130.

19 California Health and Safety Code Section 131019.5

Appendix C: Principles and Recommendations in the Safeguarding California Plan

PRINCIPLES TO SAFEGUARD CALIFORNIA

Principle 1: Consider climate change in all functions of government.

Principle 2: Partner with California's most vulnerable populations to increase equity and resilience through investments, planning, research, and education.

Principle 3: Support continued climate research and data tools.

Principle 4: Identify significant and sustainable funding sources to reduce climate risks, harm to people, and disaster spending.

Principle 5: Prioritize natural infrastructure solutions build climate preparedness, reduce greenhouse gas emissions, and produce other multiple benefits.

Principle 6: Promote collaborative adaptation processes with federal, local and regional government partners.

Principle 7: Increase investment in climate change vulnerability assessments of critical built infrastructure systems.

CLIMATE JUSTICE PRINCIPLES FOR SAFEGUARDING CALIFORNIA

Principle 1: Actively engage, educate, and partner with communities to enable early, continuous, and meaningful participation in adaptation initiatives.

Principle 2: Identify the most vulnerable communities to climate change to prioritize initiatives and build grassroots capacity.

Principle 3: Support and coordinate adaptation efforts across jurisdictions and policy areas to maximize community resilience.

Principle 4: Promote holistic approaches to climate adaptation that maximize co-benefits and economic development.

Principle 5: Make equity an integral consideration for climate research.

EMERGENCY MANAGEMENT

Recommendation EM-1: Employ research and deploy tools and data to demonstrate how climate change will affect all phases of emergency management and identify how climate change exacerbates factors and existing conditions that impact emergencies and disasters.

Recommendation EM-2: Enhance preparedness and coordination to address climate change impacts and inform emergency management policy.

Recommendation EM-3: Incorporate climate considerations into emergency planning efforts at all levels.

Recommendation EM-4: Identify access and functional needs communities exposed to greater risks from climate impacts and work collaboratively to build community resilience.

Appendix C

PPRINCIPLES AND RECOMMENDATIONS

ENERGY

Recommendation E-1: Continue to support climate research for the energy sector to better inform climate adaptation and mitigation strategies.

Recommendation E-2: Use common climate scenarios in all energy research and planning, and work to help standardize climate scenarios across state government planning and investment.

Recommendation E-3: Continue incorporating implications of climate change into all energy sector planning and decision-making.

Recommendation E-4: Support local adaptation planning efforts and increase outreach about available analytical tools.

Recommendation E-5: Investigate means to provide long-term support for Cal-Adapt advancement, maintenance, and expansion.

Recommendation E-6: Increase climate resiliency in low-income and disadvantaged communities.

LAND USE AND COMMUNITY DEVELOPMENT

Recommendation L-1: Develop innovative governance models and equitable public engagement strategies to engage residents, especially vulnerable and disadvantaged communities, to be sustainable and resilient.

Recommendation L-2: Provide technical support, guidance, and capacity building to implement climate adaptation initiatives in local, regional, tribal, and state government and communities.

Recommendation L-3: Coordinate state laws, regulations, guidelines and policies to promote climate resilience and hazard avoidance and mitigation through local, regional and state planning.

Recommendation L-4: Integrate economic development initiatives with programs designed to bolster resilience.

Recommendation L-5: Ensure a coordinated and robust strategy is implemented across state, regional, local, and tribal governments to the state's most vulnerable populations and disadvantaged communities.

Recommendation L-6: Provide financial assistance to promote investment in climate adaptation through land use and community development.

PUBLIC HEALTH

Recommendation P-1: Promote community resilience and health equity by improving underlying economic, environmental, social, and living conditions.

Recommendation P-2: Educate, empower, and engage Californians to reduce vulnerability to climate changes through mitigation and adaptation.

Recommendation P-3: Promote mitigation and adaptation strategies with public health and equity benefits, and assure they do not have unintended consequences for health equity.

Recommendation P-4: Establish, improve, and maintain robust surveillance mechanisms.

Recommendation P-5: Improve public health preparedness and emergency response.

Recommendation P-6: Collaborate with multiple agencies and organizations at local, state, and federal levels.

Recommendation P-7: Identify and assess impacts, conduct research, and use the best available data to inform policies and programs that protect health and equity.

TRANSPORTATION

Recommendation T-1: Understand climate trends that impact transportation.

Recommendation T-2: Complete analysis of vulnerability assessments and prepare adaptation plans to address identified vulnerabilities.

Recommendation T-3: Inform the transportation decision-making processes.

Recommendation T-4: Improve transportation system resiliency.

Recommendation T-5: Maintain and enhance information sharing and education.

AGRICULTURE

Recommendation A-1: Advance water management and energy efficiency in agricultural operations.

Recommendation A-2: Build soil organic matter on farms and ranches to achieve multiple benefits.

Recommendation A-3: Support dairies in climate smart management practices.

Recommendation A-4: Increase farmland conservation.

Recommendation A-5: Grow the Climate Smart Agriculture outreach platform.

BIODIVERSITY

Recommendation B-1: Strengthen the climate adaptation component of conservation planning efforts at multiple scales.

Recommendation B-2: Enhance habitat connectivity and protect climate refugia through strategic acquisition and protection activities.

Recommendation B-3: Increase restoration and enhancement activities to increase climate resiliency of natural and working lands.

Recommendation B-4: Increase biodiversity monitoring efforts to better understand baseline conditions and make possible the early detection of climate impacts.

Recommendation B-5: Continue incorporating climate considerations into state investment decision processes related to fish and wildlife conservation.

Recommendation B-6: Provide educational opportunities to the public and state agency staff regarding climate impacts and adaptation options for ecosystems, fish, wildlife, and plants.

Appendix C

PRINCIPLES AND RECOMMENDATIONS

FORESTS

Recommendation F-1: Restore fire as a core ecological process, complemented by fuels reduction, working forests, and thinning to enhance forest health, resilience, and long-term carbon stability.

Recommendation F-2: Increase reforestation efforts on wildfire and pest-impacted areas and protect forested lands from conversion to non-forest uses.

Recommendation F-3: Manage forests to support statewide water infrastructure and to protect forested source watersheds.

Recommendation F-4: Elevate biodiversity considerations in forest restoration and conservation planning efforts.

Recommendation F-5: Continue investing in urban forestry to enhance the health of current urban forests and expand urban tree canopy statewide.

Recommendation F-6: Promote wood products markets, particularly innovative utilization of thinned material and other biomass, to support forest-dependent economies and ongoing forest management activities.

Recommendation F-7: Foster fire-adapted communities through local planning and fire preparedness.

Recommendation F-8: Ensure that forest monitoring and applied research activities match decision-making needs.

OCEANS AND COASTS

Recommendation O-1: Support planning and adaptation to reduce hazards and to increase the resilience of coastal communities, infrastructure, development, and other resources.

Recommendation O-2: Design and implement nature-based projects to protect and enhance the adaptive capacity of coastal and marine ecosystems, including beaches and wetlands.

Recommendation O-3: Develop actionable science that reflects the latest and evolving trends over a range of spatial and temporal scales.

Recommendation O-4: Continue to assess community and ecosystem vulnerability to climate impacts.

Recommendation O-5: Provide pathways for meaningful community engagement (such as education and outreach) in coastal decision-making processes.

Recommendation O-6: Coordinate across agencies and external partners to ensure efficient problem solving and widely communicate resources for ocean and coastal adaptation strategies.

WATER

Recommendation W-1: Vigorously prepare California for flooding.

Recommendation W-2: Support regional groundwater management for drought resiliency.

Recommendation W-3: Diversify local supplies and increase water conservation and use efficiency.

Recommendation W-4: Reduce Sacramento-San Joaquin Delta climate change vulnerability.

Recommendation W-5: Prepare California for hotter and drier conditions and improve water storage capacity.

Recommendation W-6: Address water-related impacts of climate change on vulnerable and disadvantaged populations and cultural resources.

Recommendation W-7: Continue to mainstream climate considerations into water management through improved understanding of climate risks and tool development.

Recommendation W-8: Utilize low-impact development and other methods in state and regional storm water permits to restore the natural hydrograph.

Recommendation W-9: Require closer collaboration and coordination of land use and water planning activities to ensure that each reinforces sustainable development that is resilient to climate changes.

Recommendation W-10: Protect and restore water resources for important ecosystems.

PARKS, RECREATION, AND CALIFORNIA CULTURE

Recommendation PC-1: Augment public access to the coast and coastal recreation while protecting beaches and coastal areas consistent with resource conservation priorities.

Recommendation PC-2: Increase and improve access to climate-resilient recreation opportunities in inland, mountain, and freshwater regions.

Recommendation PC-3: Maximize opportunities to connect urban populations to natural spaces through urban parks, wetlands, and river parkways.

Recommendation PC-4: Understand the scope of climate change impacts to cultural resources and integrate climate change into the management of cultural resources.

Recommendation PC-5: Incorporate climate change in all California State Park and conservancy planning and decision-making.

Recommendation PC-6: Engage the public and foster ongoing and diverse partnerships to create a shared commitment to stewardship and to harness complementary skills, capacities, and support.

Appendix D: California's Fourth Climate Change Assessment Research Supporting the Safeguarding California Plan

The following fifty-seven high-level initiatives constitute a comprehensive and interconnected policy framework to make California's natural resources more resilient and to represent a broad and interlinked strategy to protect California's people and infrastructure from climate change. The State's investments in research through the Fourth Climate Change Assessment are designed to directly inform this comprehensive adaptation approach. This table shows how these ongoing research projects link to the existing adaptation framework while spurring new action to safeguard California.

PROJECT TITLE	INFORMING RECOMMENDED ACTIONS
Addressing Institutional Vulnerabilities to Climate Change: Drought as Stress Test for Water Allocation and Environmental Protection	B-5, F-5, O-2, W-2, W-5
Advancing Hydro-Economic Optimization to Identify Vulnerabilities, Tradeoffs, and Adaptation Opportunities in California's Water System	W-2, W-5, W-7
Assessing and Communicating the Impacts of Climate Change on the California Coast	EM-1, E-3, L-1, L-3, P-2, T-1, T-2, O-4, O-5
Assessing Vulnerability and Improving Resilience of Critical Emergency Management Infrastructure in California in a Changing Climate	EM-1, EM-3, L-2, P-3, P-5, T-2, O-2, O-4, O-5, W-1
California Mussels as Bio-Indicators of the Ecological Consequences of Global Change: Temperature, Ocean Acidification, and Hypoxia	B-4, B-5, O-1, O-2, O-3
Climate Change in Los Angeles County: Grid Vulnerability to Extreme Heat	EM-3, E-1, E-2, E-3, E-4, L-2, P-1, P- 3, T-2
Climate Scenario Development, Weather Forecasting, and Probabilistic Modeling for the Natural Gas and Electricity Sectors	EM-1, EM-3, E-1, E-2, E-3
Distributed Evaluation and Assessment Program for California's Transportation Fuel Sector: Identifying Strategies for Reducing Vulnerability to Improve Resilience for Extreme Weather	EM-1, E-1, E-2, E-3, T-2, T-3, T-4
Drought Planning and Climate Adaptation of Small Self-Sufficient Water Utilities	EM-1, EM-4, L-2, L-5, P-1, P-3, A-2, W-2, W-3, W-5, W-6, W-7, W-9
Economic and Environmental Implications of California Crop and Livestock Adaptations to Climate Change and Climate Policy	A-3, A-4, A-5
Fuel Treatment for Forest Resilience and Climate Mitigation: Critical Review	B-3, B-4, F-1, F-4, F-5, F-6
High Resolution Measurement of Levee Subsidence Related to Natural Gas Infrastructure in the Sacramento-San Joaquin Delta	W-1, W-4
Identification of Natural Infrastructure Options for Adapting to Sea Level Rise	B-3, B-5, O-1, O-2
Improving Hydrological Snowpack Forecasting for Hydropower Generation Using Intelligent Information	E-1, E-2, E-3, W-7
Increasing Soil Organic Carbon to Mitigate Greenhouse Gases and Increase Climate Resiliency for California	A-1
Innovations in Measuring and Managing Forest Carbon Stocks in California	F-1, F-5, F-6, F-7
Investigations on the Climate Vulnerability and Identification of Resilience Options for Regional Natural Gas and Electricity Systems	E-1, E-2, E-3
Investigations on the Impacts and Adaptation Options for Regional Electricity and Natural Gas Systems from Sea Level Rise	O-1, O-2, O-5

Migration Corridors as Adaptation to Climate Change: Why, How, and What Next	B-1, B-2, F-5
Modeling the Impact of Wildfires on California's Transmission and Distribution Grid	EM-1, E-1, E-2, E-3, F-6
Monitoring the Urban Heat Island Effect and the Efficacy of Future Countermeasures	EM-3, E-1, E-2, E-3, L-2, P-3, P-7, P-8, F-3
Overcoming Financial and Institutional Barriers to Implementing Local Government Adaptation Strategies	EM-4, E-4, L-1, L-2, L-3
Preparing Public Health Officials for Climate Change: A Decision Support Tool	EM-4, E-4, L-2, L-5, P-1, P-3, P- 4, P-7
Risk Modeling and Cognitive Science Characterization of Barriers to Climate Change Adaptation in California's Power Sector	EM-1, E-1, E-2, E-3, E-4
Soil Water Dynamics, Carbon Sequestration, and Greenhouse Gas Mitigation Potential of Using Composted Manure and Food Waste on California's Rangelands	A-1, A-3, W-9
The Adaption Blind Spot-Electrical Grid Teleconnected and Cascading Climate Change Impacts on Community Lifelines in Los Angeles	EM-1, EM-3, E-1, E-2, E-3, E-4, L-2, P-1, P-3, P-5, T-2
The Impact of Changing Wildfire Risk on the California Homeowners' Insurance Market	P-1, F-1, F-6, F-7
Visualizing Climate-Related Risks to the Electricity System Using Cal-Adapt	EM-1, E-1, E-2, E-3, E-5, L-2, P-1, P-3, P-7, T-3, T-5

Appendix E: Metrics for Changing Climate Conditions and Resilience Outcomes

Changing climate conditions necessitate an adaptive management approach. An adaptive management approach is informed by tracking changing climate conditions and the performance of a plan or project. Building check points into a project or plan timeline can help to create a system for regular review and, if needed, adjustments.

Developing a robust set of metrics to track progress and identifying points – either in process, design, or operation – where adjustments can be made is a key part of an adaptive management approach. Ongoing and inevitable climate impacts require changing processes that have been static, and state agencies need to develop metrics, report regularly on changing conditions and state performance, and incorporate lessons learned for more effective interventions.

Metrics should be developed from the outset of the project or plan, and should capture the performance outcomes, changing climate conditions, and overall climate awareness of programs and policies implemented by state agencies. Regular reporting is a key component for ensuring transparency and accountability in state operations and establishing trust in the efficacy and effect of climate adaptation initiatives.

Metrics should be developed to track progress in the following areas:

1. **Changing Climate Conditions:** Once key risks are identified, metrics should be identified to track the progress and occurrence of change.
2. **Resilience Outcomes:** Metrics should be developed that track the performance of a plan or investment, both in terms of resilience to climate change and in meeting management objectives. Metrics should track proactive action taken by the state to enhance resilience.

This appendix presents conceptual metrics for review and comment. These metrics measuring the changing climate and resilience may serve as the foundation for efforts to integrate more comprehensive tracking and evaluation in future updates to the Safeguarding California Plan.

Appendix E

METRICS FOR CHANGING CLIMATE CONDITIONS

CHANGING CLIMATE CONDITIONS METRICS

CLIMATE IMPACT METRIC	CONTEXT AND RATIONALE
2016 Estimated Average State and Local Disaster Recovery Costs per Fire Management Assistant Grant (FMAG) Declared Wildfire	The extreme and unpredictable wildfire behavior challenges the State's ability to quickly mobilize sufficient resources and personnel in wildfire emergencies, thus increasing the cost of these disasters and demonstrating the immense financial burden climate change has on the State's response efforts. These are response costs to FMAG declared only fires; there were an additional 5,687 fires in 2016.
Number of Critical Infrastructure Interruption Scenarios	Climate change continues to increase the likelihood of extreme heat events as well as drought, which could lead to or exacerbate utility and other disruptions to lifeline systems. Interruptions to critical infrastructure, such as the energy, dams, and agriculture sectors, threaten lives and water, food, and health security for California constituents; particularly among access and functional needs populations who are disproportionately impacted during interruptions.
Increase in Cooling Degree Days (CDD) since 1950	Energy demand for space cooling is approximately proportional to CDD. Since 1950 CDD has increased by about 49% with sharper increases in 2014 and 2015 (see Figure 1).
Decline in Heating Degree Days (HDD) since 1950	Energy demand for space heating on cold days is approximately proportional to HDD. Since 1950 HDD has decreased by about 19% with sharper decreases in 2014 and 2015.
Trend of significant weather-related energy disturbances	Climate change is projected to increase extreme weather events, which may lead to increased significant weather-related energy disturbances. This metric can indicate whether climate change is impacting the reliability of the state's energy system, and indicate needed responses.
Trend of hydropower generation in the summer months	Climate change is expected to reduce hydropower generation in the summer months. There is a downward trend since the early 2000s driven mainly by reductions in wintertime precipitation. Hydropower can ramp up and down to help balance the grid and it is an important low cost source of electricity in the summer.
Average annual extreme heat Land Surface Temperature (LST) difference between urban and rural areas	The urban heat island effect leaves our urban communities more vulnerable to the compounding negative health impacts and system disruptions caused by higher temperatures, when compared to more rural communities. The concentration of heat in urban areas, caused by a "combination of heat-absorptive surfaces (such as dark pavement and roofing), heat-generating activities (such as engines and generators), and the absence of vegetation (which provides evaporative cooling)", exacerbates existing disparities, especially for disadvantaged communities. While this metric does not provide a disaggregated assessment of vulnerability within urban communities, it demonstrates how urban land use, transportation, and design decisions can either mitigate or exacerbate the risks that increased temperatures pose. The State should continue to incentivize and invest in land use and infrastructure strategies that reduce the urban heat island effect and minimize, to the extent feasible, the difference in Land Surface Temperature between urban and rural areas.
Number of residents who are members of vulnerable populations in hazard areas	This metric may be able to capture whether expanding hazard areas due to climate change are disproportionately impacting vulnerable populations and inform State responses. We know climate change will exacerbate existing environmental hazards for the most vulnerable in society, so spatially tracking the expansion of risk and vulnerability will be important.
Households in "at-risk" toxic site exposure areas	Climate change increases the risk of disruption and damage to critical infrastructure across the state, including toxic sites. For example, toxic sites along the California coast are at increased risk of flooding and inundation due to sea level rise. Further, communities living in proximity to these sites face an increased threat of exposure to toxic substances.
Heat deaths, hospitalizations, and emergency room visits	This metric is aimed at evaluating the effects of increasing temperatures across the state. As hot days hot nights and heatwaves have become more frequent the emergence or increase in heat-related deaths, hospitalizations or emergency room visits could be an indicator to communities that are vulnerable to heat-exposure.
Rate of allergic disease-related hospitalizations and emergency room visits	As climate change continues, it is expected that extreme temperature days and weather patterns will increase in occurrence. A changing climate can alter the production, allergenicity, distribution, and seasonal timing of aeroallergen. High pollen concentrations and longer pollen seasons can increase allergic disease burden.
Rate of asthma diagnoses and emergency room visits	This health outcome metric can be used to document and evaluate the contribution of environmental hazards on asthma emergency room visits. Subsequently, this information could be used to design, implement, and/or evaluate new interventions. Changes in climate, particularly extreme heat events, interact with air quality, which can increase vulnerability to poor air quality and allergens that have negative impacts on asthma.

Appendix E

METRICS FOR CHANGING CLIMATE CONDITIONS

CLIMATE IMPACT METRIC	CONTEXT AND RATIONALE
Human cases of reportable vector-borne diseases	Changes in temperature, precipitation, and humidity can greatly impact the transmission of vector-borne diseases (i.e. Lyme disease, West Nile Disease, Zika), with relation to disease incidence and vector range. Collecting information on vector-borne diseases will allow for detection of changes that may be related to climate change.
Days with unhealthy air quality across state as aggregate or in an indicator area	As climate change continues, it is expected that air quality is to worsen. Air quality provides information on the concentrations of pollutants in the outdoor air. Health effects from unhealthy air quality can include respiratory disease, cancer, heart disease, and stroke.
Disaster funds disbursed to fix transportation assets after climate events (flood, wildfire, landslide)	This metric shows the cost of protecting state highway infrastructure. Historic climate related impacts have already cost the state millions of dollars, and this amount will grow as climate change accelerates, further stressing transportation assets and the system at large. Early adaptation measures could save the state a significant amount of money.
Miles of transportation network impacted by wildfire	Under future climate projections, drought and higher temperatures are projected, which will exacerbate wildfire conditions. Wildfires not only have the potential to damage roadway infrastructure but also threaten homes, businesses, and human life. This metric, when analyzed over time, will assist transportation agencies in understanding the speed and extent of increase in impacts from climate change.
Miles of transportation network impacted by coastal and/or inland flooding	Transportation assets are vulnerable to the impacts of sea level rise – the greatest threat to infrastructure. Coastal and inland flooding pose potentially significant damage to the state transportation system. This metric, when analyzed over time, will assist transportation agencies in understanding the speed and extent of increase in impacts from climate change.
Miles of transportation network impacted by precipitation-induced landslides	This metric, when analyzed over time, will track changes in the most consistent impact to transportation infrastructure. Caltrans has been studying and identifying areas at risk of landslides for years – a major risk that will increase with more intense precipitation events expected under future climate projections.
Snow water content compared to average	This metric is important because California agriculture is reliant on irrigation water. Several metrics of precipitation are relevant to agricultural water supply: reservoir conditions, average regional precipitation, winter snowpack, snow water content and surface water deliveries. Due to uncertainty in models of future California precipitation trends, it is difficult to anticipate how water availability will change by 2050. Many models agree the drought is likely to be more common and more severe.
Drought-related idled land	This metric is important because drought-related idled land represents a manifestation of agricultural vulnerability to climate change (as well as other stressors such as changes in markets, regulations, and input costs). The Center for Watershed Science at the University of California assessed the economic impact of the ongoing drought in 2016 on California agriculture. The authors determined that in 2016, 6.6% more land was fallowed due to the drought than would be idle in an average precipitation year. This translates to lost jobs and income.
Cumulative winter chill hours (hours less than 45° F)	This metric is important because certain types of fruit and nut trees are especially impacted by warming winter temperatures. Warm winters can lead to incomplete winter dormancy and sporadic blooms in the spring months. The negative impact of reduced winter chill is projected to grow. By 2050, winter chill hours could be half of observed hours in 1950.
Heat stress impacts to crop and livestock	This metric can track extreme heat events as well as the response of the agricultural sector to extreme heat through producer surveys and annual crop reports. There are many published studies demonstrating the negative consequences of heat stress on livestock, including decreased production, reduced feed efficiency/intake, increased poultry mortality rates, and potentially poor immune function resulting in susceptibility to disease. Livestock producers monitor production and well-being closely and invest in adaption when factors like heat begin to have long term effects. On livestock operations adaption to heat usually involves mitigation via coolers, fans, sprinklers and shade, adjusting water pH, and potentially shifting breeding to include more heat tolerant species.
Species ranges	Individual species, both native and invasive, are expected to move across the landscape in response to changing climatic conditions. Observed changes in where species are found, (e.g. upward in elevation, or northward) can indicate shifts in species distributions associated with climate change. For wildlife, range shift data can also provide insight into the locations of important wildlife corridors needed to maintain connectivity as the climate changes.
Area of plant community types	This metric is aimed at capturing any increases or decreases in the total area of vegetative community types that may be associated with changing climatic conditions. Vegetative communities are often associated with habitat types that support certain species; changes in the underlying vegetation (or other habitat attributes) can have repercussions for the wildlife it supports and ecosystem services that it provides.

Appendix E

METRICS FOR CHANGING CLIMATE CONDITIONS

CLIMATE IMPACT METRIC	CONTEXT AND RATIONALE
Species abundance and diversity	Climate impacts to individual fish, wildlife, and plant species can collectively alter broader natural community structure and composition. Tracking species diversity (number of species and their relative abundance in a given ecosystem) can serve as a measure of changing community dynamics (e.g. native versus non-native species diversity). Presence or relative abundance of plant and animal species in both aquatic and terrestrial environments can be monitored as part of this effort (e.g. key species population levels).
Fish and wildfire mortality events	Climate change will likely have a negative impact on the overall health of some fish and wildlife populations, and could result in increases in mortality events or overall extinction risk for some species. This metric would track mortality events to identify any trends that may be linked to changing environmental conditions or stressors brought about by climate change. This may include mortality events directly tied to climatic factors like heat stress and reduced water availability, or events that are more indirectly tied to climate change, such as the emergence or spread of existing diseases, pathogens and parasites.
Timing of life cycle events (phenology)	Climate change is altering the timing of life cycle events such as migration, leaf emergence, reproduction, pollination of native plants and crops, metamorphosis (i.e. transition from larvae to adult), and hibernation. These events can be tracked for certain species to identify patterns related to changing seasonal climate conditions.
Human-wildlife conflicts	Wildlife that is under stress due to climate change and other factors will search for alternate food, water, and habitat as necessary. This can result in conflicts between humans and wildlife. Monitoring human-wildlife conflict incident data will help us determine whether or not these occurrences are increasing in the face of climate change, and improve our understanding of impacts to the urban-wildlife interface.
Soil burn severity	Fire severity has been increasing beyond the historical norm. Surveyors in the 1800s wrote that large tree death from fire was an uncommon occurrence, and by the 1980s, approximately 20% of fire footprints were severely burned. By the early 2000s, high severity in fires over 500 acres in size increased to almost 30%, and the Rim Fire of 2013 and King Fire of 2014 were almost 40% and 50%, respectively. High severity burn patches were historically small, commonly under 10 acres in size, which allowed living trees on the edges to quickly reseed the burned area, and it created diverse habitat in a small area. In contrast to this healthy functionality, the King Fire had a single high-severity burn patch of over 30,000 acres in size and the Rim Fire had a high-severity burn patch over 50,000 acres.
Deforestation after wildfire	During the last decade, 700,000 of the 2.3 million acres of U.S. Forest Service forested lands affected by wildfire have been classified as deforested. This is equal to a deforestation rate of 30.43% on the lands affected by wildfire.
Deviation of current average fire frequency and severity from past fire regimes	Over the last few decades, wildfires in California's conifer forests have grown bigger and have exhibited larger and larger uniform patches of severe fire.
Trend in acreage of elevated tree mortality	Five consecutive years of severe drought in California, a dramatic rise in bark beetle infestation and warmer temperatures are leading to historic levels of tree die-off. In total, a cumulative number of 102 million trees have died on California's forested lands since 2010. This scale of die-off is unprecedented in California's modern history, and millions more drought-stressed trees that are not yet dead are expected to die in the coming months and years. As stressors like heat, drought, pests, disease, and a rising snowline increase with climate change, California will continue to struggle with massive tree die-offs.
Average observed sea level rise in inches over the past century	Sea levels measured at stations in San Francisco and La Jolla have risen at a rate of 8 and 6 inches over the century, respectively. Sea level rise in California could lead to flooding of low–lying areas, loss of coastal wetlands such as portions of the San Francisco Bay Delta system, erosion of cliffs and beaches, saltwater contamination of drinking water, impacts on roads and bridges and harmful ecological effects along the coastline.
Number of Californians living in flood-prone areas	As of 2013, one in five Californians were exposed to the hazards of flooding in California. This metric captures the number of Californians living in the 500-year floodplain, and includes risks from tsunami flooding, engineered structure failure flooding, and coastal flooding.
Coastal ocean temperature change over the past century	Sea surface temperatures at La Jolla have increased by about 1.8° F over the past century at about twice the global rate. Warmer ocean waters contribute to global sea level rise and extreme weather events, and can impact the marine ecosystem and its populations.

Appendix E

METRICS FOR CHANGING CLIMATE CONDITIONS

CLIMATE IMPACT METRIC	CONTEXT AND RATIONALE
Impact on fisheries of climate-impacted states of emergency	Climate change impacts are predicted to have direct physiological effects on marine fish, impacting species growth, reproductive capacity, and distribution, as well as indirect effects on marine fishery ecosystems, food webs, and habitats. Climate change impacts that will affect marine fisheries and food webs include changes in oceanographic processes which drive nutrient enrichment and primary productivity, changes in ocean temperature, changes in the timing of upwelling, and changes in dissolved oxygen concentrations. The role of direct and indirect climate impacts on marine fisheries and fishery states of emergency, such as the 2015 Dungeness crab fishery closure, will be investigated with this metric.
Oxygen concentration in California current	Dissolved oxygen concentrations in the ocean are an indicator for physical and biological processes within the marine environment. There was a significant decrease in dissolved oxygen in the California Current System from 1984 to 2006, and climate change models predict a continued decline in dissolved oxygen. This can lead to significant and complex ecological changes to marine ecosystems: in addition to the direct adverse effects of lower oxygen concentrations (hypoxia), shallower oxygen-deficient zones can also lead to a compression of favorable habitat for certain marine species and an expansion of favorable habitat for other species. Sampling and monitoring by the California Cooperative Oceanic Fisheries Investigations (CalCOFI) program provides data for this indicator.
Mean temperature departure, October through September	Temperatures are projected to increase due to climate change, providing an easily tracked observational record. Temperatures impact the type of precipitation that falls (rain or snow), evaporation rates, water demands by agriculture and people, water quality, as well as energy demands (which often require significant water use for generation). This impact is projected to grow; by 2050, average high temperatures are projected to be 3-4° F higher than mid-20th century.
Percentage of rainfall as total precipitation	As temperatures increase, the proportion of annual precipitation that falls as snow will decrease. A trend toward 'more rain, less snow' creates the need to adjust water management to accommodate the changes in precipitation timing and type. This impact is projected to grow as the climate warms, with year-to-year variability continuing, and the percentage of precipitation falling as rain increasing over time.
3-year average of Sacramento River runoff in April through July in percent of water year runoff	Streamflow is captured by reservoirs for water supply and is a key driver of aquatic ecosystem health. Year-to-year variability in streamflow is a natural feature of California's hydrology; all of the impacts listed above act to intensify this annual variability. For aquatic species, these impacts put stress on the amount, timing and temperature of the water. For supply, extreme variability in streamflow reduces reliability.

RESILIENCE OUTCOMES METRICS

GOVERNMENT RESPONSE METRIC	CONTEXT AND RATIONALE
Percentage of Local Hazard Mitigation Plans that address climate impacts	The State needs to promote the incorporation of climate change resiliency strategies into local hazard mitigation plans and grants quickly to comprehensively address growing climate risk.
Amount of California's energy from renewable sources	With 27% of its electricity coming from renewable sources in 2016, California is ahead of schedule to reach the state's goals of 33% renewable energy by 2020 and on track to meet 50% by 2030. While renewable energy is also crucial for the state's efforts to reduce greenhouse gas emissions to mitigate the effects of climate change, renewable energy production also helps California be more resilient by creating a more diversified and distributed energy supply.
Gigawatt hours of energy saved by efficiency and conservation initiatives	Energy efficiency and conservation are key climate adaptation efforts to ensure system reliability, and also has great benefits for climate change mitigation and consumer savings. This metric combines efficiency gains from codes and standards, efficiency programs, and market and price effects to show the cumulative annual efficiency and conservation savings for electricity from 1990 through the present.
Reduction in rate of land consumed for development	The State's natural resources are an integral part of the State's climate programs. Healthy, well-maintained natural systems can provide significant climate mitigation benefits and can also provide resilience in the face of change. Natural infrastructure is the preservation and/or restoration of ecological systems, or utilization of engineered systems that use ecological processes, to increase resiliency to climate change and/or manage other environmental problems (AB 1482 and SB 379). The State continues to promote and support local land use and development strategies that preserve ecologically intact and functioning natural infrastructure systems and habitats. The State is also invested in promoting the use of natural and ecological processes and features that are engineered to supplement traditional built infrastructure (for example, water treatment facilities that utilize ecologically functioning wetlands).
Total funding available that directly considers and builds resilience to climate impacts	Since climate change is already exacerbating existing inequities and vulnerabilities, efforts to build healthy and equitable communities needs to be central to the State's adaptation strategy.
New units approved in hazard areas	This metric would help the State track whether existing land use and hazard avoidance guidance is effectively safeguarding Californians.
Community service hours that build directly build adaptive capacity in communities	California Emergency Response Team, California Conservation Corps service programs, and Civic Spark
Local jurisdictions with climate action plans, adaptation plans, general plans, and hazard mitigation plans that address climate, health, and equity for vulnerable populations	Senate Bill 379 requires local jurisdictions to address climate adaptation and resiliency strategies in their next revision of a local hazard mitigation plan, or in the safety element of the general plan (beginning in 2022, if the local jurisdiction has not adopted a local hazard mitigation plan). The bill requires the update to include goals, policies, and objectives based on a vulnerability assessment identifying the risks that climate change poses to the local jurisdiction. This is an opportunity to plan to reduce harms to vulnerable populations from climate change.
State agency plans (infrastructure, investment, operational) or grant guidance documents that a.) identify populations vulnerable to climate change health impacts, b.) plan to reduce vulnerability through increased provision of resources, services, jobs or technical assistance, and c.) engage vulnerable populations in making decisions about programs, policies or funding.	Executive Order B-30-15 requires State agencies to take climate change into account in their infrastructure and investment decisions, and mandates that vulnerable populations be protected the process. The State agency guidance to implement the Executive Order helps agencies a.) identify populations vulnerable to climate change health impacts, b.) plan to reduce vulnerability through increased provision of resources, services, jobs or technical assistance, and c.) engage vulnerable populations in making decisions about programs, policies or funding. This item will help monitor the degree of implementation of the Executive Order.

GOVERNMENT RESPONSE METRIC	CONTEXT AND RATIONALE
Climate change, housing, transportation or land use investment plans or programs that incorporate measures to prevent residential and economic displacement	Transit investments and other amenities such as improved housing options are often provided to improve livability and reduce the need to drive, thus reducing greenhouse gases. These strategies may inadvertently drive up median area income, property taxes, and rents. A possible result of such changes is that existing residents and small business owners may no longer be able to afford living or doing business in their neighborhoods, and will be forced to move farther away. Displacement has harmful effects on physical and mental health of children and adults, and most harms people with low incomes.
Change in tree canopy	Increasing the amount of tree coverage has a number of benefits for climate change and our communities including reduction of air pollution, calming of traffic, reduction of neighborhood violence, and the reduction of storm water runoff, which decreases flood risk and soil erosion while improving water quality.
Change in impervious surface coverage	Impervious surfaces often are dark-colored and thus absorb more heat, contributing to the heat island effect. They also do not allow water to infiltrate into the soil. Allowing water to infiltrate into soil reduces flooding, recharges ground water supplies, and filters water.
Low-income and senior housing units receiving weatherization and energy efficiency upgrades.	Weatherization and energy efficiency measures have many benefits for climate vulnerable communities including the reduction of: susceptibility to extreme heat and cold; energy consumption, which decreases power plant emissions and air pollution; utility costs allowing more to be spent on other needs; and health and safety risks within the home.
State-owned roads that have a climate change vulnerability assessment	This metric will inform stakeholders of the potential impacts to transportation infrastructure to make more informed decision-making.
"Complete Street" features built into transportation infrastructure projects	This metric will identify progress towards integration of complete streets strategies and features that provide resilient travel options that are not petroleum-based and increase physical activity. Complete street features include bike lanes, crosswalks, transit amenities, and other design and livability features. To keep pace with impacts like temperature rise in urban areas, state government should increase funding in areas with poor air quality over time.
Number of transit stops (including high-speed rail) providing service to vulnerable or low-income populations.	Public transit access increases overall resiliency by providing economic opportunity, reducing emissions, and offering evacuation routes during emergencies.
Number of transit stops that serve as emergency centers	This metric demonstrates the state's commitment to resilience of transit-dependent Californians by creating more emergency centers at transit stops. To keep pace with impacts like storm events, state government should increase over time.
Volume of water to be conserved through the State Water Efficiency and Enhancement Program projects over 10 years	This metric shows how California is investing in efficient irrigation practices to increase the state's resilience to water shortage. To keep pace with impacts like water insecurity, state government should increase funding over time and address other methods to maintain a secure water supply for human, environmental, and agricultural needs.
Healthy Soils Program projects	This metric shows how California is investing in soil health to increase the state's resilience by sequestering carbon and tapping into the multiple benefits of soil. To keep pace with impacts such as drought, California should increase funding for the healthy soil program. The funding of research, demonstration projects, and outreach to the agricultural community will all be needed actions.
Acres of farmland conserved through state agricultural conservation easement programs	This metric shows how California is investing to increase the state's resilience by conserving farmland. To keep pace with impacts like population growth, state government should continue to fund farmland conservation easements in an effort to promote sustainable growth and the multiple environmental benefits provided by farmland. Details should be included about the percentage of these easements that require improved management for climate adaptation/mitigation.
Percentage of species included in climate change vulnerability assessments	Climate change vulnerability assessments provide insight into which species may be at highest risk from climate impacts, and why. Ensuring that a broad range of species and especially special status species are represented in these assessments will constitute progress towards improving our understanding of projected climate impacts to fish, wildlife, and plants, and filling important gaps in scientific information.
Number of projects underway to implement 2015 SWAP conservation strategies with climate co-benefits	The conservation goals and strategies identified in the 2015 State Wildlife Action Plan (SWAP) were developed in part to address risks associated with climate change, and strategies have been directly linked to state and national climate adaptation strategies for fish, wildlife, and plants. SWAP implementation is an important vehicle for building robust and resilient ecosystems.

RESILIENCE OUTCOMES

GOVERNMENT RESPONSE METRIC	CONTEXT AND RATIONALE
Percentage of conservation plans that include climate adaptation strategies or actions for fish, wildlife, plants, or ecosystems	Species and ecosystem-based approaches to conservation planning occur at multiple scales to conserve biological diversity in perpetuity. Incorporating climate adaptation science and strategies into these efforts is crucial to their success. This metric can serve as an indicator of state agency progress towards integrating climate adaptation into conservation plans and frameworks.
Acres of terrestrial and aquatic habitat restored through state agency-administered restoration grant programs and restoration	Restoration and enhancement of degraded ecosystems, and activities such as invasive species removal, can protect ecological function and increase ecosystem resiliency to climate impacts. This metric serves as a measure of the magnitude of on-the-ground actions being taken or supported by state agencies to generally promote adaptation by ensuring terrestrial, aquatic, and marine ecosystems are healthy and more likely able to cope with or adapt to change.
Number of state agency staff enrolled in climate-related education courses and other trainings	This metric can be used to evaluate progress towards increasing awareness of climate impacts to biodiversity and adaptation options by state agency staff working on natural resource issues.
Acres of forested land treated to reduce fire risk/acres of land proactively restored through prescribed burns or managed natural ignitions	In October 2015, Governor Brown declared a state of emergency and formed a Tree Mortality task force to help mobilize additional resources for the safe removal of dead and dying trees. The US Forest Service is a key member of this task force, and in 2016, reprioritized $43 million to help protect people from hazard trees and conditions created by dead and dying trees. CAL FIRE and its partners have removed more than 423,000 trees in 10 counties, inspected and cleared of dead trees nearly 52,000 miles of roads and powerlines, treated more than 26,000 acres, and created roughly 1,300 acres of fuel breaks to date.
Acres of private forests in easements	This metric will track the acres of forestland protected from conversion to non-forest easements through programs between landowners and land trusts or governance agencies, such as the Federal Forest Legacy Program and the California Forest Legacy Program. Details should be included about the percentage of these easements that require improved management for climate adaptation/mitigation.
Projects and programs that focus on sea-level rise and climate adaptation	Local Coastal Programs, projects that demonstrate innovative shoreline management, use green infrastructure, ready our fisheries management and fishing practices for climate change, and other climate resilience projects are being implemented across the state. This metric will track the number of such projects.
Acres of coastal wetlands and coastal habitat restored or protected	This metric will track the acreage of coastal wetlands, marshes, and critical habitat restored along the coast. Plans such as the 2015 update to the Baylands Ecosystem Habitat Goals, which offer recommendations for promoting healthy baylands in light of climate-induced erosion and inundation, can guide these efforts.
Percentage of coastal population living in area with vulnerability assessments, mapping, and/or local planning for sea level rise	This metric will track regional preparedness for sea level rise, including the percentage of coastal population living in areas that have incorporated sea level rise in Local Coastal Plans and local general plans and the percentage of the coast with vulnerability assessments and mapping.
People who receive training or information annually on coastal and ocean climate risks and adaptation planning	This metric will track participation in outreach events, webinars, and other trainings on coastal and ocean climate risks and adaptation planning.
Local progress in achieving water conservation	California is acting to increase the state's resilience through water conservation, which will help reduce the impacts of increased drought duration, intensity and frequency, as well as maintain a sustainable water supply. The state released its Water Conservation Plan public review draft in November, 2016. The plan implementing Governor Brown's Executive Order B-37-16 will be final in January, 2017. The EO ordered the state to move towards using water more wisely, eliminate water waste, strengthen local drought resilience, and improve agricultural water use efficiency and drought planning. Much progress has been made at the local level toward water conservation. The State should track these measures as a climate change metric, continue to set guidance and find more ways to address vulnerability.
Urban water use reduction	California is investing in water supply reliability and taking action to increase resilience through water use efficiency. Implementation of the Water Conservation Act of 2009 (SBX7-7) is achieving urban water use reduction statewide by 20 percent per capita by the year 2020, helping agricultural water suppliers with efficient water management practices, and responding to the Governor's call for Californians to reduce their water usage by 20 percent during the drought. This metric can show how the State is dealing with water supply reliability issues by addressing water outages/quality in rural communities and other efficiency efforts and outreach.

GOVERNMENT RESPONSE METRIC	CONTEXT AND RATIONALE
Percentage of Groundwater Sustainability Agencies that have attained sustainability	The state passed the sustainable Groundwater Management Act (SGMA) in 2014. To help adapt to climate change impacts, increased demand for groundwater, and changing streamflow and replenishment, the water sector is establishing process and approach for determining the extent and magnitude of climate change and sea level rise impacts to sustainable groundwater management practices at the groundwater basin level. Groundwater basin boundaries are set, Groundwater Sustainability Agencies (GSAs) are being formed, regulations have been adopted requiring GSAs to attain sustainability by 2042 or earlier and to consider changing climate conditions over the planning period and beyond, and SGMA Best Management Practices (BMPs) were released. Tracking progress on these actions as climate change metrics will show how California is investing in/acting to increase the state's resilience by managing groundwater sustainably. California faces the ongoing threat of undesirable results caused by groundwater depletion, and moving forward state government needs to further its work in managing and using groundwater in a sustainable manner, to support the implementation of groundwater sustainability plans.