

Safeguarding California: Implementation Action Plans



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Please visit www.resources.ca.gov/climate/safeguarding to find links to the entire document containing all ten sectors' Implementation Action Plans as well as individual files for each sector. For further updates on Safeguarding California, including the upcoming implementation progress reports and the 2017 update, you can subscribe to the California Natural Resources Agency's Climate ListServ at the bottom of the webpage.

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Nate Kauffman, founder and creator of The Live Edge Adaptation Project



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for the societies that invest in them, enormous improvements in social and environmental justice and health are possible. Find more about LEAP on Nate Kauffman's website: www.n8kaffman.com.

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“From eroding sea cliffs to shrunken mountain snowpack, some of the effects of climate change in California are obvious. Other effects are not so obvious but potentially powerful. Warmer average temperatures will affect everything from when butterflies appear to where wine grapes can be grown. This comprehensive report characterizes the potential threats and mitigation and adaptation measures we can take across state government, from shading the concrete hardscapes of our cities to retrofitting fish hatcheries to cope with warmer streams.”

California Natural Resources Secretary,
JOHN LAIRD



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Acknowledgments

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In accordance to Governor Edmund G. Brown Jr.'s Executive Order B-30-15, the Natural Resources Agency identified a lead agency to lead adaptation efforts in each sector. This page shows the lead agency for each sector and lists the key staff that authored and contributed to each Implementation Action Plan. The hard work of many individuals and groups went into these plans, and many state entities served advisory and contributing roles.

The Natural Resources Agency is led by Secretary John Laird and Undersecretary Janelle Beland, who provided the direction and guidance for implementing the vision of Safeguarding California.

Assistant Secretary for Climate Change JR DeLaRosa and Climate Policy Advisor Joey Wall coordinated the process to create the Implementation Action Plans.

Nancy Vogel, Sam Chiu, Sam Diaz, Claire Jahns, Heather Lockey, Russ Henley, and Pat Kemp of the Natural Resources Agency deserve special thanks for their work and support.

Agriculture: Department of Food and Agriculture

- Carolyn Cook (Department of Food and Agriculture)
- Carla Sanchez (Department of Food and Agriculture)
- Amrith Gunasekara (Department of Food and Agriculture)

Biodiversity: Department of Fish and Wildlife

- Whitney Albright (Department of Fish and Wildlife)
- Kevin Hunting (Department of Fish and Wildlife)
- Tara Ursell (Department of Parks and Recreation)
- Jay Chamberlin (Department of Parks and Recreation)

Emergency Management: Office of Emergency Services

- Megan Walton (Office of Emergency Services)
- Christina Curry (Office of Emergency Services)
- Jose Lara (Office of Emergency Services)

Energy: Energy Commission

- David Stoms (Energy Commission)
- Guido Franco (Energy Commission)
- Kristin Ralff-Douglas (Public Utilities Commission)
- Diane Brown-Tapia (Department of General Services)
- Jana Romero (Energy Commission)
- Eli Harland (Energy Commission)
- Howard Sacks (Department of General Services)
- Gina Maucieri (Department of General Services)

Forestry: Department of Forestry and Fire Protection

- Kim Carr (Department of Forestry and Fire Protection)
- John Melvin (Department of Forestry and Fire Protection)

Land Use and Community Development: Department of Housing and Community Development

- Paul McDougall (Department of Housing and Community Development)
- Lisa Bates (Department of Housing and Community Development)
- Joey Wall (Natural Resources Agency)
- JR DeLaRosa (Natural Resources Agency)
- Louise Bedsworth (Governor's Office of Planning and Research)
- Michael McCormick (Governor's Office of Planning and Research)
- Randall Winston (Strategic Growth Council)

Oceans and Coastal Resources and Ecosystems: Ocean Protection Council

- Yoon Kim (Ocean Science Trust)
- Nick Sadrpour (Ocean Protection Council)
- Cat Kuhlman (Ocean Protection Council)
- Abe Doherty (Ocean Protection Council)
- Jennifer Phillips (Ocean Protection Council)
- Nicole Russel (State Lands Commission)
- Kelly Malinowski (State Coastal Conservancy)
- Steve Goldbeck (Bay Conservation and Development Commission)
- Joe LaClair (Bay Conservation and Development Commission)
- Jay Chamberlin (Department of Parks and Recreation)
- Tara Ursell (Department of Parks and Recreation)
- Lauren Garske (California Coastal Commission)
- Michelle Jespersen (California Coastal Commission)

Public Health: Department of Public Health

- Dorette Quintana English (Department of Public Health, CalBRACE project staff)
- Solange Gould (Department of Public Health)
- Linda Helland (Department of Public Health)
- Gurjeet Kaur-Singh (Department of Public Health, CalBRACE project staff)
- Jacqueline Chan (Department of Public Health)
- Dan Woo (Department of Public Health)
- Robert Lipton (Department of Public Health)

Contributions by CDPH Cal-BRACE project staff to the Public Health Section were supported by Cooperative Agreement Number 5UE1EH001052-03/04 funded by Centers for Disease Control and Prevention. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the Centers for Disease Control and Prevention or the Department of Health and Human Services.

Transportation: State Transportation Agency

- Kate White (State Transportation Agency)
- Nick Burmas (Department of Transportation)
- Meg Cederoth (High-Speed Rail Authority)
- Steve Cliff (Department of Transportation)
- Melissa Thompson (Department of Transportation)

Water: Department of Water Resources

- Andrew Schwarz (Department of Water Resources)
- Elissa Lynn (Department of Water Resources)
- Kamyar Guivetchi (Department of Water Resources)
- Scott Olling (Department of Water Resources)
- Jelena Hartman (State Water Resources Control Board)
- Greg Gearheart (State Water Resources Control Board)
- Diana Messina (State Water Resources Control Board)
- Gail Linck (State Water Resources Control Board)

Advisory and Contributing State Entities:

- San Francisco Bay Conservation and Development Commission
- California Coastal Commission
- California Conservation Corps
- California Department of Community Services and Development
- California Department of Fish and Wildlife
- California Department of Food and Agriculture
- California Department of Forestry and Fire Protection
- California Department of Housing and Community Development
- California Department of Insurance
- California Department of Parks and Recreation
- California Department of Public Health
- California Department of Resources Recycling and Recovery
- California Department of Transportation
- California Department of Water Resources
- California Energy Commission
- California Environmental Protection Agency
- California Health and Human Services Agency
- California Ocean Science Trust
- California Public Utilities Commission
- California State Coastal Commission
- California State Coastal Conservancy
- California State Lands Commission
- Delta Conservancy
- Governor's Office of Planning and Research
- Governor's Office of Emergency Services
- Ocean Protection Council
- Office of Environmental Health Hazard Assessment
- State Water Resources Control Board

Executive Summary



AGRICULTURAL SECTOR PLAN



BIODIVERSITY AND HABITAT SECTOR PLAN



EMERGENCY MANAGEMENT SECTOR PLAN



ENERGY SECTOR PLAN



FORESTRY SECTOR PLAN



LAND USE AND COMMUNITY DEVELOPMENT SECTOR PLAN



OCEANS AND COASTAL RESOURCES AND ECOSYSTEMS SECTOR PLAN



PUBLIC HEALTH SECTOR PLAN



TRANSPORTATION SECTOR PLAN



WATER SECTOR PLAN



Executive Summary

Science tells us that the Earth’s climate is changing, and human activity is the primary cause of these changes. Climate disruption drives extreme weather events such as coastal storm surges, drought, wildfires, floods and heat waves. As Californians are painfully aware, these events can be devastating. It is imperative that we act to reduce the vulnerability and increase the resilience of our residents, communities and natural resources.



Climate disruption drives extreme weather events such as coastal storm surges, drought, wildfires, floods and heat waves.

California released its first comprehensive plan for adapting to climate change in 2009, and updated that strategy with the 2014 report *Safeguarding California: Reducing Climate Risk*.

Since 2009, California has experienced several of the most extreme natural events in its recorded history: severe drought, an almost non-existent Sierra Nevada winter snowpack, five of the top 20 largest forest fires ever recorded in the state in terms of acreage burned, and back-to-back years of the hottest average temperatures. According to the California Climate Tracker, the winter average minimum temperature of 2014-15 for the Sierra Nevada

region was 32.1 degrees Fahrenheit, the first time this value was above water’s freezing point in 120 years of record-keeping.

As greenhouse gas emissions continue to accumulate and climate disruption grows, such destructive events will become more frequent. The historical record, which once set our expectations for the traditional range of weather and other natural events, is becoming an increasingly unreliable predictor of the conditions we will face in the future.

This document details how California will build the resilience of our residents, communities, and ecosystems to the emerging impacts of

Safeguarding California: Reducing Climate Risk gave guidance, high-level recommendations, and a statewide vision for decision makers dealing with ongoing and inevitable climate impacts in 2014. These Implementation Action Plans are the master blueprint for executing actions it recommends.



climate change. The ten implementation plans presented here represent a master blueprint for executing actions recommended in the 2014 report *Safeguarding California: Reducing Climate Risk*, as called for in Governor Brown’s April 2015 Executive Order (B-30-15).

We use a number of words, including adaptation, resilience, readiness, and safeguarding, to describe a simple concept: ensuring that people, communities, and natural systems are able to withstand the impacts of climate disruption. By drawing upon reliable, time-tested strategies today, we can increase resilience to the effects of climate change and mitigate the harmful impacts to future generations. We know that healthy forests clean

our air and water, wetlands help absorb rising tides and storm surges, and parks, open space, and farmland sequester carbon and minimize the effects of urban heat islands. Each sector’s implementation plan in this report aims to ensure that all communities—particularly those most vulnerable to climate change—can help to shape our climate adaptation strategies.

After a robust public process to gather feedback, the Implementation Action Plans now incorporate many suggestions on how to undertake specific actions to follow through on existing recommendations. The input received on changing the State’s adaptation policy will be taken into account for the *Safeguarding California* update in 2017.



Drought, flooding, fires, and heat waves all pose health, economic, and logistical challenges to disadvantaged communities that may lack the financial and organizational resources to respond to and recover from a disaster.

Climate science continues to improve and add to our knowledge of impacts and response. As the science evolves, we must accelerate the pace at which we translate science into action to protect against these powerful environmental changes. We also need to integrate social scientists and communications experts to convey climate change impacts in a manner that furthers understanding and sparks collective action. California’s geographic diversity necessitates ongoing assessment to determine climate vulnerabilities. Understanding where we’re most vulnerable to impacts allows us to effectively prioritize actions and maximize limited resources.



A recent study from the University of California, Davis pegged the total economic impact of the 2015 California Drought at \$2.7 billion, with an estimated 10,100 seasonal farm worker jobs lost.

For lower-income individuals and communities, the challenges of responding and adapting to climate change are even greater. Drought, flooding, fires, and heat waves all pose health, economic, and logistical challenges to disadvantaged communities that may lack the financial and organizational resources to respond to and recover from a disaster. A recent study from the University of California, Davis pegged the total economic impact of the 2015 California Drought at \$2.7 billion, with an estimated 10,100 seasonal farm worker jobs lost.

Understanding the concerns of the most vulnerable residents and incorporating diverse voices in the planning of our adaptation strategies will make our recommendations more responsive and effective, and we are committed to working in tandem with advocates to develop new policies in future updates. The compilation of sector implementation plans for climate resilience includes a new sector focused on “Community Development and Land Use.” This new plan describes local and regional work currently underway to strengthen communities

through integrated efforts in the areas of energy, water, public health, and urban planning.

The sector highlights how integrated regional approaches are crucial for building community resilience across the state. Linking community development and land use allows us to raise the quality of life for all and meet our sustainability goals.

Through the combined efforts of the Governor’s Office of Planning and Research, local governments, and the state’s Climate Action Teams, it is possible to achieve well-coordinated, resilience-building regional actions. The successful completion of projects such as the “Breuner Marsh Restoration Project,” currently underway

In addition to Executive Order B-30-15, Assembly Bill 1482 and Senate Bills 246 and 379 were all signed by the Governor in 2015 to strengthen the State’s resilience to climate change. These bills support the work of local governments to plan and implement adaptation actions and help link state guidance and resources with local and regional efforts.



along the Point Pinole Regional Shoreline in Richmond, will help inform future opportunities to connect multiple sectors and maximize resilience by incorporating bike pathways, public recreation, and wetlands restoration.

Ensuring that California is ready for the changing climate will also require revising routine tasks of State governance. These plans demonstrate how state agencies are implementing the Governor's directive to take climate change into account in all planning and investment decisions—in part through full life-cycle cost accounting. The Strategic Growth Council's Affordable Housing and Sustainable Communities Program, for example, makes resilient placement and design a threshold consideration for project proposals. Climate change adaptation in California is being addressed in many areas; from cutting-edge construction to grant guidelines, every sector and every lever for change in government has to be a part of the strategy.

Climate disruption creates an unprecedented challenge that demands cooperation. While reducing greenhouse gas emissions will help California avoid the most harmful effects, we must also recognize that some impacts are now inevitable. Moving forward, we must come together to take meaningful action as we adapt to our changing reality. United, we can protect our homes, communities, and state, and continue to prosper.



AGRICULTURAL

Ensuring the sustainability of food production in the face of climate risks will require a concerted collaborative effort by farmers and ranchers, government agencies, agricultural service organizations, and other partners.



BIODIVERSITY AND HABITAT

Supporting ecosystem resilience to climate change will require increased linkage between habitats, innovative management strategies, and the reduction of non-climate stressors. Monitoring will be essential to ensure that these strategies are effective.



EMERGENCY MANAGEMENT

Working together, we can promote and implement risk reduction activities and increase our awareness and resilience to threats, hazards, and vulnerabilities, and coordinate the development of strategies, actions and plans to manage risk and create long-term sustainability.



ENERGY

While the energy sector is primary contributor to climate change, its supply and demand infrastructure is also vulnerable to climate change impacts such as those associated with extreme events, sea level rise, and heat waves.



FORESTRY

Forests can help absorb carbon dioxide and counteract the emissions that cause climate change, but, California forests are also in need of protective actions to prepare them to withstand mounting climate threats such as increasing temperatures, drought, increasing risk of pest infestations, and increasing risk of severe wildfires.



LAND USE AND COMMUNITY DEVELOPMENT

Land use and housing decisions can ensure that communities and infrastructure are located and built to minimize the effect of climate impacts like sea-level rise, wildfires, and flooding. Building grassroots capacity to address risks from climate change can help communities implement solutions that span sectors.



OCEAN AND COASTAL ECOSYSTEMS AND RESOURCES

Climate change presents new threats to ocean and coastal ecosystems and resources including sea-level rise, extreme events, and ocean acidification, and continued investments are needed in climate-smart ocean and coastal management.

Cross-Sector Principles

Climate impacts span sectoral and jurisdictional boundaries and responding to climate risks requires coordination between state agencies and across political boundaries (international, national, regional, state and local).

Collaboration across entities is necessary for information sharing, can help generate innovative new approaches to addressing climate risk, and can help optimize the utilization of the resources available to address climate threats. These strategies guide cross-sector collaboration:

- Make the risks Californians face from a changing climate an integral part of all core functions of government.
- Provide risk reduction measures for California's most vulnerable populations.
- Identify significant and sustainable funding sources for investments that reduce climate risks, human loss, and disaster spending.
- Support continued climate research and data tools to inform policy and risk reduction activities.
- Maximize returns to investments by prioritizing projects that produce multiple benefits and promote sustainable stewardship of California's resources.
- Promote collaborative and iterative processes for crafting and refining climate risk management strategies.
- Support regional and local approaches to integrate sectors and address priorities across California's diverse regions.

The Natural Resources Agency is committed to implementing these strategies, and cross-sector integration and complementarity will be a key focus in the year ahead and the 2017 update to Safeguarding California.



WATER

The major impacts of climate change on California's water sector may be changes in the timing, form, and amount of precipitation, changed runoff patterns, increases in the frequency and severity of extreme precipitation events (floods and droughts), and sea level rise, affecting both water supplies and water quality.



TRANSPORTATION

Impending climate impacts not only have implications for decisions regarding the siting of new transportation infrastructure, but also climate maintenance and operation plans, planning and design features of transportation systems, including system design for emergency planning and extreme weather events.



PUBLIC HEALTH

Climate change poses direct risk to public health. And impacts the natural systems-air, water, food – and built environments that sustain our health. Climate adaptations planning strengthens on going health protection, while promoting healthy and resilient communities.

Agricultural Sector Plan



AGRICULTURAL SECTOR PLAN



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WATER SECTOR PLAN

Agricultural Sector Plan



Introduction

California benefits from one of the most valuable and diverse agricultural industries in the world, producing over 400 different commodities which were valued at \$54 billion in 2014. Over a third of the United States' vegetables and two-thirds of its fruits and nuts are grown in California (CDFA, 2015). Furthermore, 20% of U.S. milk is produced in California (CDFA, 2015). Livestock products (dairy products, meat, eggs and wool) and specialty crops (fruits and vegetables, tree nuts, dried fruits and horticulture and nursery crops, including floriculture production) epitomize California agriculture and are exported throughout the world contributing to local, national and global food security. Agriculture is successful in California due to the unique climate, prime soils, innovative farming techniques and critical irrigation infrastructure. The state's many microclimates allow for production of a diversity of food crops, in some cases, year-round production.

Impacts from climate change threaten the agricultural industry in California. The great diversity of the state's agriculture does lend some resilience to the sector as a whole, but also increases the complexity of adaptation due to the varied impacts to individual crops or livestock animals. Research in California indicates that agriculture is vulnerable to climate change as well as other pressures such as urban development. Several studies predict declines in crop yields during the 2050 and 2100 timeframes (Deschenes and Kolstad, 2011; Medellin-Azuara et al, 2011; Lobell et al, 2006).

In order to protect California's resources, including agriculture, from the impacts of climate change, the state has developed a three-pronged approach to climate change policy: reduce emissions, facilitate adaptation to climate change impacts,

and outcome-based scientific research to direct policy for both mitigation and adaptation efforts (CNRA, 2014). *Safeguarding California: Reducing Climate Risk*, the state's adaptation strategy produced by the California Natural Resources Agency (CNRA) in coordination with many other state agencies, provides a summary of potential impacts to California from climate change and builds a foundation for ensuring that California's economic sectors build resilience. Its recommendations help guide state government's actions to aid in the transformations that will safeguard California's agricultural sector from climate change. Many initiatives serve the dual role of both mitigating greenhouse gas emissions while increasing





adaptive capacity, illustrating the comprehensive movement to ensure a thriving and productive agricultural industry in the state despite ongoing and inevitable climate impacts.

This implementation plan is a crucial step in realizing this positive future in the face of climate change. It succinctly lays out the vulnerabilities

that the State must help build resilience against, and goes on to outline specific actions to address the recommendations presented in *Safeguarding California*. Most importantly, the plan details initiatives that will be implemented and provides insights into how adaptation can be tracked over time.

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Vulnerability Assessment

The first step in addressing climate change is to analyze impacts and the vulnerabilities they create. California has undertaken many vulnerability assessments, so this section will only give a high-level overview of climate change impacts and vulnerabilities. Specific resources to help further understand the climate threats faced by agriculture are cited.

It must be noted that changes in climate lead to complex multi-factorial impacts on the agricultural sector such as changes in the way that plants interact with pests or beneficial species (such as pollinators). There may be unforeseen impacts because ecosystems, including those on working lands, are dynamic and highly variable throughout California. Impacts will occur in tandem and some may have synergistic or feedback effects.

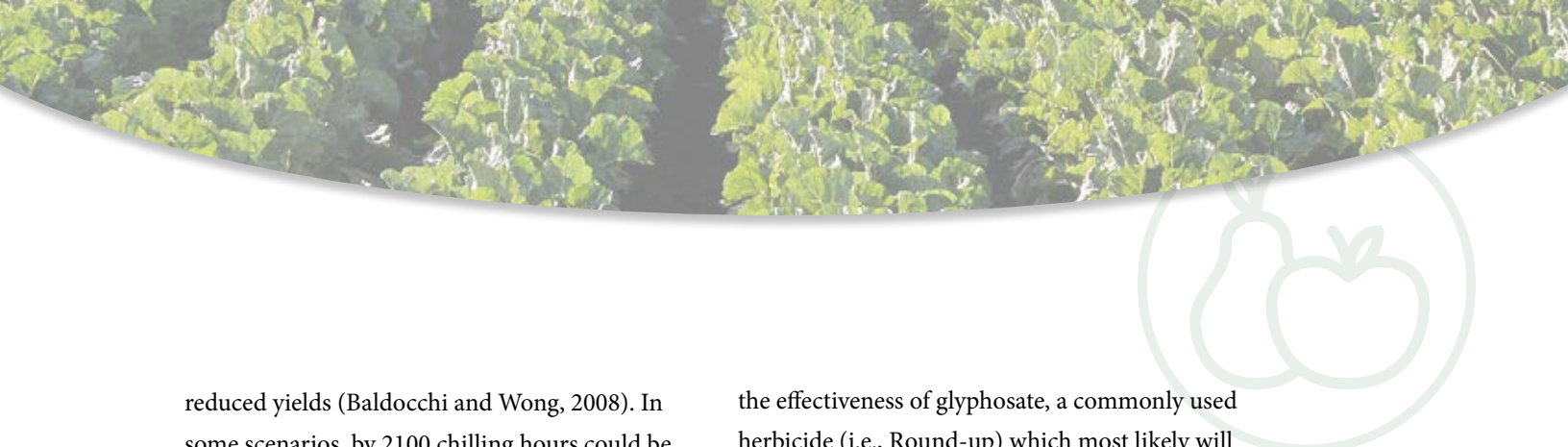
EXTREME HEAT AND TEMPERATURE CHANGE

According to a recent vulnerability assessment completed by the United States Department of Agriculture (USDA) Southwest Regional Climate Hub, the average maximum temperature in California is expected to increase by 2-4°C by

2070 (2015). Record warm temperatures are becoming more common, impacting both crops and livestock. Increases in temperature beyond optimal ranges cause losses. In livestock, heat waves and extreme temperature lead to heat stress, lower milk or egg production and changing disease epidemiology (CNRA, 2014). Crops are also impacted by increasing temperatures; the severity is dependent on the crop and developmental stage of the crop during the heat event.

For example, winter chill hours, which are necessary for tree fruit and nuts to complete dormancy, have decreased since the 1950s resulting in

Crops are impacted by increasing temperatures; the severity is dependent on the crop and developmental stage of the crop during the heat event.



reduced yields (Baldocchi and Wong, 2008). In some scenarios, by 2100 chilling hours could be reduced by 80% from 1950 (Hatfield et al, 2014). California's premium winegrape regions will also be affected by increasing temperatures as grape varieties are sensitive to climate. A study estimated that suitable winegrape growing regions in California could shrink significantly by 2050, 60% in some scenarios (Hannah et al, 2013).

Changes in temperature and precipitation patterns may allow for pest and disease distributions to change or for new invasive species to become established in California where once they could not (CDFA, 2013). State and federal programs to exclude, detect and eradicate invasive species from California will be stretched as incidences increase. Several studies predict that some endemic pest generations will increase with increased temperature. One example includes navel orangeworm, a pest of walnuts and almonds, which will increase from 2-3 generations per year in 1950 to 5 generations per year before 2100 (Luedeling et al, 2011). These additional pest pressures will likely lead to increased pesticide use, an environmental concern and also an additional cost to farmers, and strain the ability of existing state programs to manage and control pests.

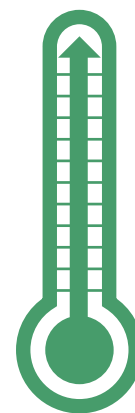
Other farm inputs may also increase in cost. Research shows that elevated atmospheric CO₂ levels can reduce the nutritional quality of forage crops such as alfalfa and pasture; leading to higher feed costs for livestock operators. Furthermore, elevated atmospheric CO₂ decreases

the effectiveness of glyphosate, a commonly used herbicide (i.e., Round-up) which most likely will lead to increased use or higher concentrations of applications (Hatfield et al, 2014). Droughts can also exacerbate weed problems because weeds utilize water that would otherwise be used by drought-stressed crops, resulting in the need for more effective weed-control tools.

A recent study shows that climate change has doubled the likelihood of extreme heat in the Central Valley; in particular nighttime temperatures are observed to be higher since the 1960s due to climate change. These high nighttime temperatures sustain heat exposure for vulnerable populations who may not have access to affordable air conditioning. The study's authors conclude that agricultural workers are at increased risk of mortality due to sustained heat events because nighttime offers no relief from heat stress (Mera et al, 2015).

EXTREME WEATHER EVENTS

Extreme winter storms and floods present a clear danger to agriculture. A report by the U.S. Geological Survey (USGS) found that a single extreme 1000-year winter storm could cause up to \$725 billion in damages to the California economy,



A recent study shows that
CLIMATE CHANGE
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much of that from flooding in the Central Valley. Climate change makes it more likely that California will experience extreme events like the Great Flood of 1862, which covered much of the state's prime agricultural land in up to twenty feet of water (Ingram, 2012; Porter et al, 2011). In more recent history, flooding in 1997 caused substantial losses to the agriculture sector including;

- Crop losses totaled \$107 million, with the largest losses being walnuts, wine grapes, winter wheat, and alfalfa.
- Livestock losses were another \$12 million.
- Damages to farm infrastructure (irrigation systems, roads, buildings, and fences) totaled \$109 million (Porter et al, 2011).

Climate scientists have shown that climate change will cause more precipitation to fall in fewer but heavier events, increasing flood risk and making water management more difficult. Soil erosion often results during heavy precipitation events as the soil's ability to take in the water is exhausted. Soil is lost as the sediment flows downstream; causing pollution from nutrients and sediment-loading downstream (Hatfield et al, 2014). Strategies to improve soil water holding capacity in combination with modernization of flood control infrastructure could help mitigate soil erosion and capitalize on floodwaters for groundwater recharge.

DROUGHT

Because California has a Mediterranean climate, with little or no precipitation falling during the late spring and summer months, agriculture is dependent on the collection and movement of water for crops and livestock needs. Elevated temperatures in the region will undoubtedly negatively impact water

storage in snow pack, necessitating changes to the way water is managed, delivered and used in the state as evident from the current ongoing four-year drought (see the Water Sector Plan for more information).

In 2014 and 2015 California agriculture experienced the greatest ever reduction in water availability due to low stream flows and low reservoir levels.

- Statewide losses due to drought in 2014 included 17,100 total agricultural jobs and \$2.2 billion.
- Net water shortages for agriculture in the 2014 drought most severely affect the Central Valley with at least 410,000 acres lost to fallowing and \$800 million in lost farm revenue (Howitt et al, 2014).
- In 2015, 542,000 acres were estimated to be fallowed – which is 114,000 more acres than in 2014.

Climate scientists have shown that climate change will cause more precipitation to fall in fewer but heavier events, increasing flood risk and making water management more difficult.



- Direct agricultural costs of drought in 2015 are estimated to be about \$1.84 billion and 10,100 direct seasonal jobs. When multiplier effects are considered, losses to all economic sectors are as high as \$2.74 billion and nearly 21,000 total jobs (Howitt et al, 2015).

During times of drought, groundwater is more heavily relied on to maintain agricultural production (and to keep crops and livestock alive). Unfortunately groundwater depletion represents a terrible vulnerability to climate change and results in secondary impacts such as aquifer collapse and subsidence. NASA recently announced that the rate of subsidence in the Central Valley has increased due to the drought with some areas in the San Joaquin Valley sinking a foot in less than a year (Farr et al, 2015). Subsidence represents permanent loss of water storage since the depleted aquifer collapses under the weight of the earth above. This is directly opposed to agricultural adaptation to climate change and leaves the industry less resilient to future water scarcity. One of the most practical and cost effective methods for ensuring aquifers are sustainable into the future is utilizing on-farm groundwater recharge during months of heavy precipitation. The practice of groundwater recharge on agricultural lands is critical to ensuring long term use of groundwater for multiple purposes and future generations. Programs that incentivize farmers or streamline permitting for water recharge projects may facilitate this activity in areas where the benefits can be maximized.

SEA-LEVEL RISE

In fertile coastal and estuarine farmland—like that found in the Bay Delta and along the central coast—sea-level rise will combine with other impacts to heighten harmful effects like salinity intrusion into surface and groundwater. In the Pajaro Valley on California’s Central Coast studies indicate that saltwater flows into the groundwater basin at a rate of 200 feet per year (Wallace and Lockwood, 2010). This is to the detriment of the high-value vegetable and fruit growers in the region who are adapting with water conservation, but also must cope with impaired water quality and future uncertainty. In the Sacramento-San Joaquin Delta, drought reduces the volume of water flowing out to the ocean and allows for saline water to creep inland, impacting sensitive ecosystems and farms both in the Delta and also in areas that receive irrigation water from the Delta such as the South San Joaquin Valley. Groundwater recharge projects during increased precipitation events on farms have been shown to mitigate saltwater intrusion.

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Current Actions to Prepare for Climate Impacts

Safeguarding California: Reducing Climate Risk identifies high-level actions needed to protect California agriculture from the impacts of climate change. The California Department of Food and Agriculture (CDFA), state and federal partner agencies have engaged on several of these actions. CDFA has developed outreach and incentive programs such as the Healthy Soils Initiative, the State Water Efficiency and Enhancement Program (SWEEP), the Dairy Digester Research and Development Program (DDRDP) and he developed tools and partnerships that support adaptation efforts. These efforts are listed in Table 1 and discussed in depth in the following sections.

Table 1. Summary of Adaptation Activities to Date

Actions are not listed in any order of importance. Ongoing activities (F and G) are not discussed in further detail since the ongoing work on those items is outside of state agencies.

RECOMMENDED ACTIONS FROM SAFEGUARDING CALIFORNIA	ACTIONS TAKEN TO DATE
A. Develop Best Management Practices That Reduce Climate Risks	CDFA – The Healthy Soils Initiative CDFA – Specialty Crop Block Grant Program
B. Development Incentive Programs for Sustainable Practices for Resilience	CDFA – State Water Efficiency and Enhancement Program (SWEEP) CDFA – Dairy Digester Research & Development Program (DDRDP) CEC – Water Energy Technology (WET)
C. Implement Resilient Water Management	CDFA – SWEEP DWR – Agricultural Water Use Efficiency 2014 Sustainable Groundwater Management Act
D. Reduce Farmland and Rangeland Conversion	The California Land Conservation Act of 1965 DOC – The California Farmland Conservancy Program DOC – High Speed Rail Agricultural Land Mitigation Program Strategic Growth Council- Sustainable Agricultural Land Conservation Program OPR – General Plan Guidelines Update CDFA – Benefits of Farmland Conservation whitepaper
E. Develop New Technologies	USDA/Colorado State University Comet-Planner Pest and Invasive Species Monitoring and Forecasting



F. Collect and Preserve Agricultural Genetic Material	Ongoing activity at federal level and through the State University systems
G. Invest in Improvements to Adaptive Agricultural Equipment	Ongoing activity at the industry level and at universities

A. DEVELOP BEST MANAGEMENT PRACTICES THAT REDUCE CLIMATE RISKS

California’s farmers and ranchers are already responding to climate impacts, but the State can help by compiling and developing a set of best practices to reduce climate risk. These management techniques will build local and regional resilience in California’s 43 million acres of agricultural land. The **Healthy Soils Initiative** is the central piece of CDFAs’s efforts to develop climate-smart management practices.

Governor Brown introduced the Healthy Soils Initiative in his proposed budget for the 2015 – 2016 fiscal year. The purpose of the Healthy Soils Initiative is to build the organic matter content in soils which offers multiple benefits that contribute to food security and climate change resilience. Soils that are rich in carbon, or soil organic matter (SOM), are more resistant to erosion (such as could occur in an extreme wind or precipitation events), have greater water retention (providing resiliency during water scarcity) and provide nutrients to crops, among numerous other ecosystem benefits.

Consistent with this initiative, several actions have been identified to:

- Protect and restore soil organic matter in soils with management practices such as no till and

cover crops to ensure climate change mitigation and food and economic security

- Identify sustainable and integrated financing opportunities, including market development, to facilitate increased soil organic matter
- Provide for research, education and technical support to facilitate healthy soils
- Increase governmental efficiencies to enhance soil health on public and private lands
- Ensure interagency coordination and collaboration

CDFAs, as the lead agency for the Healthy Soils initiative, has outlined both short and long-term goals for a healthy soils program including developing and demonstrating best management practices (such as utilizing cover crops, conservation tillage, and increased use of soil amendments) for sequestering carbon and creating soils that are resilient to climate change impacts.

The purpose of the Healthy Soils Initiative is to build the organic matter content in soils which offers multiple benefits that contribute to food security and climate change resilience.



The Healthy Soil Initiative is a multi-agency effort and has the potential to have beneficial cross-media effects on water resources, climate change adaptation and mitigation, nutrient management and waste reduction. Maximizing these co-benefits, particularly within disadvantaged communities, is an objective for the program. The Healthy Soils Initiative will require close collaboration with stakeholders. As the initiative develops, a better understanding of how soils play a role in climate change resiliency and food security will be realized. CDFA is positioned to share that understanding with agricultural stakeholders.

CDFA also administers federal funding in the **Specialty Crop Block Grant Program**. This money is designated to research, outreach and education projects that enhance the competitiveness of California’s specialty crops. There are several funding categories, one of which is focused on environmental stewardship and conservation including the development of management strategies that facilitate specialty crop adaptation to climate change impacts.

B. DEVELOP INCENTIVE PROGRAMS FOR SUSTAINABLE PRACTICES FOR RESILIENCE

Safeguarding California reported that action is needed to develop incentive programs for sustainable, science-based practices that create resilience to climate impacts for croplands and rangelands. The State is successfully pushing forward on research, pilot programs, and grants that provide farmers with the financial and technical support they need to implement

sustainable practices that are good for their bottom line, Californians, and the climate.

Senate Bill 103, emergency drought legislation from March 2014, designated \$10 million from the Greenhouse Gas Reduction Fund for CDFA to disperse to farmers for the implementation of

irrigation practices that save water and reduce greenhouse gas (GHG) emissions. The resulting program, the **State Water Efficiency and Enhancement Program** (SWEEP), promotes both climate change mitigation and adaptation through water management and energy efficiency, making agriculture more resilient to the impacts that climate change will have on water and energy resources.

CDFA designed SWEEP to provide grants for irrigation improvements that conserve water (e.g., conversion of flood irrigation to micro irrigation or implementation of water management tools) with energy efficiency components (e.g., conversion of diesel pumps to electric or renewable energy sources) that reduce GHG emissions. These projects have allowed farmers to effectively manage water resources and create resiliency in their operations through the use of on-farm technologies (e.g., soil water sensors and irrigation scheduling).

As the Healthy Soil Initiative develops, a better understanding of how soils play a role in climate change resiliency and food security will be realized. CDFA is positioned to share that understanding with agricultural stakeholders.

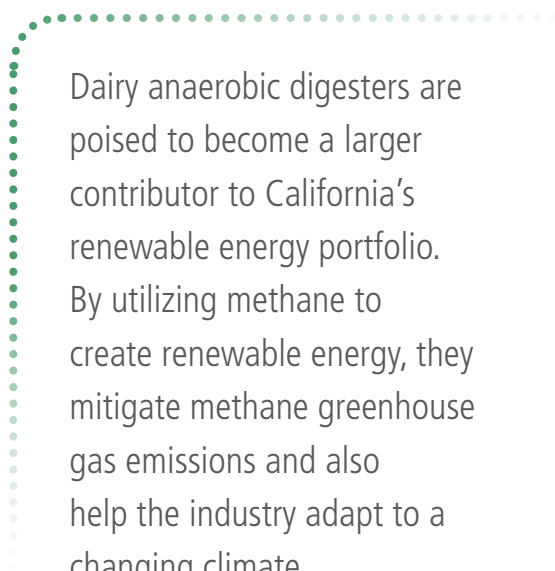


The development of the SWEEP is consistent with the recommendation of CDFA's Climate Change Consortium to incentivize such practices that can improve water management (CDFA, 2013). The Consortium was a group of farmers and scientists who were brought together in 2011 by CDFA to evaluate climate change impacts and provide feedback to the department on what is required by the agricultural community to adapt to climate change.

CDFA's leadership in developing SWEEP also connects with broader cross-sectoral and intergovernmental efforts that involve state action to adapt to climate change through agricultural water management. The **Water-Energy Technology (WET)** Program, for instance, will provide financial assistance to implement innovative technologies on farms that will lead to water savings and reduced GHG emissions. The WET Program complements SWEEP by incentivizing conversion to low pressure drip systems that can save water and reduce energy and greenhouse gas emissions and other innovative technologies. CDFA is working with the Department of Water Resources, California Water Resources Control Board and the Energy Commission, the entities administering the program, to maximize its impact on building resilience on farms.


CDFA is also working on incentivizing practices to obtain both mitigation and adaptation on California dairies through the **Dairy Digester Research and Development Program (DDRDP)**.

Dairy anaerobic digesters are poised to become a larger contributor to California's renewable energy portfolio. By utilizing methane to create renewable energy, they mitigate methane greenhouse gas emissions and also help the industry adapt to a changing climate. Digesters can provide dairy operators with an additional income source which offers economic security and on-farm diversification. Additionally, the by-product of digestion, digestate, is a useful soil amendment which can contribute to healthy soils and improve crop health. The expansion of anaerobic digesters in California will also assist the energy and transportation sectors adapt to climate change by providing a renewable and flexible fuel source which will be essential as California's population increases.



Dairy anaerobic digesters are poised to become a larger contributor to California's renewable energy portfolio. By utilizing methane to create renewable energy, they mitigate methane greenhouse gas emissions and also help the industry adapt to a changing climate.

In 2014, CDFA was provided \$12 million from the Greenhouse Gas Reduction Fund to provide grants for digester development and to fund research and demonstration projects that study and facilitate changes in manure management practices at California dairies that will directly result in greenhouse gas emission reductions: and, facilitate improved understanding of the scientific and technical aspects of dairy digesters to provide



information about their economic feasibility, widespread implementation and environmental benefits.

In July 2015, CDFA announced that four new dairy digester projects would receive funding, in addition to one existing defunct digester that would receive funds to help re-start operation. CDFA expects the program to continue as a climate change adaption and mitigation measure.

C. IMPLEMENT RESILIENT WATER MANAGEMENT

CDFA continually engages with stakeholders and irrigation specialists regarding the best methods to promote water efficiency in agricultural systems. CDFA has a responsibility to promote sustainable agriculture in California and through conversations with irrigation experts, farmers and ranchers, and agency partners it has become clear that agricultural water use in California is complex and solutions must be regionally driven. Implementation of improved water management must balance a variety of factors such as groundwater recharge, surface water delivery and allocation systems, crop type and productivity and wildlife management.

The SWEEP program, mentioned above, is one effort by CDFA to incentivize improved water management on farms. The Department of Water Resources is administering the **Agricultural Water Use Efficiency Program** (Ag WUE) which provides funding to agricultural water suppliers to make improvements to conveyance systems. This program delivers a critical piece of statewide

agricultural water management and facilitates flexibility in agricultural water management to the benefit of all Californians.

Historic legislation passed and signed by Governor Brown in 2014, the **Sustainable Groundwater Management Act**, initiated an important process of strategic groundwater management in California. The ongoing drought has drawn attention to this critical need in California. The Department of Water Resources and the State Water Resource Control Board have been tasked with leading the effort which revolves around integrated regional water management.

Moving forward, CDFA will continue to investigate innovative water management strategies that agricultural operators are utilizing throughout the state to deal with specific water quantity concerns and new technologies that can contribute solutions. California's substantial investments in water management will certainly have broad benefits for the agriculture sector; for more information on this comprehensive effort, see the water sector's implementation plan for *Safeguarding California*.

D. REDUCE FARMLAND AND RANGELAND CONVERSION

According to *Safeguarding California*, reducing the rate of farmland conversion will buffer against climate risks by supporting smart growth, reducing unsustainable sprawl, and promoting sustainable food systems and ecosystems. Farmland conservation is a critical component of ensuring food security. Since California's farmland is so



unique, it will be imperative for California to have sufficient farmland in the right locations to allow for food production and flexibility as impacts of climate change become more severe (CDFA, 2015). Recent research showing that, acre-to-acre, urban areas emit seventy times more greenhouse gases than farmland in California emphasizes the important role that farmland conservation has to play in our climate change policy (Jackson et al, 2012).

Rangeland, a category of farmland, offers many ecosystem services such as wildlife, including pollinator, habitat and protection of biodiversity, carbon sequestration opportunities and water and nutrient cycling. Rangeland conservation is a strategy that offers adaptation potential to the agriculture, biodiversity, and water sectors.

The **California Land Conservation Act** of 1965 (known as the Williamson Act) allows landowners to enter into restrictive land use contracts with local governments. These contracts limit the use of the land to agricultural production, compatible uses, or open space. In return, the landowner benefits by having the property taxed based upon the value of its agricultural production and not its potential market value, which always includes some speculative value. Participating landowners are protecting 16.3 million acres (California Department of Conservation, 2013). The **California Farmland Conservancy Program**, has also been a valuable tool in providing permanent protection of important farmland in the state, with over 70,000 acres currently under permanent agricultural conservation easements, as a result of state and partner investments.

The Department of Conservation has developed a new program, the **High Speed Rail Agricultural Land Mitigation Program**, which is designed to mitigate agricultural land loss due to California's High Speed Rail Project through the use of agricultural land easements on agricultural land of similar location, size and quality as farmland that is lost as a result of building California's high speed rail system.

In 2014 the State took an additional step to promote farmland conservation. The **Sustainable Agricultural Lands Conservation (SALC)** program is administered by the Strategic Growth Council and the Department of Conservation.

This program was developed with input from multiple state agencies, including CDFG. The Strategic Growth

Council allocated \$5 million in the 2014-2015 fiscal year from the Greenhouse Gas Reduction Fund for the program. During the 14-15 fiscal year, The SALC program included \$1 million for cities and counties for farmland conservation planning. A second

component of the program included \$4 million for the purchase of agricultural conservation easements. In future years, this comprehensive program will also include a third component; payments to landowners for utilizing management practices that reduce GHG emissions. This

The SALC program included
\$1 million
 for cities and counties for
 farmland conservation planning.



program is not only designed to reduce GHG emissions, but also strengthen agriculture’s adaptive capacity by protecting prime farmland from development.

E. DEVELOP NEW TECHNOLOGIES

CDEFA is a key partner in creating new technologies to build resilience in California’s working lands. CDEFA worked with USDA and Colorado State University to develop a new tool called **COMET-planner**. This tool has been designed to enable farmers to assess the GHG emission reductions from implementing various land management practices. Some of the practices incorporated in COMET-Planner include conservation tillage, strip tillage, cover cropping, windbreak establishment and habitat restoration,

among others. The development of tools to help agriculture adapt to climate change is one of the recommendations referenced in the Climate Change Consortium final report (2013).

Climate change is expected to lead to temporal and geographical shifts in not only food production but also impacts from pests and invasive species. One recommendation outlined in the Climate Change Consortium final report states that CDEFA should “develop and adopt **pest forecasting tools** that account for the effects of climate change.” CDEFA has initiated preliminary efforts to evaluate and understand pest and invasive species movement with climate change using internal pest detection databases. CDEFA will evaluate other new technologies to optimize and reuse waste energy in agricultural operations to ensure food security.

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Next Steps

Despite the broad range of efforts being undertaken by state government to reduce climate risk, adaptation to climate impacts is an ongoing process that will require substantial resources and ingenuity to continually advance. *Safeguarding California* makes clear that adaptation is an iterative process; it will require broadening and improving upon current efforts as climate impacts continue to grow more extreme and expose additional vulnerabilities. This section details the research questions and additional actions that the State will undertake as it continues its mission to safeguard California’s people, environment, and economy.

RESEARCH NEEDS

Demonstration Projects

CDEFA’s Climate Change Consortium provided a suite of recommendations regarding climate

change adaptation. There are management practices in the scientific literature used in other regions of the world that may have applicability in California for climate change adaptation. Demonstration projects that can provide



proof-of-practice are needed in California to test the adaptation strategies and economic benefits/limitations of these practices. Types of demonstrations include (CDEA, 2013):

- Structural, mechanical, or biological methods to reduce crop heat stress;
- Crop training systems for perennial crops to protect them from heat stress and sunburn;
- Cover cropping and crop rotations that can efficiently utilize irrigation systems and prevent runoff;
- Water conservation and/or efficiency outcomes of grower use of soil moisture monitoring, on-farm water storage, and improved irrigation uniformity;
- Benefits of habitat restoration in large-scale agricultural systems.

Co-composting of Dairy Manure and other Organic Wastes

The California 4th Climate Change Assessment for Research scope of work includes a proposal submitted jointly by CDEA and CalRecycle regarding co-composting of dairy manure and food waste. This research relates to several statewide policies including the diversion of organic waste from landfills and the Healthy Soils Initiative. This proposal seeks to quantify the water retention benefits and GHG reductions of aerobically composted food waste and manure in comparison to non-composted manure and food waste. Increasing the moisture-holding capacity of soil is a drought adaptation strategy as it will

promote water conservation and improved crop health.

Economic and Environmental Costs, Benefits, and Risks of Climate Change Adaptation

The California 4th Climate Change Assessment for Research scope of work includes research

regarding the economic risks posed by climate change to California's major food crops and the likely costs of adaptation strategies.

The purpose of this proposal is to provide growers and the agricultural community information needed to inform the decision-making process regarding farming practices in relation to

climate change impacts. The research proposal seeks to answer the following:

- Identification of where specific major crops grown in the state are vulnerable to climate change impacts including potential economic loss;
- Potential practical barriers and economic cost (including potential resources to cover the costs) for specific large acreage specialty crops to be relocated (including infrastructure considerations) to other regions of the state if climate change-related impacts (e.g., increased

The California 4th Climate Change Assessment for Research scope of work includes research regarding the economic risks posed by climate change to California's major food crops and the likely costs of adaptation strategies.



temperature, flooding, reduced winter chill hours) render the current growing regions unsuitable in the future;

- Evaluation of current California conditions and climate analogs (at 50 years and 100 years in the future) through modeling to determine if specific adaptation measures can be used and potential economic cost of those measures;
- Model projections of where specialty crops will be best-suited under future climate conditions in consideration of agronomic variables and natural resources (e.g., soil type, topography, water availability);
- Benefits of maintaining wild or restored habitat in agriculture areas to lessen climate change impacts to agriculture and help adapt to a changing climate (e.g., quantifying in dollar amount the benefits of establishing native pollinator or beneficial predator habitat);
- Impact of climate change on rural and urban food security in disadvantaged communities throughout the state;
- Identify regions of California with the greatest vulnerability to loss of agricultural employment opportunities;
- Identification of potential partnerships and resources (e.g., conversion of food processing facilities to accommodate crop shifting) as adaptation measures to address climate change impacts to specialty crop agriculture in California.

ADDITIONAL ACTIONS

1. Identification of management practices for adaptation

Farmers commonly participate in community learning, learning from others' experiences. CDFA will work with partner agencies such as the USDA Southwest Climate Hub to develop a management practice forum and online reference tools. Demonstration projects will be beneficial to prove the efficacy of potential adaptation practices in California. To complement demonstration projects, a forum for agriculturalists to share their on-farm experiences and experiments regarding water efficiency measures, crop heat stress strategies, alternative crops, among others, would be valuable and help with the implementation of management practices as potential adaptation strategies.

CDFA will consult with agricultural operators, agronomists (potentially local and international) and other stakeholders, including conservation groups, regarding management practices that have been demonstrated to provide adaptive capacity. CDFA will compile the known literature on the practices and post these in an interactive user-friendly tool for growers and ranchers.

CDFA will work with partner agencies such as the USDA Southwest Climate Hub to develop a management practice forum and online reference tools. Demonstration projects will be beneficial to prove the efficacy of potential adaptation practices in California.



CDFa will then solicit critical feedback from California agriculturalists regarding the potential benefits of the practice. CDFa will develop outreach programs and materials to complete the development of such tools and services.

2. Coordinate a Joint Water Management Incentive Program with the Department of Water Resources

CDFa initiated discussions with the Department of Water Resources (DWR) to coordinate a joint grant program that would maximize the water savings benefits and funding available from both agencies. The joint project would direct funding to both a water supplier, such as an irrigation district to make improvements or modernizations to conveyance infrastructure, and to the agricultural operations along that conveyance system to make on-farm improvements to save water and energy. Through this effort, CDFa and DWR hope to demonstrate the maximum benefits that can be achieved from irrigation modernization efforts. Discussions to date have focused on the feasibility and coordination of this effort.

3. Utilize a sub-committee of the Environmental Farming Act Science Advisory Panel, including farmers and researchers, to develop compost application use rates to support a CDFa incentives program on soil health

At the July 17, 2015 meeting of the Environmental Farming Act Science Advisory Panel (SAP) CDFa was directed by the panel to form a sub-committee to development recommendations on

composting guidelines. The value of compost as a soil amendment has been recognized qualitatively and to some extent quantitatively. In order to support the Healthy Soil Initiative, CDFa will convene a technical scientific sub-committee to make recommendations on application rates for compost to agricultural lands. The objective of this sub-committee is to propose compost use application rates that can be used to support a CDFa incentive program on healthy soils application. There is also overlap with climate adaptation as compost has been recognized as an amendment that can improve soil structure, water-holding capacity and nutrient availability to crops. CDFa will ensure to take into consideration the environmental concerns, including unintended consequences, of compost addition to croplands and rangelands as part of this effort with the Environmental Farming Act Science Advisory Panel.

4. Pest and Invasive Species Forecasting and biodiversity enhancements

According to the Climate Change Consortium final report, CDFa should develop and adopt pest forecasting tools that account for the effects of climate change. CDFa will provide resources into understanding any correlations that exist between internal databases and observed climate changes

CDFa initiated discussions with the Department of Water Resources (DWR) to coordinate a joint grant program that would maximize the water savings benefits and funding available from both agencies.



in California. The efforts will be ongoing with the intention of adopting predictive models that assist the Department’s pest and invasive species programs to effectively control pest and invasive species populations and mitigate food crop loss. The Department also recognizes the importance of pollinators and existing biodiversity at the interface

of agriculture. The Department will continue to evaluate methods to enhance native pollinators as part of their Ecosystem Services work.

TIMELINE

The figure below is a timeline of activities related to the agricultural Safeguarding Implementation Plan

ID	Task Name	Start	Finish	Q1 16			Q2 16			Q3 16			Q4 16			Q1 17			Q2 17		
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1	1. Promote Management Practices	1/1/2016	6/30/2017	[Timeline bar from 1/1/2016 to 6/30/2017]																	
2	Consult with agronomists and partners for an established management practice	1/1/2016	8/31/2016	[Timeline bar from 1/1/2016 to 8/31/2016]																	
3	Post on CDFA’s website	6/1/2016	6/1/2016	[Timeline bar from 6/1/2016 to 6/1/2016]																	
4	Post case studies for practice	7/1/2016	10/31/2016	[Timeline bar from 7/1/2016 to 10/31/2016]																	
5	Compile all information on practice into short summary document to post	11/1/2016	1/31/2017	[Timeline bar from 11/1/2016 to 1/31/2017]																	
6	Consult for 2nd management practice	9/1/2016	11/30/2016	[Timeline bar from 9/1/2016 to 11/30/2016]																	
7	Post 2nd practice on CDFA’s website	12/1/2016	12/1/2016	[Timeline bar from 12/1/2016 to 12/1/2016]																	
8	Post case studies for 2nd practice	1/2/2017	6/1/2017	[Timeline bar from 1/2/2017 to 6/1/2017]																	
9	Summary document for 2nd practice	5/1/2017	6/30/2017	[Timeline bar from 5/1/2017 to 6/30/2017]																	
10	2. CDFA/DWR Joint Water Management Grant Program	1/1/2016	6/30/2017	[Timeline bar from 1/1/2016 to 6/30/2017]																	
11	Draft Joint RFP	1/1/2016	8/2/2016	[Timeline bar from 1/1/2016 to 8/2/2016]																	
12	Stakeholder and Public workshops	1/1/2016	8/17/2016	[Timeline bar from 1/1/2016 to 8/17/2016]																	
13	Application Period	5/2/2016	8/31/2016	[Timeline bar from 5/2/2016 to 8/31/2016]																	
14	Joint Review	9/1/2016	10/14/2016	[Timeline bar from 9/1/2016 to 10/14/2016]																	
15	Project Installations	11/1/2016	5/2/2017	[Timeline bar from 11/1/2016 to 5/2/2017]																	
16	Project Verifications	12/1/2016	5/1/2017	[Timeline bar from 12/1/2016 to 5/1/2017]																	
17	Invoicing & Closeout	12/1/2016	6/30/2017	[Timeline bar from 12/1/2016 to 6/30/2017]																	
18	3. EFA SAP Subcommittee Recommendations on Compost	1/1/2016	11/21/2016	[Timeline bar from 1/1/2016 to 11/21/2016]																	
19	Form subcommittee	1/1/2016	2/15/2016	[Timeline bar from 1/1/2016 to 2/15/2016]																	
20	Coordinate information on compost application rates for 3 CA crops	1/1/2016	4/19/2016	[Timeline bar from 1/1/2016 to 4/19/2016]																	
21	Work with NRCS to develop interim conservation practice standard for compost	4/20/2016	8/9/2016	[Timeline bar from 4/20/2016 to 8/9/2016]																	
22	Incorporate the interim practice into any CDFA Healthy Soils Initiative Incentive Programs	8/10/2016	11/21/2016	[Timeline bar from 8/10/2016 to 11/21/2016]																	
23	4. Pest and Invasive Species Monitoring and Forecasting	1/1/2016	6/9/2017	[Timeline bar from 1/1/2016 to 6/9/2017]																	
24	Correlation studies using pest detection databases and observed changes in climate	1/1/2016	9/30/2016	[Timeline bar from 1/1/2016 to 9/30/2016]																	
25	Research predictive models that can be used for pest forecasting	4/15/2016	10/13/2016	[Timeline bar from 4/15/2016 to 10/13/2016]																	
26	Evaluate cost of developing grower tools using the correlation and model studies	10/17/2016	6/9/2017	[Timeline bar from 10/17/2016 to 6/9/2017]																	



Monitoring and Evaluation

While *Safeguarding California* informs efforts to expand the state’s capacity to adapt to climate change impacts, there are many challenges in monitoring and evaluating that capacity. Both climate change impacts and the initiatives undertaken by state government are continually changing. Tools like Cal-Adapt.org show that climate change will lead to worsening impacts at least until the end of the century and almost certainly much longer. At the same time, human behavior and government responses will also necessarily evolve as a new climate emerges and the depth of understanding grows. To track how effectively social systems deal with both ongoing trends and the intensifying events like storms and drought that characterize many climate impacts, a broad set of metrics will need to be developed. This section will begin to explore the relevant monitoring and evaluation already done, the impacts and considerations that must be taken into account to adequately assess resilience, and a few metrics that would inform assessments of adaptation initiatives so far.

Ongoing monitoring efforts already help evaluate what climate adaptation actions need to be taken. The OEHHA Indicators report shows trends in climate impacts, including winter chill, freezing level elevation, extreme heat events, annual air temperature, and annual precipitation. These indicators can be compared to other monitoring efforts underway in state government. CDFA tracks related factors through the California Agricultural Statistics Report, the Pest Prevention Environmental Impact Report and crop and livestock pest and disease occurrences, the Department of Conservation maps farmland quality and protection status throughout out the state. Studying the relationships between various indicators can illuminate the vulnerabilities that state government can help address.

The following specific metrics are examples of the types of data that state government can use to assess the efficacy of its adaptation efforts for the agricultural sector:

- Crop yields, trends and revenues
- Volume of water conserved through the State Water Efficiency and Enhancement Program
- Energy generation from the methane produced by dairy digesters funded through the Dairy Digester Research and Development Program.
- Increases in soil organic matter accomplished through the Healthy Soils Initiative
- Viability of farmland in emerging climate regimes (financial and biological sustainability)



- Farmer engagement and participation in management of resources and in adaptation efforts
- Interaction with online climate tools such as COMET-planner and forums
- Track health impacts from extreme heat to agricultural workers
- Track incidence of plant and animal pests and diseases including changes in distribution, new introductions and establishments in consideration of climatic changes
- Farmland conversion rates near city centers
- Food Security, or the access to enough safe and nutritious food for an active, healthy life.

Climate change is inevitably going to transform California's agricultural sector. The goal of agricultural adaptation efforts should be sustainability and continued vibrancy in the agricultural community at all farm sizes. Engagement with stakeholders must be an underlying theme throughout all state activities in order to achieve successful proliferation of information and elicit collaborative efforts. CDFA will continue to engage with partners and stakeholders to find new ways to build resilience in the sector.

Biodiversity and Habitat Sector Plan



AGRICULTURAL SECTOR PLAN



BIODIVERSITY AND HABITAT SECTOR PLAN



EMERGENCY MANAGEMENT SECTOR PLAN



ENERGY SECTOR PLAN



FORESTRY SECTOR PLAN



LAND USE AND COMMUNITY DEVELOPMENT SECTOR PLAN



OCEANS AND COASTAL RESOURCES AND ECOSYSTEMS SECTOR PLAN



PUBLIC HEALTH SECTOR PLAN



TRANSPORTATION SECTOR PLAN



WATER SECTOR PLAN

Biodiversity and Habitat Sector Plan



Introduction

In 2014, *Safeguarding California: Reducing Climate Risk* outlined the major risks climate poses to biodiversity in the state, and identified opportunities to address these risks through natural resource management.

Some of the major challenges facing the biodiversity sector include the accelerated spread of invasive species, barriers to species migration or movement in response to changing climatic conditions, direct impacts to species health, and mismatches in timing between seasonal life-cycle events such as species migration and food availability. Since the release of the first state adaptation plan in 2009, California state agencies and partners have made important progress with respect to preparing for risks to biodiversity, including many groundbreaking collaborative efforts, as outlined in *Safeguarding California*. Since 2014, climate change has continued to make its way into natural resource management efforts and become an integral part of on-the-ground restoration and conservation activities. Also since 2014, even more research has been carried out to increase our understanding of climate impacts and the vulnerabilities of fish, wildlife, and habitats, and to ensure that our on-the-ground actions are based on best available science.

Still, more work is needed. Additional tools and resources targeted towards state agency staff are needed to help natural resource managers respond

to the challenge of climate change in a meaningful way, and ensure that management and planning efforts are leading to on-the-ground adaptation actions. Continuing education and outreach efforts within, between, and outside of state agencies will be an important part of this effort. Additionally, there are a few key research gaps related to species vulnerability that need immediate attention.

In this Implementation Plan we provide a quick review of major vulnerabilities in the biodiversity sector, and highlight actions taken by state agencies since the release of *Safeguarding California* to address these vulnerabilities. We also identify critical information gaps and next steps towards meeting the overarching goals outlined in *Safeguarding California* to protect fish, wildlife, and habitats in California for generations to come.

Since 2014, climate change has continued to make its way into natural resource management efforts and become an integral part of on-the-ground restoration and conservation activities.



Vulnerability Assessment

This section includes a brief overview of climatic changes projected for California and the broad implications for biodiversity and habitat.

INCREASED TEMPERATURES

Increases in seasonal and annual average temperature in California, as well as subsequent changes in soil moisture, will likely lead to changes in natural community composition and species interactions. Biological impacts such as changes in the timing of seasonal life-cycle events, food web disruptions, species migration, range shifts, and extinction risk are also expected to result. Many of these impacts have already been observed in the state. For example, as reported in the 2013 Indicators of Climate Change in California report, the range of some conifer-dominated forests in the Sierra Nevada are shifting to higher elevations; in Yosemite National Park, distribution shifts of some mammal species populations have also been observed and these populations are being found at different elevations compared to the early 1900s. Additionally, butterflies in the Central Valley have been appearing earlier than usual compared to the past four decades. In the marine region, warming temperatures and reduced upwelling in the oceans has affected the marine food web with negative impacts to auklet breeding and sea lion pup mortality.

Increased temperatures have also led to declines in snowpack and changes in timing and amount of streamflow. Changing hydrologic regimes and

increases in stream temperature may degrade aquatic and riparian habitat for many species. The coupled changes in temperature and precipitation will also result in conditions that are conducive to the spread of pathogens, parasites, diseases and invasive species, which will impact both aquatic and terrestrial ecosystems.

SEA-LEVEL RISE

Accelerated sea-level rise may result in the loss of substantial areas of critical habitat for a variety of coastal species. Sea-level rise will also result in salt water intrusion into fresh water resources near the coast and reduce the amount of fresh water available for plants, wildlife, and competing agricultural and metropolitan uses.

PRECIPITATION CHANGES AND EXTREME EVENTS

Wildfire, flood, and drought are all projected to increase in frequency and severity due to climate change. The prolonged drought in California is already impacting many species; high temperatures and record low-flows have led to

Biological impacts such as changes in the timing of seasonal life-cycle events, food web disruptions, species migration, range shifts, and extinction risk are also expected to result.

¹ <http://oehha.ca.gov/multimedia/epic/pdf/ClimateChangeIndicatorsReport2013.pdf>



eighteen native fish species becoming at high risk of extinction, including delta smelt, most salmon runs, and several trout species (PPIC 2015²). These conditions are consistent with what is expected from long-term climate change.

VULNERABILITY ASSESSMENTS FOR FISH, WILDLIFE, AND PLANTS

Several vulnerability assessments carried out in recent years have illuminated which species and habitats in California may be most vulnerable to the climate risks outlined above. Freshwater fish in California³, bird species of special concern⁴, rare plants⁵, and California amphibians and reptiles⁶

have all been the subject of climate vulnerability assessments.

Since the release of *Safeguarding California*, vegetative communities in California have also been assessed for their vulnerability to climate change. Vegetation was assessed at the macrogroup level, consistent with the conservation targets presented in the 2015 State Wildlife Action Plan, and supportive of the state's efforts to employ an ecosystem-based approach to conservation. Results of the study will help identify climate refugia and highly vulnerable areas in the state. The report was recently finalized by UC Davis researchers and is available on the SWAP 2015 website⁷.

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Current Actions

Numerous organizations and agencies are taking action to prepare for climate impacts in the biodiversity and habitat sector; progress in the field of climate adaptation and mitigation would not be possible without this multitude of organizations and people at work, and the many partnerships and resource leveraging that occurs between them. The content below highlights a subset of this climate adaptation work that has taken place since the release of *Safeguarding California*. This list is meant to serve as a report on the progress of select state agencies with responsibilities related to natural resource management (e.g. the California Department of Fish and Wildlife [CDFW] and the Department of Parks and Recreation [DPR]), and should not be viewed as an exhaustive list of actions taking place in California to prepare for climate impacts.

² http://www.ppic.org/main/publication_quick.asp?i=1160

³ <http://www.energy.ca.gov/2012publications/CEC-500-2012-028/CEC-500-2012-028.pdf>

⁴ Gardali T, Seavy NE, DiGaudio RT, Comrack LA (2012) A Climate Change Vulnerability Assessment of California's At-Risk Birds. PLoS ONE 7(3): e29507. doi:10.1371/journal.pone.0029507 2012.

⁵ <http://climate.calcommons.org/article/featured-project-vulnerability-assessment-rare-plants>

⁶ <http://www.dfg.ca.gov/wildlife/nongame/>

⁷ <https://www.wildlife.ca.gov/SWAP/Final>



Activities below are grouped into five major categories that correspond to the “Actions Needed to Safeguard Biodiversity and Habitats” presented in *Safeguarding California*.

Develop Management Practices to Help Safeguard Species and Ecosystems from Climate Risk

California’s natural resource management efforts are largely focused on maintaining robust species populations and healthy ecosystems. *Safeguarding California* identified two types of actions needed to successfully manage natural resources in the face of climate change: 1) Improve habitat connectivity and protect climate refugia, and 2) Implement adaptive management studies. The following paragraphs describe actions taken to incorporate climate considerations into the state’s biodiversity and habitat-related management practices.

State Wildlife Action Plan 2015 Update: After a multi-year development period, the 2015 State Wildlife Action Plan was finalized on October 1, 2015 and recently approved by the U.S. Fish and Wildlife Service. It is now available on the CDFW website. Climate change adaptation was considered during the development of SWAP 2015 by analyzing the impacts of climate change on ecosystems, using climate change vulnerability as a criterion for Species of Greatest Conservation Need, and developing conservation strategies that address impacts of climate change. The SWAP 2015 update identifies how the SWAP conservation strategies align with *Safeguarding California* and the National Fish, Wildlife, and Plants Climate

Adaptation Strategy, thus achieving and being accountable for important climate adaptation co-benefits through SWAP’s planned implementation.

The SWAP 2015 also includes nine sector-specific Companion Plans that were developed through sector-specific partnerships. These Companion Plans set a stage for achieving the State’s conservation priorities

through continued partnership and by mutually managing and conserving the State’s natural and cultural resources. The Plans provide shared recommendations and key best practices for implementation

and collaboration within each sector; one of the two cross-cutting themes across the companion plan sectors is the recognition of the need to cooperatively address climate change. The draft Companion Plans can be viewed online.⁹

California Endangered Species Act (CESA)

Listed Species Planning: CDFW is currently finalizing a conservation strategy for Mohave ground squirrel that incorporates climate modeling and vulnerability analysis for climate change adaptation. The conservation strategy addresses climate change adaptation through two

California’s natural resource management efforts are largely focused on maintaining robust species populations and healthy ecosystems.

⁸ <https://www.wildlife.ca.gov/SWAP>

⁹ <https://www.wildlife.ca.gov/SWAP/Final/Companion-Plans>



main objectives: 1) establish multiple scenario projections through modeling the potential effects of climate change on the species, and develop management strategies to address the impacts; and 2) establish conservation targets based on modeled refugia. Habitat that may become suitable to the species is clearly identified as a conservation priority.

More broadly, CDFW is also beginning to address climate adaptation through permit conditions as part of its CESA regulatory program.

Safeguarding Species and Ecosystems in the Delta by Prioritizing At-Risk Areas: CDFW has recently accelerated its efforts to include climate change considerations in prioritization exercises for restoration opportunities in the state. For example, sea level rise, changing hydrologic regimes, and other climate risks have been integrated into the Department's Ecosystem Restoration Program Conservation Strategy; this conservation strategy is incorporated into the Delta Stewardship Council's Delta Plan, which serves as a blueprint for restoration of the Delta and Suisun Marsh. Through consideration of these climate risks, the Department has prioritized restoration projects in geographic areas in the Delta and Suisun Marsh that can accommodate the movement of habitats and species to higher elevation in response to sea level rise. Projects that can accommodate additional flood flows (e.g. Yolo Bypass) and achieve co-benefits of additional floodplain habitat to fish and wildlife species have also been prioritized.

Adapting Fish Production and Hatchery

Operations for Climate Change: Integrating the best available science and associated predictive models, CDFW managers are initiating programmatic shifts in hatchery operations to directly account for climate change adaptation. Actions include, but are not limited to: retrofitting hatchery infrastructure statewide to accommodate increases in water temperature, degraded water quality, and variable water supply due to altered hydrology resulting from climate change; actively participating in two pilot programs to evaluate the State's ability to re-introduce at-risk salmon runs above rim dams and back into historic habitat with colder water than lower elevations that can serve as climate refugia; and making capital improvements within the Department's hatchery programs to be prepared for future needs for transferring or trucking trout and salmon during extreme environmental conditions brought on or exacerbated by climate change.

CDFW managers are initiating programmatic shifts in hatchery operations to directly account for climate change adaptation.



Incorporating Climate Change into Land

Acquisition Practices: The Department of Parks and Recreation includes climate adaptation and connectivity as official criteria for the acquisition of park property. This enhances the ability of DPR to contribute to landscape-scale and regional efforts to protect habitat, biodiversity,



and open space. CDFW has incorporated climate considerations into Land Acquisition Evaluations (LAEs) and Conceptual Area Protection Plans (CAPPs) to determine how a proposed acquisition might facilitate adaptation of species and vegetation communities to climate change, and the potential for climate change to diminish key wildlife and habitat values on those lands.

Habitat Restoration in State Parks: Because DPR's habitat restoration activities are focused on restoring natural ecosystem resilience, a large proportion of these efforts result in improved connectivity for species and ecosystems. Common projects include the restoration of fish passage through the removal of dams and other barriers, the restoration of degraded dune systems to allow for protection of coastal habitats and wetlands, the restoration of degraded forest habitats and potential for natural fire regimes, the restoration of natural floodplain actions, etc.

Additional Actions to Support Species

Persistence: CDFW has taken several steps to support robust species populations in the face of climatic change. Efforts to promote resilience of wildlife populations include maximizing water availability, removing non-native competitors, enhancing quantity and quality of habitat, and enhancing population numbers and distribution for species threatened with extinction. Actions already underway include captive breeding of Amargosa voles for release into restored habitat, removal of exotic aquatic species in remaining habitat areas of threatened frogs, and repair of

water pumps and retention/conveyance systems for maintaining flooded marsh for tricolored blackbirds, giant garter snake, Amargosa voles and other sensitive species.

Enhance Biodiversity Monitoring to Detect Climate Impacts

The activities described below are examples of how the state is working to detect climate-related impacts to biodiversity and habitat across the landscape and gain insight into how natural systems are responding.

Instream Flow Studies: The California Department of Fish and Wildlife conducts stream flow studies in priority watersheds and recommends instream flow regimes to the State Water Board to help assure that water flows within streams are maintained at levels that are adequate for long-term protection, maintenance and proper stewardship of fish and wildlife resources. The instream flow program is currently collecting stream flow and fish data in response to the persisting drought; these drought year data will be useful for gaining a more complete understanding of hydrologic variability in watersheds and potential changes in fish distribution as the climate changes.

Efforts to promote resilience of wildlife populations include maximizing water availability, removing non-native competitors, enhancing quantity and quality of habitat, and enhancing population numbers and distribution for species threatened with extinction.



Wildlife Health Monitoring and Response:

CDFW monitors, assesses and provides response support for wildlife mortality events as they may be linked to water availability and stagnation both seasonally and through long-term climate change. Continuing these activities creates an opportunity to use this information to determine if such events are tied directly to climate change. As a result of climate change, it is expected that wildlife species health and condition will decrease as forage and prey species are influenced by persistent drought conditions (e.g., raptors, deer). Avian disease events may occur in greater frequency and over an extended seasonal period (e.g., Avian Cholera), and botulism poisoning events are expected to increase as anaerobic conditions and temperatures increase. Cyanobacteria (or blue-green algae) events have already increased in recent years in both marine and lake ecosystems. These are the types of information that are currently monitored, and that will be essential to detecting trends on the landscape associated with climate change.

Support Environmental Stewardship Across Sectors

Safeguarding California identifies two key strategies to support environmental stewardship across sectors: 1) Promote nature-based solutions for adapting to climate risks, and 2) Create, maintain and support tools that help resource managers determine when and where to focus conservation activities that will protect biodiversity in the face of climate risks. These two concepts align with Governor Brown's directive to prioritize natural infrastructure solutions in all state

planning and investment, and their application to California's adaptation efforts is demonstrated throughout the implementation plans for each sector in *Safeguarding California*. The actions below illustrate relevant efforts undertaken in the biodiversity and habitat sector.

Sustainable Groundwater Management: CDFW, the Department of Water Resources, State Water Board, and other agencies, universities, and NGOs, are working together to implement the Sustainable Groundwater Management Act (2014). CDFW is providing input into the development of metrics and measurable objectives to protect habitat, streamflows and groundwater dependent ecosystems. Sustainable management of groundwater basins and implementation of these sustainability objectives will provide greater protection and resilience of species and habitats that



may be impacted by climate change and altered hydrology. Initial emphasis is on high and medium priority basins that have interconnected surface and groundwater systems, groundwater dependent ecosystems and at-risk native species.

Using Natural Solutions to Protect from Extreme Events: Many of DPR's habitat restoration projects also provide benefits in terms of reducing climate risks. For example, efforts to control invasive understory species in forest and woodland understories also reduce the availability of

Dune restoration and coastal infrastructure setbacks have ensured that coastal habitat continues to be available and other resources remain relatively protected from storm surges and extreme events.



flammable, unnatural wildfire “fuels”. Similarly, dune restoration and coastal infrastructure setbacks have ensured that coastal habitat continues to be available and other resources remain relatively protected from storm surges and extreme events.

Creating and Maintaining Tools for Natural Resource Managers: In addition to a guidance document to address sea level rise in project planning, DPR has developed and published an internal website with climate change resources for natural resource managers. The website provides staff with information that is up-to-date, concise, and relevant for land managers at the state park scale. DPR has also increased internal capacity for providing support to field staff on topics related to climate change.

Improve Understanding of Climate Risks to Biodiversity and Habitats

Safeguarding California identified the following actions needed to improve our understanding of climate risks to biodiversity and habitat: 1) Complete habitat and vegetation mapping, 2) Refine regional connectivity analyses, 3) Perform additional climate vulnerability analyses, 4) Understand extreme events and disturbance regimes, and 5) Identify opportunities to address the emissions that contribute to climate change. The efforts described below are examples of activities that will help fill these important climate-related information gaps in the biodiversity and habitat sector.

Climate Vulnerability Assessment of Vegetative Communities in California:

In 2014 CDFW funded a comprehensive, statewide climate change vulnerability analysis of vegetative communities to better understand climate risks to California’s biodiversity. This research, carried out by UC Davis, was completed as part of the SWAP 2015 update and is intended to be used together with taxon specific vulnerability assessments to help identify where habitats and species that are highly vulnerable to climate change exist. Conservation and adaptation can then be focused on those areas to ensure habitats are restored and resilient, and movement is unimpeded for vulnerable species.

In 2014 CDFW conducted a rapid assessment of 358 sensitive species of amphibians, reptiles, birds and mammals to determine which species were most vulnerable to current drought conditions.

Vulnerability information at this scale will support ecosystem-based conservation and planning and management efforts, and can also be used to increase our broader, ecoregional understanding of the vulnerabilities of biodiversity to climate change. The final report is now available on the CDFW website.¹⁰

Prioritization of Nongame Terrestrial Species through Risk Assessment:

In 2014 CDFW conducted a rapid assessment of 358 sensitive species of amphibians, reptiles, birds and mammals to determine which species were most vulnerable to current drought conditions based on life history

¹⁰ <https://www.wildlife.ca.gov/SWAP/Final>



characteristics, population size and distribution, and importance of water to their life stages. This followed vulnerability assessments for At-risk Birds at a statewide level, rare plants, and at a smaller scale, San Francisco Bay tidal marsh birds and Sierra Nevada birds. The 2014 assessment resulted in a list of 48 Priority I and 65 Priority II species that merit highest consideration for resource assessment in the field. Since more frequent drought-like conditions are projected to occur in the future, we expect that these species are also highly vulnerable to climate change. These assessments, which include on-going data collection, additional focused surveys, and establishing monitoring programs at larger scales will develop a more comprehensive understanding of wildlife response to climate change going forward.

Greenhouse Gas Emissions Reduction through Wetland Restoration: In 2014, CDFW received auction proceeds from the state's Cap and Trade Program via the Greenhouse Gas Reduction Fund. In response, CDFW created a new 'Wetland Restoration for Greenhouse Gas Reduction Grant Program'¹¹ to fund on-the-ground restoration projects that directly result in greenhouse gas emissions reductions. The program is focused on coastal wetlands state-wide, Sacramento-San Joaquin Delta wetlands, and mountain meadows. To date, the program has funded 12 projects totaling \$21 million, which will result in approximately 2,500 acres of restored or enhanced habitat. Each project will monitor, measure, and report GHG reductions pre- and post- project implementation.

¹¹ <https://www.wildlife.ca.gov/Conservation/Wetlands-Restoration>

¹² http://www.dfg.ca.gov/Climate_and_Energy/Climate_Change/Climate_College/

Funding awards were announced in April 2015, and projects officially began in June 2015.

Share Information and Educate the Public

Exchanging information on climate risks to biodiversity and the appropriate adaptation strategies/actions is necessary to illustrate the importance of climate adaptation and ensure that a

cohesive and collective approach to adaptation is taken. The following actions are identified in *Safeguarding California* to promote information sharing between agencies and the public: 1) Create and maintain partnerships that support biodiversity conservation in a changing climate, and 2) Promote public education and outreach on climate change impacts to biodiversity. The paragraphs below describe recent education and outreach efforts to support climate education in the biodiversity and habitat sector.

CDFW Climate College¹²: The CDFW Climate College is intended to provide foundational knowledge for all staff and partners on climate change science and its impacts to fish, wildlife, and habitats, with the ultimate goal of effectively incorporating projected climate impacts into the state's resource planning, management, and project activities. In spring 2014 CDFW held the second

In 2014 CDFW funded a comprehensive, statewide climate change vulnerability analysis of vegetative communities to better understand climate risks to California's biodiversity.



iteration of its Climate College, focusing on the state's marine resources. The course described California's unique challenges and opportunities in managing its 1,100 miles of coastline, bays/estuaries, and marine protected areas under climate impacts. The course also featured case studies to show examples of responses to climate impacts. Lecture topics covered atmospheric changes, physical oceanic changes, sea level rise, ecosystem responses, and conservation planning.

Climate Science Alliance – South Coast: The Climate Science Alliance – South Coast is a new

partnership that was formed in 2015 to create and support a network of leaders, scientists, and natural resource managers in the south coast region focused on sharing ecosystem-based resiliency approaches to safeguard our communities and natural resources from climate change risks. Development of the Alliance is supported by a partnership between the California Department of Fish & Wildlife, the California Landscape Conservation Cooperative, the San Diego Regional Climate Collaborative, the California Wildlife Foundation, and the Robert and Patricia Switzer Foundation.



Next Steps

While climate adaptation and mitigation efforts have accelerated in the biodiversity and habitat sector, there is more work to be done. When reviewing the major adaptation categories presented in the Safeguarding California and listed above, several areas emerge as being substantial gaps in our adaptation efforts while simultaneously providing the biggest opportunities moving forward. For example, creating and sharing tools and climate change resources that lead to direct management activities, vegetation mapping and biodiversity monitoring, and a few remaining gaps in climate vulnerability assessment, are all areas where steps can be taken in the next couple of years to move our collective adaptation efforts forward.

The content below further describes existing gaps in our climate adaptation efforts and how these informational and management-type gaps could be filled. The actions are divided into two general categories – 1) those that will be a continuation of an existing effort, and 2) those that represent new initiatives or projects. In addition to identifying actions that address shortcomings

in our adaptation efforts, we also identify actions that will continue to push us forward in areas where substantial progress has already been made; it is equally important to continue making strides in these areas of relative progress to avoid complacency.



EXPANDING EXISTING PROGRAMS OR PROJECTS TO FULFILL SAFEGUARDING RECOMMENDATIONS

Expanding Biodiversity Monitoring in

California Wetlands: CDFW has an opportunity through its new ‘Wetland Restoration for GHG Reduction Grant Program’ to advance biodiversity monitoring in California wetlands. This can be achieved by first bolstering language in future project solicitations with respect to monitoring of co-benefits to fish and wildlife resulting from project implementation. CDFW will subsequently be able to refine monitoring and reporting requirements for co-benefits in accompanying grant agreements for projects funded through this program. This task will be completed for the FY2016-2017 grant solicitation.

Climate Change & CEQA Planning: Climate change adaptation considerations are already being incorporated into the CEQA review process at CDFW; however, there is a need to develop an approach to incorporating climate change impacts and risks to biodiversity in a way that leads to adaptation actions for fish and wildlife. Developing a uniform approach is especially important given the complex nature of review and the widespread coordination of staff and partner organizations that is required across CDFW Regions and at headquarters in Sacramento. Over the next year, CDFW will revamp its efforts to develop a systematic approach to addressing climate change adaptation in the CEQA review process. Climate Science Program Staff will work with the CEQA Program and Regional Offices to generate guidance

on CEQA and climate change adaptation for internal use. This task will be completed in 2016.

Implementation of the 2015 State Wildlife

Action Plan: Implementation of the conservation strategies outlined in the 2015 SWAP will help to ensure that key habitats in California are resilient to the impacts of climate change, and will have the co-benefit of implementing recommendations from 2014 Safeguarding California and the National Fish, Wildlife and Plants

Climate Adaptation Strategy. SWAP implementation will be accomplished directly through many of the department’s existing programs including federal grants, Cap and Trade investments, conservation planning, and conservation partnerships. The department will periodically evaluate the success of these strategies against these actions and others that are part of the overall conservation emphasis that permeate department programs.

State-wide Vegetation Mapping: California needs a comprehensive, high-resolution, state-wide digital vegetation map, created in compliance with the Survey of California Vegetation (SCV)

Climate change adaptation considerations are already being incorporated into the CEQA review process at CDFW; however, there is a need to develop an approach to incorporating climate change impacts and risks to biodiversity in a way that leads to adaptation actions for fish and wildlife.



standards. Conservation, infrastructure, and land use planners identify such a map as one of the top data requirements for the state, and change detection for fish and wildlife habitat is predicated on having accurate, high resolution data. To date, approximately 42 percent of the state has been mapped to SCV standards. CDFW has already prioritized areas for vegetation classification and mapping in the state based on environmental stressors and conservation planning needs. CDFW is looking to expand its current efforts to complete this work, and will seek funding opportunities and support to continue these efforts in the coming years.

Updating State Agency Website Materials on Climate Change & Biodiversity: CDFW's Climate Science Program website¹³ is one of the channels through which climate risks to biodiversity are communicated to the public. Over the next several months, CDFW staff are committed to overhauling the website by replacing outdated information with recent research and publications on risks to biodiversity and habitat. The website will also include newly developed information on how CDFW is working to minimize risks to climate change and enhance resilience of California ecosystems, with links to other state agency climate change efforts. Initial material will be based on the actions identified in Section 3 of this document. The website update will be completed by mid-2016.

Expanding Funding for Ecosystem Restoration: The Department of Parks and Recreation will continue pursuing funds for restoring native

ecosystems through available resources, including funds in a range of Proposition 1 programs. In addition, State Parks Transformation Action Plan has a strategic goal of protecting natural and cultural resources and will identify best practices, projects, and other efforts to address climate change adaptation as part of this goal moving forward.

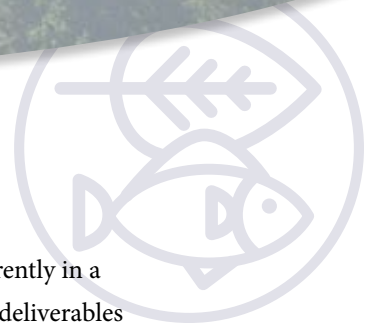
Expansion of Existing Tools and Guidelines for Natural Resource Managers: DPR will continue to update available resources and develop additional guidance for natural resource managers to increase the consideration of climate change to resource management. Through the Transformation Team effort, mentioned above, it is anticipated that increased opportunities for monitoring and research, and information sharing will be created to ensure that all managers are aware of best practices for ensuring resilient natural landscapes.

Incorporating Climate Change into Invasive Species Management: Preventing the introduction and spread of invasive species is the most effective

means of minimizing their negative impacts and reducing this non-climate stressor. Moving forward, the Invasive Species Program at CDFW plans to incorporate climate change adaptation into the next California Aquatic Invasive Species

Preventing the introduction and spread of invasive species is the most effective means of minimizing their negative impacts and reducing this non-climate stressor.

¹³ http://www.dfg.ca.gov/Climate_and_Energy/Climate_Change/



Management Plan revision by: identifying new pathways for the movement of invasive species; evaluating how potential conservation efforts, such as wildlife corridors, relocations, and habitat restoration efforts, may facilitate the spread of invasive species; and prioritizing control and eradication that would yield the highest benefit to larger climate change adaptation efforts. These planning efforts will be designed to remain flexible and relevant as environmental conditions change. The revision of the California Aquatic Invasive Species Management Plan is slated for completion in July 2016.

NEW INITIATIVES TO FILL IMPLEMENTATION GAPS

Creating New Tools and Materials for State

Agency Staff: Many excellent tools and resources for decision-makers have been developed in the biodiversity and habitat sector. There is often a need to condense the information pool and tailor these resources to a specific end-user to maximize utility. To that end, CDFW will develop support materials that are specifically relevant to its work and responsibilities as a steward of the state's natural resources. A new project is currently under development to generate reference materials and guidance for CDFW staff on how to incorporate climate change into their daily work as appropriate. This effort will potentially include compiling existing resources, performing new analyses (e.g. a GIS analysis of which Department Lands are expected to experience the greatest impacts from climate change), generating report materials, and

advertising results. This project is currently in a planning phase; project activities and deliverables will be solidified by mid-2016.

Enhancing Organizational Capacity to Better Address Climate Change:

DPR's Transformation Action Plan (for reshaping key areas of the Department over 2 years) will provide opportunities for enhancing existing efforts and developing new program areas to address climate change adaptation as part of its strategic goal of protecting and enhancing the natural and cultural resources of the system.

Utilization of the State-wide Vulnerability Assessment for Vegetative Communities:

The vulnerability assessment for vegetative communities in California was recently completed by UC Davis through State Wildlife Grant funding from CDFW. To ensure that the results and information gleaned from this research are utilized, a couple of key actions will be taken. First, CDFW will hold a public meeting in spring of 2016 to present the results of the study and increase awareness of this new source of information. Second, CDFW will generate a brief guidance document to include recommendations on how these research results could be used in existing programs and projects at the Department. This guidance document may result in a series of presentations or other outreach attempts to ensure it is publicized and has a better chance of reaching the appropriate Department staff. The guidance document will be generated in 2016.



Climate Vulnerability Assessment for Terrestrial

Mammal Taxa: Another gap in our climate vulnerability knowledge is surrounding climate risks to terrestrial mammals. As of June 2015, researchers at UC Davis began working with staff from CDFW's Nongame Wildlife Program and Biogeographic Data Branch to identify species at risk from climate change. The project will generate spatially explicit projections of future distribution for these species, and will designate their climate change vulnerability in five classes ranging from "Extremely Vulnerable" to "Potentially Increasing." The objective of this project is to provide CDFW and other conservation and land management organizations a quantitative and spatially-explicit depiction of the potential effects of climate change on California's terrestrial mammal taxa considered most at risk from projected climatic regimes and coastal inundation. This project will be completed in June 2016.

Assessing Vegetative Communities in State

Parks: DPR is initiating an assessment of its vegetative communities, beginning with forest resources, including a description of forest condition and management practices. This assessment will help identify climate risks and opportunities to incorporate adaptation planning to on-the-ground management.

Comprehensive Vulnerability Overview: As additional vulnerability analyses are completed, there will be a need to look across these studies and assimilate the findings in order to gain a better understanding of overall climate risk to

biodiversity across California. CDFW will develop a method for cross-comparing the results of existing vulnerability studies for fish and wildlife, including birds, reptiles and amphibians, mammals, and vegetative communities.

This method and subsequent implementation will initiate upon completion of the mammal assessment in 2016.

Migration Corridors and Refugia as Adaptation

Strategies: As regional climate changes, the conditions that made habitat suitable for a species will shift to new geographic locations, often northward or upward in elevation. To survive, species must migrate across the landscape to follow the shifting habitat conditions that they require. Maintaining connectivity through migration corridors and "stepping -stones" will facilitate the movement of species between currently suitable areas and to newly suitable areas over time as the climate changes. There is a need to critically review existing efforts designed to identify migration corridors and temporary refugia, and to identify critical habitat linkages and climate refugia where needed as informed by the critical review. This information gap is expected to be fulfilled as part of the state's 4th climate change assessment in 2016.

As of June 2015, researchers at UC Davis began working with staff from CDFW's Nongame Wildlife Program and Biogeographic Data Branch to identify species at risk from climate change.



Monitoring and Evaluation

Monitoring and evaluation is often the most difficult part of a project to complete, whether due to resource limitations and barriers, or simply a lack of knowing what to monitor and how to evaluate success. For both of these reasons, there is much to do in the way of monitoring and evaluation to detect climate impacts on the landscape and to measure resiliency of species and habitats to these changes. This difficult but important step will require monitoring many different kinds of data and information at all stages throughout the adaptation planning and implementation processes. In this section we discuss 1) indicators of climate change occurring in California, specifically to detect impacts to biological systems, and 2) metrics for monitoring adaptation activities and the subsequent increase in resilience.

INDICATORS OF CLIMATE CHANGE IN CALIFORNIA: IMPACTS TO BIOLOGICAL SYSTEMS

Establishing metrics for detecting climate change and related impacts may seem more feasible than determining how best to measure resiliency; on-the-ground adaptation implementation is relatively nascent for most agencies and it will take time to see the effects of these actions unfold. However, climatic changes and related impacts to the California landscape are already being observed. The OEHHA climate change indicators¹⁴ have been developed to detect physical and biological changes on the landscape that are indicative of climate change in California. The indicators identified to detect impacts of climate change on vegetation and animals are of particular importance to the biodiversity and habitat sector. Current indicators include such factors as changes in vegetation distribution, tree

mortality, changes in migration patterns of birds and butterflies, abundance of certain fish species, breeding and abundance patterns of several marine species, and more. In general, migratory patterns, species abundance and distribution, reproductive observations, and mortality events are all appropriate indicators of environmental changes and potential drivers.

Other indicators that would be useful for detecting climate-related impacts to biological systems are described below, and could be strong additions to the existing list of indicators presented in the 2013 OEHHA report:

- 1) **Wildlife health:** There are several indicators related to wildlife health that could be useful for detecting climate-related impacts to wildlife in California. Disease emergence and distribution, distribution and prevalence of existing diseases, body condition, and mortality events could all be

¹⁴ <http://www.oehha.ca.gov/multimedia/epic/2013EnvIndicatorReport.html>



indicators of large-scale environmental change. Ultimately these health or mortality factors should be directly reflected in population status, and monitoring of health factors and population status will need to be linked to fully understand climate-related impacts.

- 2) **Invasive species:** Tracking the distribution of select aquatic and/or terrestrial invasive species could help determine if the spread of these species is accelerating in response to changing climatic conditions that are observed.
- 3) **Vulnerable species:** In general, focusing monitoring efforts on highly vulnerable species and communities may be a good strategy for early detection of climate impacts, as this is where climate impacts will likely be observed first (if not already evident). The numerous vulnerability assessments for fish, wildlife, and habitats that have either already been conducted or are currently underway, can help determine where to focus these monitoring efforts in the future.
- 4) **Streamflow:** Changes in the timing and amount of streamflow can have a multitude of implications for aquatic habitat and species. Given the current understanding of relationships between streamflow data and habitat quality, once changes in streamflow are detected, it may be possible to identify which riparian systems and species are most likely at-risk, and management actions can be adjusted accordingly where appropriate.

5) **Other Key Ecological Attributes:** The SWAP

2015 identifies key ecological attributes (KEAs) for each conservation target presented in the plan. KEAs are the attributes of an ecosystem that most contribute to the viability of that ecosystem (e.g. area and extent of a community, community structure and composition, hydrologic regime, etc.). Status indicators for each KEA have also been identified, and these indicators build on those listed in the OEHHA report (see table 1.5-2 in SWAP 2015). These KEAs and associated indicators may be additional factors for detecting climate-related impacts to biological systems.

Focusing monitoring efforts on highly vulnerable species and communities may be a good strategy for early detection of climate impacts, as this is where climate impacts will likely be observed first.

Monitoring indicators requires that a certain amount of measurable information and data be either already available or easily attainable. As more baseline information becomes available, it may be possible, and in some cases necessary, to change or add other indicators to this list.

METRICS TO MEASURE INCREASED RESILIENCY OF NATURAL SYSTEMS TO CLIMATE CHANGE

Equally important to detecting climate impacts to biological systems are efforts to monitor resiliency. In general, indicators for a resilient landscape will



likely be based on ecosystem function and health (see list of new indicators above). Declines in disease occurrence, low or stable mortality rates, and deceleration in the spread of invasive species are examples of what we might expect to see in a resilient ecosystem. The SWAP 2015 devotes a chapter to the topic of monitoring and evaluation, which includes a framework for developing effectiveness measures and other ideas that could

be relevant to the climate adaptation strategies for the biodiversity and habitat sector presented in the 2014 Safeguarding Plan. The most appropriate measures of ecosystem function and health, and the necessary frequency of measurement, may need to be locally or regionally defined by bringing multiple organizations and expertise together.

Emergency Management Sector Plan



AGRICULTURAL SECTOR PLAN



BIODIVERSITY AND HABITAT SECTOR PLAN



EMERGENCY MANAGEMENT SECTOR PLAN



ENERGY SECTOR PLAN



FORESTRY SECTOR PLAN



LAND USE AND COMMUNITY
DEVELOPMENT SECTOR PLAN



OCEANS AND COASTAL RESOURCES
AND ECOSYSTEMS SECTOR PLAN



PUBLIC HEALTH SECTOR PLAN



TRANSPORTATION SECTOR PLAN



WATER SECTOR PLAN





Emergency Management Sector Plan

Introduction

California (CA) promotes collaborative community-based planning and preparedness among stakeholders from all sectors of society and disciplines, working together to ensure effective response to emergencies (CA State Emergency Plan, 2009). Emergency management is a comprehensive system of policies, practices, and procedures designed to protect people and property from the effects of emergencies or disasters. It includes programs, resources, and capabilities to mitigate, prepare for, respond to, and recover in an all-hazards approach. While the scope, severity, and pace of future climate change impacts are somewhat difficult to predict, it is clear that the impacts will have bearing on emergency management capabilities and cause an increased need for services. The severity of emergencies is determined not only by the occurrence of natural events (that may be increasing in magnitude and frequency due to climate change), but also on the level of exposure and socio-economic vulnerability to those events (Safeguarding CA, July 2014).

Extreme weather is already changing the condition of emergency management. California continues to experience unprecedented drought conditions, which have already been occurring for more than four years. Destructive fires have also increased in their frequency, severity, and intensity - greatly impacting communities and the resources used to combat the fires. The toll of extreme weather events is being felt globally in terms of losses and costs: it is well documented that 2011 was one of the most costly years for natural disasters on record, in terms of the number and severity. Our approach to climate must be distributed and multi-faceted: public awareness, planning and increased resilience, and adjusting our resources and tactics to effectively respond and recover from future events. This plan describes how CA is moving forward to address climate in emergency management.

There are four phases of emergency management, and given the current and expected increase in climate change-related hazards projected for the future, climate must be considered in all phases:

1) Preparedness:

Activities conducted in advance of an emergency to develop operational capabilities and improve response to disasters and/or emergency events. This phase takes place before an emergency occurs, and can include plans and/or preparations made to save lives and to help response and rescue operations.

California (CA) promotes collaborative community-based planning and preparedness among stakeholders from all sectors of society and disciplines, working together to ensure effective response to emergencies (CA State Emergency Plan, 2009).



2) Response: Activities conducted to save lives and prevent harm to the public, property, animals, and the environment during an emergency. This phase takes place during an emergency, and puts preparedness activities and plans into action.

3) Recovery: Activities that restore vital life-support systems to minimum operating standards after an emergency and support the return of communities to a (new) state of normalcy.

4) Mitigation: Actions taken to eliminate or reduce the severity of long-term risk to human/animal life, property, and the environment from the impacts of future disasters. This phase includes any activities that prevent an emergency, reduce the chance of an emergency happening, or reduce the damaging effects of unavoidable emergencies. Mitigation activities can take place both before and after emergencies.

The CA Governor’s Office of Emergency Services (Cal OES) has responsibility under the CA Emergency Services Act (ESA, Government Code Section 8550) to do, in part, the following:

- Support and act on behalf of the Governor’s Office during an emergency event
- Mission assign tasks to state agencies to be performed during an emergency
- Facilitate the rendering of mutual aid throughout the state

- Lead and direct state agency activities in support of local government during an emergency

Cal OES is also tasked with developing and maintaining a statewide emergency response system for use by all emergency response agencies

(ESA, Government Code Section 8607). The Standardized Emergency Management System facilitates prioritization of needs, interagency coordination, and the efficient flow of resources and information. SEMS is the state’s emergency response system and the fundamental structure for the response phase of emergency management. State agencies are required to use SEMS by law, and local government entities must use SEMS to be eligible for reimbursement of response-related costs under the state’s disaster assistance programs. SEMS by design is flexible and scalable.

The challenges posed by climate change could significantly alter the types and magnitude of hazards faced by communities within California and the emergency management professionals serving them. The Emergency Management Sector Implementation Plan, developed in support of *Safeguarding California: Reducing Climate Risk* (July 2014), describes an assessment of CA’s vulnerabilities as related to climate change (from

The challenges posed by climate change could significantly alter the types and magnitude of hazards faced by communities within California and the emergency management professionals serving them.



an emergency management perspective), current emergency management actions being taken to prepare the state for both existing and future

climate impacts, and recommended next steps and strategies.

Vulnerability Assessment

CA is a wealth of diverse populations and geophysical and weather-related characteristics. CA’s geologic and geographic extremes are demonstrated by the fact that the state has both the highest and the lowest elevation points within the contiguous United States. Given this diversity, the climatic conditions vary significantly depending on latitude, elevation, and proximity to the coast (State of CA Emergency Plan, 2009). Climate impacts, such as more extreme weather events, sea level rise, changing temperature and precipitation patterns, and more severe and frequent wildfires, present new risks and uncertainties that will affect all phases of emergency management. Without actions to incorporate climate considerations into emergency management efforts, climate change will increase risk to public safety, property damage, and

emergency response and recovery costs to government and taxpayers (Safeguarding CA, July 2014).

As the effects of climate change continue to become more noticeable, vulnerability to the increased hazards associated with climate change is expected to surge for human and animal populations, the environment, and the state’s agricultural resources. The state is already vulnerable to a host of hazards, including earthquakes, floods, fires, volcanic eruptions, landslides, dam and levee failures, severe weather (including both atmospheric river storms and droughts), and tsunamis. Further hazards include emergencies related to hazardous materials,

nuclear power plants, cybersecurity, terrorist attack, pandemic/epidemic, and food and water supply (agricultural). Some of the direct impacts of climate change that create vulnerabilities that emergency managers must address include the following items.

INCREASING SURFACE AIR TEMPERATURES

The range of disasters and risks affected by increasing temperatures across California alone illustrate the breadth and severity of climate risks

Without actions to incorporate climate considerations into emergency management efforts, climate change will increase risk to public safety, property damage, and emergency response and recovery costs to government and taxpayers (Safeguarding CA, July 2014).



in the emergency management sector. While world leaders seek to limit global temperatures from rising more than 2° Celsius (3.6° Fahrenheit), California will potentially see temperature increases of up to 9 to 12 degrees in some regions, especially if global emissions are not reduced quickly and substantially.

The public health risks associated with even mild temperature rises are substantial due to the increased frequency and severity of heat waves. One report predicted that California could see up to 7,700 additional heat-related deaths per year by the end of the century—more than twice the average number of traffic deaths annually in the state today (Climate Risk in the Golden State, Risky Business). Emergency management preparedness activities will need to increase the focus on response to respiratory problems and increasing emergency room visits from vulnerable populations. Rising temperatures are also linked to the more rapid spread of diseases and pests, leading to public health and agricultural emergencies.

Wildfires are linked to multiple climate impacts and, like changing precipitation patterns, storm events, and temperatures, correlate to many public health and public safety concerns. California has already seen a rapid rise in the number and severity of wildfires, and emergency managers are working to prepare for wildfire occurrence rates that could double by 2085 (California Adaptation Strategy, 2009).

EXTREME WEATHER EVENTS

Climate change will create stronger and more frequent extreme weather events with more destructive rainfall and winds, directly affecting emergency management in the state. A study found that a single storm could cause up to \$725 billion in economic damages and directly cause harm to much of California’s population (ArKStorm, USGS). More powerful weather events along the coast will combine with sea-level rise to provide further challenges to emergency response. A 1.4 meter rise in sea-level combined with a 100-year flood event will put almost half a million Californians at risk (Impacts of Sea-Level Rise on CA Coast, CA Climate Change Center).

Powerful weather events along the coast will combine with sea-level rise to provide further challenges to emergency response

DROUGHT AND CHANGING PRECIPITATION PATTERNS

The current historic drought is the most salient example of the ways that climate change will exacerbate disasters and emergencies affecting CA. A recent study found that climate change contributed up to 27% of the severity of the current drought; even more sobering was NASA’s finding that climate change could make a mega-drought of three decades extremely likely in the next century.



These findings are indicative of the overall shift in historical weather and storm patterns, resulting in more extreme cycles between large-scale weather events causing flooding and longer periods of warmer weather and reduced precipitation resulting in drought. This cycle will create more frequent and destructive landslides, as well as negatively impact water quality and reliability. Warmer temperatures and changing precipitation patterns are also projected to cause abrupt declines in California's snowpack, which the state depends on for water supply and environmental quality. The projected loss of up to 90% of snowpack in the Sierra Nevada mountains will have many consequences for the state's mountainous regions. These factors will lead to more numerous and severe floods, wildfires, and other emergencies.

SEA-LEVEL RISE

Coastal impacts will often result from a combination of more extreme weather events and storm surge with sea-level rise, but additional factors like erosion, subsidence, and wave action also come into play to threaten critical infrastructure. Emergency managers are faced with increased vulnerabilities due to climate risks to roads, airports, water treatment plants, energy facilities, and hospitals related to sea-level rise and associated erosion and flooding.

These vulnerabilities are detailed in greater length in many areas, and Cal OES in particular has examined the impacts as they relate to its mission of protecting California's people, economy, and

environment in the event of emergencies. In the State Hazard Mitigation Plan (SHMP), climate change is characterized as a condition that will change and potentially exacerbate the impact of other hazards, rather than a distinct hazard with unique impacts. For example, extreme heat and heat waves are existing hazards that are expected to be exacerbated by climate change.

These impacts will all affect the state's emergency management efforts. Increasing hazards resulting from climate change will necessitate a more robust emergency management and response community. An increase in emergency events, and an increase in magnitude of those events, is expected to more quickly overwhelm local, county, and regional resources, and necessitate the use of more state and federal resources. Continued coordination and collaboration between all levels of government, the private sector, and tribes are imperative to ensure continued success and risk sharing among the emergency management community and the public.

Emergency managers are faced with increased vulnerabilities due to climate risks to roads, airports, water treatment plants, energy facilities, and hospitals related to sea-level rise and associated erosion and flooding.



CURRENT ACTIONS TO PREPARE FOR CLIMATE IMPACTS

Cal OES has statutory responsibility under the ESA to lead and direct state agency activities in support of local government during an emergency. Cal OES continuously works with other state agencies in all four phases of emergency management. The utmost priority in emergency management is to best protect Californians, and this plan will illustrate how ongoing and planned actions fit into the State’s broad initiative to safeguard against climate change impacts and emergencies and disasters overall. *Safeguarding California* presents four primary recommendations for emergency management to address climate change. These recommendations, and how they are being implemented, are described here.

Improve integration of climate impacts and projections into all phases of emergency management

Emergency management requires a proactive stance, and Cal OES strives to be at the forefront to integrate the best models and projections to address climate impacts in all phases of emergency management. Planning and providing incentives to incorporate that best available science that can inform emergency management is a key part of this recommendation.

To be effective, climate must be considered within the planning and risk reduction efforts already taking place. To facilitate this, Cal OES promotes the implementation of the Climate Adaptation Planning Guide (APG) and inclusion of climate

risk reduction into hazard mitigation planning efforts at all levels. In addition to the APG, the state promotes the principles of sustainability, resilience, and hazard mitigation through collaboration with key public and private sector organizations through mechanisms such as:

- Reviewing Local Hazard Mitigation Plans (LHMPs) and providing guidance on the LHMP process
- Assisting with the development of local, regional, and state emergency operation plans
- Encouraging LHMP adoption into the Safety Element of local government General Plans

APG implementation and hazard mitigation efforts also consider the vulnerability of various community resources to climate risks. Assisting communities with taking the steps to assess and protect the resources most important to their safety and wellbeing creates grassroots resilience against climate effects.

The state also continues to support the integration of climate risks into state and local government emergency planning efforts and enhance capacities at all levels to respond to and recover from emergencies in other ways. Grants, planning assistance and guidance, mutual aid agreements,

The state promotes the principles of sustainability, resilience, and hazard mitigation through collaboration with key public and private sector organizations.



post-disaster recovery, and hazard mitigation all play key roles that, when combined, help to ensure effective emergency management programs. As CA agencies continue to plan for the effects of climate change, opportunities for joint projects, information sharing, and leveraged resources between agencies must be considered.

Cal OES works with local agencies and the Federal Emergency Management Agency (FEMA) to develop LHMPs that meet local and regional needs for hazard mitigation, as well as federal requirements to qualify for disaster funding. Those funds, in turn, can be invested toward risk reduction projects. Cal OES continuously works to meet this objective and incorporate climate into our existing plan reviews of LHMPs, as well as guidance and training provided annually on the development of LHMPs. Cal OES has also developed sample language (approved by FEMA) for local jurisdictions to incorporate into their overall mitigation planning. We have seen that, increasingly, LHMPs are integrating climate change into their overall mitigation strategies. (Please refer to the Land Use and Community Development Sector Plan of this document for additional information on General Plans and SB 379).

FEMA mitigation grant opportunities include the Hazard Mitigation Assistance (HMA) Program, which consists of the Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM), and Flood Mitigation Assistance (FMA), as well as Fire Management Assistance Grants (FMAGs) and Public Assistance Grants

(Categories C-G). Assembly Bill 2140 (AB 2140, October 2006), allows a local jurisdiction to adopt their current, FEMA-approved LHMP into the Safety Element of their General Plan, which in turn can increase the percentage of available state disaster assistance through the California Disaster Assistance Act (CDAA).

Local jurisdictions must update their mitigation plans every five years in order to maintain eligibility for FEMA’s mitigation grant programs. To date, most counties in CA (80-85%) have current LHMPs. As funding opportunities arise, Cal OES continuously prioritizes those counties without current LHMPs to achieve the goal of full coverage in the state and holistically build resilience against climate impacts.

In line with the ongoing actions supporting LHMPs, Cal OES also works with many key stakeholders on the SHMP, which must be updated and approved by FEMA at least every five years. The SHMP is an umbrella document for statewide hazard mitigation, and is a collaborative effort to identify, reduce, or eliminate the long-term risk to human life and property from natural or human-caused hazards. The plan is also a proactive strategy for reducing disaster losses and building overall resilience, providing measures and guidance to protect CA’s economy

The SHMP is an umbrella document for statewide hazard mitigation, and is a collaborative effort to identify, reduce, or eliminate the long-term risk to human life and property from natural or human-caused hazards.



and environment from preventable losses and helping to bring funding to state and local agencies for hazard mitigation initiatives and projects. The Plan assesses overall mitigation progress, creates benchmarks for future action, and provides a coordinating frame of reference for state-local mitigation actions.

As part of the planning process for the SHMP, State Hazard Mitigation Team (SHMT) members meet regularly to address various implementation issues and work to prepare the subsequent update of the SHMP. The SHMT consists of over 80 agencies and organizations, and SHMT members are the primary resource for information contained in the SHMP. Working groups were established in the past to support cross-sector communications and knowledge sharing, and will likely stay part of the planning process moving forward in order to benefit future updates of the SHMP. Climate change has been incorporated into the SHMP since 2007, and will continue to be an integral component in future updates of both LHMPs and the SHMP. Starting in 2016, all states must incorporate climate into their SHMP in accordance with FEMA guidance.

Support risk sharing mechanisms

Risk sharing and cost transferring systems like insurance and disaster relief can be tools for managing climate risk. Efforts to reduce climate risks through hazard mitigation activities – including, but not limited to, fire hazard reduction, minimizing new development in areas most vulnerable to hazards, and improved flood

management – will continue to be important to manage risk and support sustainable insurance and disaster programs.

An example of a flood risk sharing mechanism is the Federal Flood Risk Management Standard (June 2015). With climate change, flooding risks could increase over time. To improve the nation’s resilience to flooding and better prepare the nation for the impacts of climate change, the President’s Climate Action Plan (June 2013) directed federal agencies to take the appropriate actions to reduce risk to federal investments. To further the Climate Action Plan, the President released Executive Order 13690 in January 2015 establishing a Federal Flood Risk Management Standard.

The new Federal Standard requires all future federal investments in and affecting floodplains to meet a higher level of resilience as established by the Standard. According to FEMA’s fact sheet on the FFRMS, the standard “...will help ensure Federal projects last as long as intended. The FFRMS will apply to the Hazard Mitigation Assistance Grants, the Public Assistance Program, and any other FEMA grants when they fund construction activities in or affecting a floodplain.” Both the Hazard Mitigation and Public Assistance

The state is continuously assessing the adequacy of its current emergency surge and response capacities and working with local government, private sector, tribal government and federal partners to address gaps.



programs require a state and/or local cost share, ensuring full inclusion in the commitment and investment in these projects.

Better understand climate impacts on all phases of emergency management

To understand how climate impacts will affect each phase of emergency management, it is important to assess adequacy of surge and response capacity in light of climate projections. Climate change is projected to increase the frequency and severity of natural disasters related to flooding, fire, drought, extreme heat, extreme cold, and storms (especially when coupled with sea-level rise). As indicated earlier in this document, this is already occurring in CA. Moving forward, more surge capability across the various emergency functions identified in the State Emergency Plan will be needed to supplement existing emergency response capacity.

The state is continuously assessing the adequacy of its current emergency surge and response capacities and working with local government, private sector, tribal government and federal partners to address gaps. Each year, the state conducts a comprehensive Threat Hazard Identification Risk Analysis (THIRA) and State Preparedness Report (SPR) that assesses our overall emergency capability needs and related gaps. The THIRA methodology provides a framework for emergency management organizations to define threats and hazards of concern to the community they represent, as well as assess the capabilities needed by the organizations to deal with the consequences of the defined

threats and hazards. This information leads to the establishment of capability targets across all of the thirty-one core capabilities defined in the National Preparedness Goal (NPG, FEMA, September 2011). The capability targets that are developed each year become the foundation of the annual SPR.

The state is also involved in multiple processes to facilitate mutual aid, both within the state and outside of the state. Along with Law Enforcement and Fire and Rescue mutual aid plans, the Emergency Manager's Mutual Aid (EMMA) and Emergency Management Assistance Compact (EMAC)

systems also facilitate surge capacity. EMMA is a program in California that supports disaster operations in affected jurisdictions by availing professional emergency management personnel from local and state government. EMAC was established in 1996, and can offer assistance during governor-declared states of emergency by allowing states to send personnel, equipment, and commodities to support disaster relief efforts in other states.

Additionally, Cal OES partners with the California Utilities Emergency Association (CUEA) and the Business and Utilities Operation Center (BUOC). CUEA serves as a central point of

The Business and Utilities Operation Center serves as a critical hub in emergency response to address the needs of impacted communities by organizing and leveraging private sector resources



contact to facilitate communications and resource management between utilities and public agencies, provide emergency response support for electric, petroleum, pipeline, telecommunications, gas, water, and wastewater utilities, and supports related preparedness and mitigation. The BUOC serves as a critical hub in emergency response to address the needs of impacted communities by organizing and leveraging private sector resources. Agencies involved in the BUOC (private sector and non-profit organizations) have agreements with Cal OES to provide this support during times of crisis.

In addition to the rigorous evaluation of emergency services in response to disasters including those caused by climate, the four phases of emergency management rely on science and research to inform decisions. This is particularly evident in the areas of weather and seismic science that over time have informed and improved the delivery of emergency management today. The state overall continues to invest significant resources to conduct and support initial climate vulnerability and cost assessments in a variety of sectors. Though great strides have been made to understand climate change and its associated hazards, it remains a new area of science as we attempt to grasp its future impacts. Additional research is still needed to expand upon and define climate vulnerabilities to CA's population, infrastructure, property, food and agriculture, and biodiversity. Monitoring and research related to extreme weather events such as flood, drought,

heat, fire, and related losses will continue to be vital in supporting emergency management and public safety in the future.

As part of the 4th Assessment of Climate Impacts on California, Cal OES developed a research proposal involving the vulnerability of state essential facilities to the effects of climate change. Further development of this proposal would provide a statewide risk assessment of existing state owned/operated structures critical to response and recovery operations that are currently located in areas of high hazard risk and subject to impacts of climate change. This 4th assessment proposal would be a comprehensive, multi-sectoral analysis addressing extreme events, local impacts, and response options to protect economic interests as well as natural resources.

Communicate climate risks

Outreach efforts are integral in helping communities better understand and plan for climate risks and extreme events such as fires, floods, storms, drought, extreme heat and extreme cold. Effective emergency planning can lower emergency response risks and costs.

The importance of outreach efforts also extends to response, recovery, and mitigation efforts. Over the past few years the state has faced a drought of historical proportions. In January 2014, the Governor declared a State of Emergency for drought, and a significant response is underway with local, state, tribal and federal agencies closely coordinating and sharing resources to support critical emergency needs. Outreach has proven



effective for drought. The call for Californians to conserve has resulted in water savings exceeding state targets.

Among the multitude of drought resources available through state and federal programs are emergency drinking water assistance as well as programs for agriculture. The state also continues to work with other stakeholders on advance planning measures to anticipate and mitigate the future effects of drought. In July 2015, a Memorandum of Understanding (MOU) was signed between Cal OES and Victoria, Australia. Victoria recently came out of a 12 year drought, and this MOU will result in increased information sharing between and impart critical lessons from this climate disaster and its resulting changes to emergency preparedness, response, recovery, and mitigation techniques.

Cal OES is also working closely with FEMA and local agencies to develop and update catastrophic disaster plans. Existing plans include a San Francisco Bay Area Earthquake Response Plan (update in progress), Southern CA Catastrophic Earthquake Response Plan, and the CA Cascadia Subduction Zone Earthquake/Tsunami Response Plan. Development of a Northern CA Catastrophic Flood Response Plan (NCCFRP) and a Volcano Response Plan are underway. The process to develop these catastrophic plans involves many agencies at all levels of government convening and determining effective disaster management strategies before an event occurs. These plans and planning efforts are tremendous assets to facilitate

local, state, federal, tribal, and private sector interaction and rapid response to catastrophic events. This is important, given the likelihood that CA will increasingly face events of a large-scale and/or catastrophic magnitude due to the projected impacts of climate.

The newly formed California Fire Service Task Force (TF) on Climate Impacts is an extension of the Blue Ribbon Fire Commission, which was initially established following the 2003 wildfires. Membership on the TF includes Cal OES, the Governor’s Office, Office of Planning and Research, CA Natural Resources Agency, CA Military Department, CAL FIRE, FEMA, US Forest Service

and representatives of all of the key fire services agencies and associations in California. In continuing to build upon the state’s wildfire preparedness, capability, and resilience efforts, the TF will review and advise on policy and operational recommendations to update past Fire Commission recommendations. The TF will also evaluate the most current climate threats and science, studies to develop new recommendations related to wildfire preparedness, response and mitigation needed to

In continuing to build upon the state’s wildfire preparedness, capability, and resilience efforts, the California Fire Service Task Force will review and advise on policy and operational recommendations to update past Fire Commission recommendations.



successfully adapt to CA's changing climate. The inaugural Task Force meeting was held in July, 2015 in Sacramento.

The California Emergency Services Association (CESA) is a professional organization that promotes mutual support and cooperation across emergency management disciplines. Climate Change and Drought were some of the topics featured at CESA in 2015. Each year Cal OES has an opportunity to conduct training with CESA that provides wide reach to a key audience. In 2015, Cal OES conducted an LHMP Workshop as part of CESA, and participated in outreach to promote and demonstrate the MyHazards and MyPlan portals. MyHazards is a tool for the general public to discover hazards in their area (earthquake, flood, fire, tsunami) and learn steps to reduce personal risk to those hazards. My Plan is a tool to assist cities, counties, special districts, state and tribal entities with assembling and assessing GIS information on natural hazards that occur in California for use in developing maps for their mitigation plans. The initial objective of both tools was to capture current and future risk information, working in combination with other tools such as Cal-Adapt. Next steps for MyHazards and MyPlan include looking into how to incorporate climate projections and sea level rise into both tools to make them even more comprehensive.

Training resources related to emergency management and climate change are in very early development. The Climate Adaptation Strategies

for Emergency Services training course is one example. The course is designed to enhance awareness about current and future climate hazards and impacts that the emergency services sector may face, and provide information about the various resources that can be used to implement local climate adaptation strategies. Continued education, outreach, and training activities supporting climate adaptation and planning will better prepare emergency personnel and the public and support the building of a more resilient nation.

Cal OES continues to lead the state's efforts to train and exercise emergency plans and staff at all levels of government. An example of this effort is the state-level Capstone exercise series. Annual Capstone CA exercises are designed to improve emergency preparedness at all levels of government for catastrophic events, and are built upon the catastrophic disaster planning efforts previously mentioned. These and other exercises supported throughout the state can be designed to focus on known hazards tied to climate (ie extreme weather events, flooding, etc). These exercises are especially critical since disasters tied to climate are projected to increase in magnitude and frequency, overwhelming local resources at a faster rate, and necessitating increased use of statewide, out of state, private sector, and federal support.



Next Steps

This section looks to identify existing programs and activities that can be expanded to fulfill Safeguarding California recommendations, as well as propose new initiatives and activities that can assist with filling any implementation gaps. Items listed in this section will continue to be expanded as implementation needs are further identified and clarified.

We can more effectively leverage and prioritize existing resources, expand programs and efforts, and influence current and future activities to help meet the recommendations in Safeguarding California. For example, continued outreach on both the LHMP and the SHMP processes will occur, with increased emphasis on incorporating climate change impacts and adaptation strategies. Continued outreach to publicize, disseminate and encourage use of available guidance—such as the APG—is critical. As we build cadres of trained emergency staff that understand climate change, they can better anticipate and meet the increasing demands of mitigating, preparing for, responding to, and recovering from future disasters in CA.

PROPOSED ACTIONS AND RECOMMENDATIONS AND ACTIONS TO CONTINUE

- Look into how we can integrate climate projections and sea level rise (SLR) into the MyHazards and MyPlan tools, and continue to update these tools as additional climate projections become available.
- Continue to pursue research to evaluate state essential facilities at risk to climate impacts – including mapping, hazard identification

(ie coastal flooding, increase in temperatures, etc), and developing an action plan to support mitigation efforts. (This item relates to the previously mentioned research proposal put forth under the 4th Climate Change Assessment). Essential facilities* may include:

- o Public safety - Fire, rescue, law enforcement
- o Hospitals
- o Medical and emergency treatment facilities
- o Emergency operations centers
- o Designated emergency shelters
- o Power generating stations or other utilities required as emergency back-up facilities for essential facilities
- o Designated communications centers
- o Aviation control towers and air traffic control centers
- o Structures containing certain quantities of toxic or explosive substances
- o Water treatment facilities required to maintain water pressure for fire suppression



**Agencies and departments may identify other essential facilities based on their mission. Other examples could include cooling centers and other critical community resources such as transportation routes. Further information on locally identified critical assets can typically be found in local preparedness and response plans.*

- Support research identifying and evaluating communities most vulnerable to climate impacts, the results of which will further support adaptation and community resiliency efforts.
- Develop an interactive tool to support the Adaptation Planning Guide (and overall adaptation activities). This tool could complement the existing MyPlan and MyHazard tools, while providing another technical resource to support communities as they update their plans and develop adaptive strategies.
- Expand Climate Adaptation training opportunities, and consider courses that will increase awareness, understanding and competency about climate adaptation. Development and delivery of training should be a joint effort of CNRA and Cal OES, and other agencies, such as CA Department of Public Health (CDPH) for health-related topics.
- Model guidance for state agencies to integrate climate risk into their state-level emergency and continuity planning efforts, building upon Safeguarding CA efforts.
- As the state reviews requests for planning funds under the Pre-Disaster Mitigation funding program, climate shall be a required component.

Update state guidance for LHMPs to include a requirement that climate adaptation be included.

- Continue to expand upon and track progress toward climate adaptation goals within the SHMP. Future updates can articulate progress and highlight new and existing activities and success stories.
- Promote climate and community resilience by leveraging both pre- and post-disaster funds to reinforce or rebuild safer communities that are able to withstand future effects of climate.

Items to continue:

- Continue to review HMGP and PDM/Pre-Disaster Flood Management applications to consider climate needs.
- Continue to review current HMGP funding opportunities and projects that will maximize climate readiness and resilience to multiple hazards.
- Continue progress on CA Fire Service TF on Climate Impacts objectives, which will include work that specifically focuses on climate impacts and fires. Consider additional climate-related TFs using this construct for other hazards.
- Continue to outreach and communicate with all levels of government on climate change impacts, adaptation strategies, and mitigation activities:
 - o Continue to provide guidance and review for LHMPs, increasing the guidance efforts on how to incorporate climate change hazards and adaptation components into local plans.



- o Continue to work with key stakeholders on updating the SHMP – building out the climate change component and tracking.
- Continue to coordinate at all levels of government (private sector, businesses, local, county, regional, state, and federal) and share information about known climate change

impacts and mitigation activities. related activities, actions, and success stories.

- Continue to support climate change assessments, which have been instrumental in guiding state policy and supporting informed responses to climate change.

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Monitoring and Evaluation

Monitoring, evaluation and continuous improvement are already integral parts of emergency management. Following each declared disaster in CA, an after action report is required to document lessons learned and areas of improvement. This is one several monitoring and evaluation activities where climate adaptation should be incorporated.

- Annual Threat Hazard Identification and Risk Assessment and State Preparedness Report
- Update of Catastrophic Disaster Plans and testing through annual Capstone exercises
- After Action Reports following disaster events, documenting and tracking corrective actions
- Update of SHMP and SHMP implementation plan to demonstrate progress

- Tracking of LHMPs that include climate and prioritizing associated funding requests for both projects and plans
- Sector-specific efforts such as the Fire Climate TF and resulting recommendations and progress reports

Cal OES will continue to seek ways and identify strategies to include climate adaptation within the existing evaluation and improvement cycle.



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Conclusion

Climate change and its impacts are already a reality affecting communities, natural resources, ecosystems, economies, and public health across the state and nation. More frequent and extreme temperatures and precipitation patterns, forest fires, heat waves, drought, snowpack and state water supply reduction, sea level rise and erosion along California’s coastline, present new risks and uncertainties that put lives and resources at risk and affect all phases of emergency management. These impacts have the potential for tremendous disruption to California communities, necessitating the aforementioned actions that will more formally incorporate climate considerations. California has arguably the most advanced emergency management programs anywhere, due to its diligence and foresight in developing and employing standardized systems and learning from disaster events. Further efforts to integrate climate will strengthen this foundation and alleviate risk to public safety, property damage, and emergency response costs now and in the years to come.

Energy Sector Plan



AGRICULTURAL SECTOR PLAN



BIODIVERSITY AND HABITAT SECTOR PLAN



EMERGENCY MANAGEMENT SECTOR PLAN



ENERGY SECTOR PLAN



FORESTRY SECTOR PLAN



LAND USE AND COMMUNITY
DEVELOPMENT SECTOR PLAN



OCEANS AND COASTAL RESOURCES
AND ECOSYSTEMS SECTOR PLAN



PUBLIC HEALTH SECTOR PLAN



TRANSPORTATION SECTOR PLAN



WATER SECTOR PLAN

Energy Sector Plan



Introduction

The infrastructure of the energy sector is vulnerable to climate change impacts such as extreme events, wildfires, sea level rise (SLR), and heat waves. This document will serve as a plan to implement the State of California’s climate adaptation strategy, which the California Natural Resources Agency updated with the report *Safeguarding California: Reducing Climate Risk* in July 2014. This chapter provides new information about potential vulnerabilities; highlights some of the progress being made to implement *Safeguarding California*; identifies next steps to substantially advance climate preparedness for the energy sector; and suggests new indicators for monitoring and evaluating adaptation in the energy sector. This implementation plan surveys the efforts already undertaken and necessary actions of those who plan, regulate, generate, transmit, or use energy.

At a workshop¹² jointly hosted by the California Energy Commission (Energy Commission) and the California Public Utilities Commission (CPUC) on July 27, 2015, four investor-owned California utilities (IOUs) and one municipally-owned utility outlined their current and future efforts to adapt to climate change. Even though this workshop targeted the electricity sector, it

provided information to develop a framework to advance adaptation efforts for the entire energy sector which also includes the natural gas and petroleum sectors, and other nontraditional parts of the energy system that may become more important in the future, such as bio-refineries and their supporting infrastructure.

Vulnerability Assessment

California’s energy system is vulnerable to a variety of climatic changes, including impacts from temperature, precipitation patterns, extreme events (including drought, wildfire, inland flooding, and severe storms), and sea level rise (Franco and Wilson, 2005; Stoms et al, 2013; California Energy Commission 2013). Some of these impacts are particularly significant to the energy sector, including more frequent and severe extreme heat episodes and decreasing snow-water content in the Sierra Nevada that are already becoming evident (*Indicators of Climate Change in California*, OEHHA, 2013). Moreover, historical climatic data will not suffice to support future management of energy systems and other

¹² http://www.cpuc.ca.gov/PUC/energy/CPUC_and_Energy_Commission_to_Hold_Climate_Adaptation_Workshop.htm



human concerns, as the climate is diverging from its historical “envelope” — in other words, 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, 2014 was the hottest year on record in California; and annual temperature moved far outside the envelope of natural variability as recorded in the last 120 years. It is also important to note that most of the warming in California occurred during the winter season, contributing to snowpack reduction in the Sierra Nevada.

Recent findings of climate impacts on California’s energy system are briefly summarized below. It should be noted, however, that significantly more research has been done to date on electricity than other aspects of the energy sector, such as natural gas or transportation fuels. Additional background on climate vulnerability of the energy sector can be found in *Safeguarding California: Reducing Climate Risk*.

ELECTRICITY

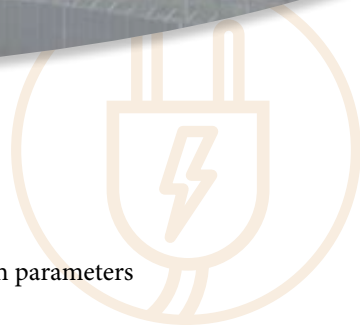
The impacts of climatic changes on California’s electricity system include: decreased efficiency of thermal power plants, substations, and some renewable generation technologies; decreased capacity of transmission lines; increased risk to electricity infrastructure of extreme events, including sea level rise, coastal flooding, and wildfires; less reliable hydropower resources; and increased peak electricity demand (Stoms et al., 2013; California Energy Commission, 2013).

Electricity infrastructure is vulnerable to sea level rise along the coast. About 25 coastal power plants may be exposed to high water levels during what is considered a 100-year flood event, which would

become more frequent with sea level rise. Prior research has shown that the increased frequency and severity of wildfires as a result of a warming climate will increase the risks of grid disruptions in our transmission lines. For example, hundreds of poles and lines were damaged and thousands of customers experienced outages as a result of the Butte and Valley fires in September 2015.

The 2015 Integrated Energy Policy Report (IEPR) included a preliminary peak electricity demand forecast that accounted for climate change. The forecast used climate scenarios developed for California by Scripps Institution of Oceanography for the Energy Commission based upon climate models used for the 2014 IPCC Assessment (IPCC, 2014). Higher projected annual maximum temperatures derived from the scenarios increased the statewide peak demand forecast by over 600 MW in the mid

Electricity infrastructure is vulnerable to sea level rise along the coast. About 25 coastal power plants may be exposed to high water levels during what is considered a 100-year flood event, which would become more frequent with sea level rise.



demand case by 2026. Staff also derived projected changes in heating and cooling degree days from the scenarios, which affect electricity consumption. The impact on consumption was slight (around 60 GWh statewide in 2026) in the mid demand forecast, as heating degree days decreased at a much higher rate than cooling degree days increased. (Kavalec, 2015).

Renewable energy technologies help mitigate climate change, but they can also be vulnerable to the impacts of climate change. For example, solar photovoltaic systems tend to be less efficient at higher temperatures.¹³ Projections for the Southwest suggest reductions of efficiency of the order 0.7 to 1.7 percent with anticipated higher temperatures in 2050 (Bartos and Chester, 2015). Information on changes in the probability and location of occurrence of excessive heat in California due to climate change can help inform research on solar photovoltaic system performance on hot days. Similarly, additional studies on changes in the probability and location of changes in wind patterns in California due to climate change¹⁴ can help inform wind energy planning, forecasting, and integration as California increases the proportion of electricity generated from wind energy. Projections of changes in solar and wind regimes for the California region have not matured enough yet to provide a clear picture of potential changes. A recent paper noted, for example, that wind performance depends not only on wind speed but also on the density of the air; unfortunately, there are currently substantial

uncertainties in the projections of both parameters (Bartos and Chester, 2015).

NATURAL GAS

The natural gas system in the Bay Area, the Delta, and the California coast is vulnerable to potential impacts of an extreme storm event coupled with sea level rise on natural gas pipelines. A recent study led by University of California Berkeley used high-resolution hydrodynamical modeling to investigate the dynamic impacts of SLR, tides, and freshwater flows (Radke et al., 2015). The research concludes that the Delta levees are nominally “prepared” for an extreme storm event (ca. 100-year event) under current sea level conditions, inasmuch as modeling indicates that extensive overtopping would not be expected. However, substantial levee failures due to overtopping would be expected due to an extreme storm event under conditions of more than about one meter of sea level rise. For example, if such a storm event were paired with a 1.4 m SLR, which is a possible high-end 2100 estimate for California, then the storm would pose extensive risk to critical natural gas infrastructure as well as other energy related and transportation infrastructure. Such risks include inundation of approximately 200 miles of natural gas transmission lines in the Bay-Delta,

Renewable energy technologies help mitigate climate change, but they can also be vulnerable to the impacts of climate change.

¹³ <http://energy.gov/eere/energybasics/articles/photovoltaic-cell-conversion-efficiency-basics>

¹⁴ <http://iopscience.iop.org/1748-9326/6/2/024008/fulltext/>



including backbone transmission at Antioch, key transmission on Sherman Island, and transmission loops in San Jose, San Francisco, and Sacramento. Additionally, under such conditions, inundation of natural gas storage at MacDonald Island is indicated (Radke et al., 2015). As pointed out by this study, additional work is needed to clarify flood risks to the Delta associated with climate change. For example, subsidence of Delta levees exacerbates vulnerability to sea level rise by lowering levee crests (Brooks and Manjunath, 2012). Due to subsidence-induced acceleration of the rate of *relative* sea level rise, extreme storm events are expected to pose substantial risks due to overtopping sooner than expected on the basis of absolute sea level rise alone.

California currently imports about 90 percent of the natural gas that it consumes, and, for this reason the integrity of large transmission lines is of high importance for the State. Thousands of miles of natural gas transmission and distribution lines cross California, bringing natural gas from producing regions. Due to the particulars of California’s geography, many of the key lines and related natural gas storage units run through the Central Valley, which has subsided dramatically in the past decade. The subsidence in the Valley has been exacerbated by unprecedented groundwater pumping in response to drought related shortages of surface water. Subsidence can affect the integrity and safety of natural gas pipelines. However, it is not yet known exactly how and where the unusually rapid rate of drought-related subsidence has affected natural gas pipelines and storage in the

Central Valley.

Observations of heating degree days¹⁵ (HDD) in California in the last few decades show a declining trend. For example, the decline of HDD was about 15 percent from 1960 to 2014 in the San Joaquin Valley, which would be expected to decrease the amount of natural gas consumed for space heating in a more or less proportional way. The overall downward trend in HDD, at least in the Central Valley, seems to be linked to reported reductions of Tule fog in the same region (Baldocchi and Waller, 2014).

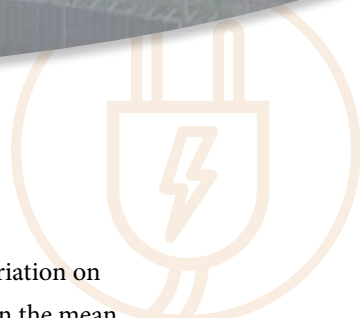


Most refineries in the state consume electricity from the electricity grid and, therefore, are vulnerable to grid disruptions, which may be due to weather-related events associated with climate change.

PETROLEUM TRANSPORTATION FUELS

Given the proximity of most of California’s refineries to the ocean, they may be at risk of saltwater intrusion and damage from SLR and storm surges (Perez et al., 2009). Additionally, most refineries in the state consume electricity from the electricity grid and, therefore, are vulnerable to grid disruptions, which may be due to weather-related events associated with climate change. Finally, water availability is also a concern for oil refineries. Refineries in California use a great deal of water to create steam used in their industrial processes. To the extent that potable water sources may have limited availability for use by refineries, other potential sources would have to be pursued along with strategies and technologies

¹⁵ A unit that measures the space heating needs during a given period of time



aimed at reducing their water intensity.

Oil pipelines may also be sensitive to SLR at port facilities. California’s petroleum and transportation fuels infrastructure normally involves the movement of raw and finished transportation fuel products via marine vessels and a network of pipelines that connect wharves to refineries, storage tank farms, distribution terminals, and associated structures. The wharf structures used to unload and load marine vessels are designed to

accommodate a wide range of tidal variation on a daily and annual basis. An increase in the mean average sea level, however, would significantly raise the maximum high tide levels, such that the existing wharf system used for moving petroleum products and other waterborne commerce may need to be adjusted. There are two railroads operating in California transporting crude oil: Burlington Northern Santa Fe and Union Pacific. Climate change is expected to increase landslides, which may have safety implications.



Current Actions to Prepare for Climate Impacts

This section briefly describes ongoing activities preparing the energy system for a changing climate using the four overall strategies identified in *Safeguarding California*.

PROTECT EXISTING ENERGY FACILITIES AND CONSUMERS FROM IMPACTS OF CLIMATE CHANGE

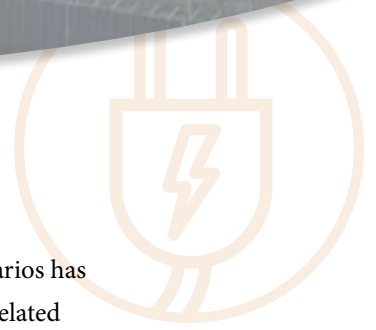
Several steps are being taken to improve the current energy system and to protect consumers from the near-term impacts of climate change. For example, after the 2006 heat wave, the CPUC required the electric utilities to start upgrading their transformers and other related equipment to be able to cope with both increased demand and relatively high temperatures at night that did not allow adequate cooling of the transformers during that event.

The San Diego Gas & Electric (SDG&E) South Bay Substation is a good example of existing

infrastructure that has been upgraded with adaptation in mind. The substation was moved and the new site was graded to withstand sea level rise of up to 8 feet. Utilities are also increasing their ability to track, monitor, and predict wildfires, they are upgrading and hardening infrastructure to withstand fires. For example, all three electricity IOUs have filed applications to replace wood utility poles with steel poles in areas with a significant fire threat. The Energy Commission’s Siting, Transmission, and Environmental Protection Division assesses sites proposed for thermal power plants larger than 50 megawatts (MW) for risks from sea-level rise and increased flooding as part of the reliability analysis of the project and equipment required under the Energy Commission’s power plant certification process.

¹⁶ <http://energy.gov/epa/partnership-energy-sector-climate-resilience>

¹⁷ SCE’s vulnerability assessment is due in Spring, 2016, because they joined the Partnership a few months after its founding.



Pacific Gas & Electric (PG&E), SDG&E, Southern California Edison (SCE), and Sacramento Municipal Utility District (SMUD) recently signed on to the Department of Energy (DOE) Climate Resilience Partnership, a voluntary effort run by the DOE to promote best resilience practices across the country.¹⁶ As part of the member agreement, each of the utilities will be required to produce a vulnerability report by late January, 2016,¹⁷ followed by a resilience plan. These reports will help formalize the information and the internal processes that the utilities have been undertaking over the last several years. It will also facilitate a gap analysis for what additional efforts need to be undertaken and highlight coordination opportunities with the energy agencies and research community. Importantly, these plans will help stakeholders and regulatory agencies better understand and approve necessary expenditures related to adaptation efforts.

Finally, *Safeguarding California* called for new vulnerability and adaptation studies in the energy sector. The California Natural Resources Agency (CNRA) is leading the preparation of California's Fourth Climate Change Assessment that will be submitted to the Governor in 2018. The Energy Commission recently initiated a comprehensive portfolio of studies to be conducted for the energy-sector part of the Assessment. The energy (Energy Commission) and non-energy studies (CNRA) will use a common set of climate, sea level rise, and socio-economic scenarios. The project developing

climate change and sea level rise scenarios has already begun. Details of the energy-related research for the Fourth Assessment are provided in the Enhance Energy-Related Climate Change Research section below.

DIVERSIFY ENERGY SUPPLY TO REDUCE CLIMATE VULNERABILITY

Several studies have been conducted to examine how the energy system in California should evolve to drastically reduce greenhouse gas (GHG) emissions (mitigation) in the next 35 years. Past studies have not investigated the link between mitigation and adaptation for the energy system. A study that started in July 2015 supported by the Energy Commission is, for the first time, making this connection. The study will investigate how to develop the energy system to drastically reduce GHG emissions while at the same time making it less vulnerable to climate impacts. The final results of the study will be available in 2017 and will provide further insights about options to drastically reduce greenhouse gas emissions from the energy sector by 2050, the potential costs associated these options, and promising technology/policy pathways.

*“California’s energy system must change drastically over the next few decades in response to policy goals to reduce GHG emissions and increase the amount of renewable energy in the electricity mix. **This evolution will require information that helps create a more climate-resilient energy system.**” 2013 IEPR, p.322*

¹⁶ <http://energy.gov/epsa/partnership-energy-sector-climate-resilience>

¹⁷ SCE's vulnerability assessment is due in Spring, 2016, because they joined the Partnership a few months after its founding.



The CPUC is continuing to implement its Self-Generation Incentive Program (SGIP) that provides incentives to support existing, new, and emerging distributed energy resources through rebates for qualifying distributed energy systems installed on the customer’s side of the utility meter.¹⁸ **Qualifying technologies include wind turbines, waste heat to power technologies, pressure reduction turbines, internal combustion engines, microturbines, gas turbines, fuel cells, and advanced energy storage systems.** Decision 14-12-033 adopted \$83 million annual SGIP collections through 2019.

As a result of AB 327, the CPUC is also in the process of creating a successor tariff for the Net Energy Metering (NEM) program to ensure that customer-sited renewable distributed generation continues to grow sustainably.¹⁹ Other efforts to increase the number of renewables on the grid include CPUC-approved changes to Rule 21 interconnection tariffs in December, 2014, that will allow utilities to interconnect inverters with advanced capabilities and establish a study period to see how they perform.

The 1939 MW of distributed solar photovoltaic (PV) deployed through the California Solar Initiative[1] is fully subscribed, but efforts to continue the low-income programs for both single family and multi-family residential markets were renewed at \$108 million over the next five

years. The New Solar Homes Partnership, administered by the Energy Commission, continues to provide incentives for solar PV systems installed on highly energy efficient new homes and has a goal of installing 360 MW of additional solar capacity. In addition to solar PV, the solar thermal program

to promote solar water heaters is authorized through 2017. In 2014, the CPUC initiated a new rulemaking to provide guidance for utility Distribution Resource Plans (DRP) that were filed in July 2015.²⁰ The goal of the DRPs is to accommodate greater deployment of distributed renewable generation, energy storage, electric vehicles, and energy efficiency and demand response technologies. This process will result in a far-reaching change to traditional distribution planning by the utilities, and it will influence investment decisions in future General Rate Cases.

In August, 2015, the CPUC released a proposed decision, the “Decision Adopting an Expanded Scope, a Definition and a Goal for the Integration of Demand-Side Resources.”²¹ While the DRPs could set values for distributed energy resources



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¹⁸ <http://www.cpuc.ca.gov/PUC/energy/DistGen/sgip/>

¹⁹ (R.) 14-07-002

²⁰ <http://www.cpuc.ca.gov/PUC/energy/drpf/>

²¹ <http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M153/K740/153740896.PDF>



(DER) as part of their grid investments, the Integration of Demand-Side Resources will turn the DRP locational data into mechanisms for procuring DERs as alternatives to traditional grid projects, or creating new tariffs that could reward existing DERs for performing grid-supportive tasks. The proposal stakes out a series of decisions to be made in Phase 1 of the new proceeding, including “the development of an end-to-end framework for integrating demand-side resources, including relevant valuation methodologies and sourcing mechanisms. The final step in Phase 1 will entail developing objectives for the adopted framework.”

At the utility scale, the CPUC and the Energy Commission continue to implement the Renewable Portfolio Standard (RPS), which requires retail sales of 33 percent renewable energy. The energy agencies are now investigating ways to achieve the Governor’s call for 50 percent renewables,²² which will likely be mandated by statute under SB 350 (De Leon, 2015), which is currently awaiting the Governor’s signature.

Through the Electric Program Investment Charge (EPIC), the Energy Commission is making investments in Technology Demonstration and Deployment activities that will demonstrate microgrid technologies, specifically microgrids that serve critical facilities. Microgrids are a technology option for making the electric grid more resilient and adaptable to climate change impacts such as increased fires, severe storms, and heat waves. Microgrids are able to disconnect

from the larger electric grid and provide stable independent power for facilities or entire communities. In 2015 the Energy Commission announced grant awards for seven microgrid demonstrations. These projects will demonstrate the ability of microgrids to utilize locally available renewable energy with energy storage and energy management systems that when coordinated together increase reliability and reduce greenhouse gases.

Of the seven microgrid grants, four of the grants are demonstrating microgrid systems for critical facilities that include a designated American Red Cross Emergency Center, fire stations, a wastewater treatment plant, and a hospital. One of the projects is being developed in Humboldt County by the Schatz Energy Research Center (SERC) at the Blue Lake Rancheria—a designated American Red Cross Emergency Center for surrounding communities in the county. SERC is incorporating a high penetration of renewable resources into the project. They are designing the microgrid to be able to island from the larger utility grid for up to seven days, which is especially important because this region of California is identified as a Local Reliability Area and is served by two transmission lines that are vulnerable to

Microgrids are a technology option for making the electric grid more resilient and adaptable to climate change impacts such as increased fires, severe storms, and heat waves.

²² <http://gov.ca.gov/news.php?id=18828>



climate change impacts. Coastal communities in Humboldt County must also be ready to respond to tsunami events, which will be more severe with rising sea level.

The state of California is also diversifying the supply of electricity to its facilities. For example, the Department of General Services (DGS) manages the statewide Power Purchase Agreements program. Under these agreements, the solar provider develops designs, installs, operates, and maintains solar photovoltaic systems using third-party financing, and then sells the generated renewable electricity to the host facility at or below utility tariff rates. This program facilitates the installation of solar power systems with no up-front cost to state departments. Since the program's inception in 2005, DGS has worked with several state agencies to implement over 38 MW of renewable energy throughout the state. With the current momentum, the state is on track to have 100 MW installed by the end of 2017. In addition to wind-powered systems, which are anticipated to be installed soon, other types of renewable energy are being examined, including solar thermal and fuel cells.

Planning for increased penetration of renewable energy in California's energy system as a long-term investment also considers climate change impacts on other resources, such as species and ecosystems. The Desert Renewable Energy and Conservation Plan (DRECP), for example, is taking an innovative approach to incorporate climate change into this plan for both preferred zones for energy

and for biological conservation. Part of that effort is to select climate-resilient areas to protect species (Flint, 2015). The DRECP is helping stakeholders understand the adaptation needs by hosting an online data platform referred to as the DRECP Climate Console with the relevant climate information.²³

Whereas the DRECP will designate Development Focus Areas that are preferred for renewable energy development in the southeast desert areas in California, the recently convened San Joaquin Valley Solar Study is intended to identify areas of least conflict that would be appropriate for solar development in this region.

Five stakeholder groups are participating: 1) Environmental and Conservation; 2) Agriculture; 3) Counties; 4) Industry; and 5) Transmission. The goal is to expedite permitting of new renewable projects to deploy clean energy more quickly.

PROMOTE ENERGY DEMAND SIDE MEASURES THAT FACILITATE CLIMATE ADAPTATION

Maintaining a reliable energy system is vital to the health and well-being of California's residents

Cross-Sector Opportunity: Bioenergy

The Governor's Proclamation of a State of Emergency on the epidemic of tree mortality released in October 2015 in California will lead to ongoing work to ensure that bioenergy production will help manage the large volume of forest management residue and help meet the state's long-term climate change adaptation goals. A working group on bioenergy has been assembled by CALFIRE to implement actions to address the immediate tree mortality and identify longer term solutions. These actions will take into account many sectors, including energy, forestry, and habitat. Their work will spur actions that deal with tree mortality at hand as well as the projected increases in warm and dry climatic conditions in California.

²³ <http://drecp.consbio.webfactional.com/climate>



and its economy. Reliable grid operation depends on meeting demand with adequate supply and ensuring uninterrupted delivery to customers. As climate change could increase electricity demand and threats to grid reliability, strategies on the customer (or demand) side can help counter those impacts. For example, energy efficiency can be a very cost-effective tool that minimizes demand all the time. Demand response (DR), in contrast, provides a strategy to rapidly decrease electricity usage temporarily when the grid is stressed from high demand, such as during extreme heat events. Zero net energy (ZNE) buildings combine efficiency with clean, on-site renewable energy generation. Because water and energy systems are tightly coupled, strategies to conserve water, particularly during drought, also reduce electricity demand. Energy storage, including that provided by electric vehicles (EVs), helps with grid reliability by supplying stored electricity during peak demand. Specific efforts in each of these categories are described below.

Energy Efficiency

Energy efficiency is a preferred energy resource under the state's loading order, which was developed in 2003 to guide investment decisions to meet California's future electricity needs in the best, long-term interest of consumers, ratepayers, and taxpayers. However, California has long been a proponent of reducing the unnecessary waste of energy for decades. For example, the Energy Commission adopted the first energy efficiency

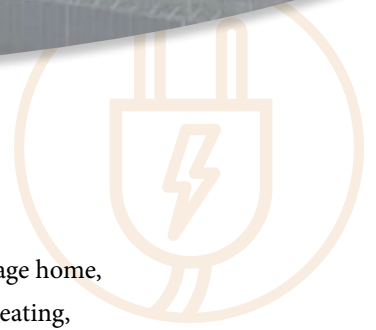


standards for appliances in 1976 and for buildings in 1978. Since then, Californians have saved \$75 billion in electricity costs.²⁴ California's per person electricity consumption has remained relatively flat, in part due to California's long-term energy efficiency efforts, while electricity consumption in the rest of the United States has increased by roughly 40 percent. Building upon these efforts, the state's Long Term Energy Efficiency Strategic Plan²⁵ updated in 2011, set forth a roadmap to achieve maximum energy savings across all major groups and sectors in California. This plan is the state's first integrated framework of goals and strategies for saving energy. The plan includes government, utility, and private sector actions, and holds energy efficiency to its role as the highest priority preferred energy resource. The CPUC is in the process of updating the plan and broadening the scope to integrate energy efficiency with other demand-side efforts including demand response, time-of-use rates, and distributed generation.

Zero net energy (ZNE) buildings combine efficiency with clean, on-site renewable energy generation.

²⁴ <http://www.energy.ca.gov/2013publications/CEC-100-2013-001/CEC-100-2013-001-CMF.pdf>

²⁵ http://www.energy.ca.gov/ab758/documents/CAEnergyEfficiencyStrategicPlan_Jan2011.pdf



Assembly Bill 758 (Skinner, Chapter 470, Statutes of 2009) requires the Energy Commission, in collaboration with the California Public Utilities Commission and stakeholders, to develop a comprehensive program to capture more energy savings from California's existing building stock. The Energy Commission approved the *Existing Buildings Energy Efficiency Action Plan*,²⁶ on September 9, 2015. This action plan provides a 10-year roadmap to dramatically reduce energy use in California's existing residential, commercial, and public buildings. The Energy Commission will work in collaboration with the CPUC, local governments, industry stakeholders, and various state and local agencies to achieve the action plan's objectives, and help the state achieve Governor Edmund G. Brown's doubling of energy savings in existing buildings by 2030, as stated in his 2015 State of the State address.

In June 2015, the Energy Commission approved the 2016 Building Energy Efficiency Standards that, when in effect, will reduce energy costs, save consumers money, and increase comfort in new and upgraded residential and nonresidential buildings. These new standards include features such as high performance attics and walls, instantaneous water heaters, and highly efficient lighting. Single-family homes built to the 2016 standards will use about 28 percent less energy for lighting, heating, cooling, ventilation, and water heating than those built to the 2013 standards. Based on a 30-year mortgage, the Energy Commission estimates that these standards will

add about \$11 per month for the average home, but save consumers \$31 on monthly heating, cooling, and lighting bills. This brings the state one step closer toward achieving the state's 2020 Zero-Net Energy (ZNE) goal for all new residential buildings. The basic premise for designing and constructing ZNE buildings is to integrate and optimize energy efficiency measures with on-site renewable generation so that a building produces and/or offsets as much energy as it consumes annually. ZNE buildings can provide consumers and building owners long-term cost savings and other non-energy benefits, such as improved comfort. These

buildings can also help reduce greenhouse gas and criteria pollutant emissions by avoiding the long-term need to generate electricity from fossil-fueled electric generation facilities. In addition, ZNE buildings can help improve local electric service reliability due to the proximity of load to on-site electric generation, and can help reduce the need to expand the electric system, benefiting all ratepayers from reduced infrastructure expansion costs, while reducing the systems overall environmental impact.

In June 2015, the Energy Commission approved the 2016 Building Energy Efficiency Standards that, when in effect, will reduce energy costs, save consumers money, and increase comfort in new and upgraded residential and nonresidential buildings.

²⁷ http://docketpublic.energy.ca.gov/PublicDocuments/15-IEPR-05/TN203806_20150310T093903_California%E2%80%99s_Existing_Buildings_Energy_Efficiency_Action_Plan.pdf



Governor Brown specifically cited ZNE as one of several effective methods to combat climate change by achieving the goals of AB 32. In his 2012 Executive Order B-18-12²⁷ and the accompanying Green Building Action Plan,²⁸ Governor Brown directed executive branch departments to design, construct, and upgrade buildings to meet ZNE building requirements, where possible. Fourteen state buildings were chosen to pilot ZNE building concepts; however, due to state budget constraints, only a handful of projects are complete or under construction. Executive Order B-18-12 also mandates that state buildings benchmark their energy and water use using ENERGY STAR Portfolio Manager. Benchmarking is the process of collecting building performance data and comparing that data to a standard metric, usually the best building practices. Building owners and operators can then use this information to better manage their building energy and water use, and improve a building's overall performance. In 2014, the state reduced water use by 22 percent compared to 2010, meeting the Executive Order's reduction goal of 20 percent by 2020, and is well on its way toward meeting the energy goal of 20 percent by 2018. State department energy use dropped by 14 percent compared to the 2003 baseline. In addition, 2014 saw an increase in on-site renewable generation, now accounting for 12 percent of total state energy use. In April 2015, the Governor's Sustainable Buildings website was launched to publically disclose the state's progress towards reducing its environmental footprint by

improving state building performance.

The CPUC has many ongoing programs to promote energy efficiency, authorizing spending of about \$1 billion per year across the state's investor-owned utilities for all end-use electricity and natural gas consumers.

A 2014 decision committed funding at that level for a ten-year period as part of their new Rolling Portfolio design, whereby energy efficiency targets will be updated annually rather than tri-annually and evaluations will be integrated within the portfolio rather than at fixed time intervals.

The long-term, committed funding will provide a longer-term perspective and could enhance market transformation for deeper and longer lasting energy savings. California's publically-owned utilities are also committed to reducing energy consumption, investing close to \$140 million in energy efficiency programs per year.

In addition to the low-income energy efficiency programs offered through the state's investor-owned and publically-owned utilities, the Department of

Cross-Sector Opportunity: Green Infrastructure

Urban greening can have many benefits that ameliorate impacts from climate change. Communities can improve the sustainability of existing built environments by incorporating greening components that provide a myriad of benefits. For example, investments in green streets and alleys, green roof projects, and greening of schools grounds and other public spaces can greatly reduce heat island effects and promote energy and water conservation, while also providing environmental and public health benefits. Investing in urban greening projects is a cross-sector priority, especially to respond to the risks faced by disadvantaged communities. The Governor's budget recognizes the need for continued investment, which will incorporate the positive impacts that urban greening projects can have on energy use.

²⁷ <http://gov.ca.gov/news.php?id=17508>

²⁸ http://gov.ca.gov/docs/Green_Building_Action_Plan_B.18.12.pdf



Community Services and Development (DCSD) invests in energy efficiency upgrades and on-site renewable generation for vulnerable and disadvantaged communities. For example, the Low-Income Weatherization Assistance Program administered by DCSD and funded by the state and the United States Department of Energy for decades, has assisted low-income households in disadvantaged communities install rooftop solar photovoltaic systems, solar hot water heater systems, and weatherization measures, such as wall and attic insulation and duct sealing. This program demonstrates the state’s commitment to leverage funding to ensure that the communities who will be most impacted by climate change are prepared and have the tools and resources to adapt to its effects.

Water Efficiency

Water will become more precious as the climate changes. Droughts are expected to become longer and more severe. Therefore water efficiency is a key adaptation strategy with a co-benefit of reducing energy demand. In response to California’s severe drought, Governor Brown’s Executive Order B-29-15 outlines bold steps to save water, increase enforcement of water use standards, streamline the state’s drought response, and invest in new water energy technologies. To accelerate the deployment of innovative water and energy saving technologies in the agricultural, residential, industrial, commercial, and desalination sectors, the California Energy Commission, jointly with the Department of Water Resources, and the State Water Resources Control Board, will implement a Water Energy Technology (WET) program if

funding is provided by the Legislature. WET will provide funding for innovative technologies that meet the following criteria:

- display significant on-site water savings, energy savings, and greenhouse gas emission reductions;
- demonstrate actual operation beyond the research and development stage;
- document readiness for rapid, large-scale deployment (but not yet widely deployed) in California;
- deploy technologies that are commercially available; and
- apply funds in existing facilities.

Executive Order B-29-15 also ordered the California Energy Commission to establish standards that improve the efficiency of water appliances, including toilets, urinals, and faucets available for sale and installation in new and existing buildings. In addition, on August 12, 2015,

Water will become more precious as the climate changes. Droughts are expected to become longer and more severe. Therefore water efficiency is a key adaptation strategy with a co-benefit of reducing energy demand.





the Energy Commission approved new standards for showerheads that are expected to save more than 2.4 billion gallons of water in the first year and 38 billion gallons after full stock turnover in 10 years. Another of the four Energy Commission responsibilities in the Executive Order calls for a short-term, statewide rebate program for water-efficient appliances and devices. Pending funding, the Energy Commission is proposing two separate programs to save water: a clothes washer residential rebate program and a targeted disadvantaged community direct install program. The programs will help residents capture water and energy savings while reducing greenhouse gas emissions.

The CPUC initiated R.13-12-011 to look into policies to promote a partnership framework between energy IOUs and the water sector to promote water-energy nexus programs. The CPUC recently adopted a water-energy calculator to quantify how much electric energy is required to move and treat water in order to calculate the energy savings of various water conservation programs and allow water utilities to tap energy efficiency funding for water conservation programs. The calculator also calculates the water resource benefits associated with water savings. A second tool is the Avoided Water Capacity Cost Model (water tool). The water tool calculates an avoided water system capacity cost associated with water savings. Water tool output is an essential input into the water-energy calculator.

Demand Response

DR is a climate-resilience strategy in that it facilitates rapid load drops when grid reliability is jeopardized or demand is higher than expected.

Although DR was not originally designed for the purpose of preparing for climate risks, it presents a powerful strategy for reducing peak energy

demand and thereby boosting grid resilience

when, for example, extreme heat waves raise peak demand.

CPUC is evaluating DR in resource planning needs and operational requirements. It has recently contracted with Lawrence Berkeley National Laboratory to conduct a study to assess the technical potential of residential, commercial, industrial end uses to provide

DR, plus economic and market potential of DR products to help establish DR goals. In addition, the CPUC has an interim target of meeting 5 percent of peak demand with price-responsive DR and has also made participation of DR in the wholesale markets possible as a flexible ramping resource and ancillary service. Passage of a new decision calling for time-of-use rates by 2018 will further help with peak load reduction and conservation. All three electricity IOUs have nearly

The CPUC recently adopted a water-energy calculator to quantify how much electric energy is required to move and treat water in order to calculate the energy savings of various water conservation programs and allow water utilities to tap energy efficiency funding for water conservation programs.



completed the installation of smart meters across their territory, which will facilitate both customer ability to participate in current time-of-use pricing plans and future pilot programs.

Automated demand response (AutoDR) is triggered by a signal from a utility or grid operator to automatically reduce a user's load to a pre-agreed level. The Energy Commission has supported the development of OpenADR, which is a communication standard protocol to increase demand response availability in California. ADR substantially increases participation compared to manual systems. OpenADR has been adopted as both a national and international standard for DR and distributed energy resource operations, allowing large numbers of loads to participate reliably in DR in other states and countries. Investments by the Energy Commission to fund development of AutoDR and Open AutoDR at the Demand Response Research Center at the Lawrence Berkeley National Laboratory are already showing results. Using AutoDR and Open AutoDR is already avoiding 260 MW of peak load in California annually. The annual net benefits (savings minus technology costs) of these technologies in California are projected to increase from \$16.5 million in 2012 to between \$39 million and \$118 million by 2020.

Energy Storage and Electric Vehicles

Energy storage technology is being hailed globally as the game-changer toward reliably managing

low-carbon, greener electricity grids. California, a national leader in advancing energy storage, envisions this technology as a critical component in reducing global warming, improving air quality, promoting energy independence, and building climate resilience. The state currently has several pilot projects, and is working toward commercialization of energy storage. By supporting technology demonstrations and bringing energy storage innovators and investors together, California Energy Commission-funded storage projects provide data and real-world experience that will help reduce investment costs and prove which solutions work best in specific applications.

The passage of Assembly Bill 2514 and the resulting California Public Utilities Commission decision set energy storage procurement targets for each of the IOUs totaling 1,325 MW to be online by 2024. In December, 2014, the California Independent System Operator (ISO), the California Public Utilities Commission (CPUC), and the California Energy Commission unveiled a comprehensive roadmap to assess the current market environment and regulatory policies for connecting new energy storage technology to the

By supporting technology demonstrations and bringing energy storage innovators and investors together, California Energy Commission-funded storage projects provide data and real-world experience that will help reduce investment costs and prove which solutions work best in specific applications.



state’s power grid.²⁹ The roadmap culminates years of work and input from more than 400 interested parties, including utilities, energy storage developers, generators, environmental groups, and other industry stakeholders. This roadmap will be used by the CPUC, Energy Commission, and the ISO to inform future regulatory proceedings, initiatives, and policies and lays a foundation to integrate energy storage technologies that benefit grid reliability and consumers.

The Energy Commission and CPUC continue to support the Governor’s Zero Emissions Vehicle Action Plan.³⁰ Significantly, in December, 2014, the CPUC issued a Decision that would allow the electric utilities to take a larger role in the deployment of electric vehicle (EV) charging stations and electrical equipment, while the Energy Commission’s Alternative and Renewable Fuel and Vehicle Technology Program is funding the expansion of public fueling stations for hydrogen fuel cell vehicles throughout the state. In addition, CPUC staff initiated a pilot program in August, 2014, to test the possibility for utilities to deploy sub-meters, which are capable of separately measuring and billing EV charging using a second meter on the customer’s side of the utility meter. Deployment of sub-meters is a critical step in allowing the utilities to offer EV-specific rates that can allow EV drivers to access low-cost energy at night and mitigate the impacts of EVs on the electric grid. As technology improves, sub-meters may eventually allow vehicles to offer energy services to the utilities, providing an additional



source of revenue to the drivers. The pilot program is divided into two phases to test different sub-metering scenarios and is expected to conclude in 2016. The Energy Commission supports EV charging R&D, and through the Alternative and Renewable Fuel and Vehicle Technology Program, supports EV charger R&D, and through the Alternative and Renewable Fuel and Vehicle Technology Program, supports EV charger and hydrogen fueling station deployment.

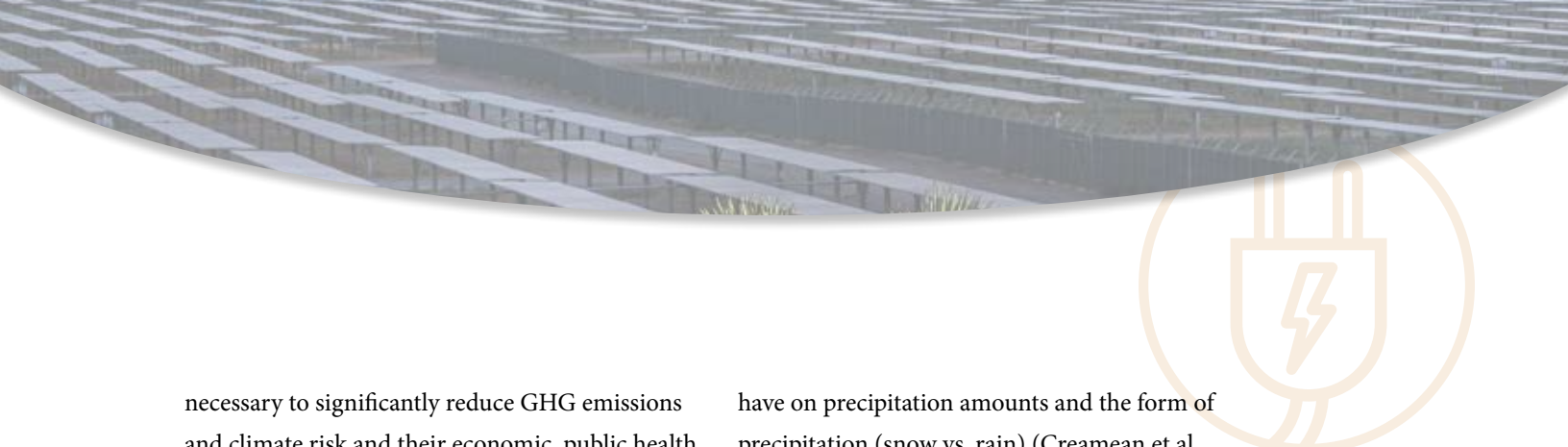
Enhance Energy-related Climate Change Research

Climate change research is one of the cornerstones of the state’s climate policies. A 5-year research agenda for the energy sector was prescribed in the recent *Climate Change Research Plan for California* (Climate Action Team, 2015). It was designed to answer policy-relevant questions that support strategies and technological innovations

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²⁹ http://www.caiso.com/Documents/Advancing-MaximizingValueofEnergyStorageTechnology_CaliforniaRoadmap.pdf

³⁰ http://www.opr.ca.gov/s_zero-emissionvehicles.php



necessary to significantly reduce GHG emissions and climate risk and their economic, public health, and environmental impacts; identify synergies and trade-offs between mitigation and adaptation strategies; and assess the vulnerability of the energy sector to climate change. The Energy Commission is implementing this agenda through the EPIC (for electricity) and Natural Gas Research and Development programs and their respective investment plans. California's Fourth Climate Change Assessment is the first major part of implementation of the research plan in the energy sector.

The Energy Commission manages several applied research projects that will enhance climate adaptation for the energy sector now and into the future. For example, Scripps Institution of Oceanography demonstrated that it is possible to develop probabilistic seasonal forecasts that can be used to prepare for the possibility of hot summer months (Alfaro et al., 2006). They also showed that using satellite data about coastal fog early in the morning can substantially reduce peak demand forecast errors in the same day (Pierce and Cayan, in preparation). Finally, a new research project with the University of California Riverside and NASA/JPL is developing a new hydrologic forecast for a major hydropower system operated by Southern California Edison (SCE). The new forecast system will take into account the important role that small particles in the air

have on precipitation amounts and the form of precipitation (snow vs. rain) (Creamean et al., 2013). SCE is heavily involved in this project providing real world expertise on the actual management of their reservoirs.

The research portfolio for the energy sector addresses vulnerability and risk assessment of climate impacts and assessment of adaptation strategies. Studies will extend the assessment of the increasing risks of sea level rise and wildfires on the electricity system begun in preliminary research by Lawrence Berkeley National Laboratory for the Third Assessment. A similar study is planned to investigate the climate vulnerabilities to the petroleum system such as refineries and oil pipelines. Other researchers will gather new empirical data on near-surface temperatures within an urban heat island to improve understanding of the determinants of the effect and provide a foundation for location-specific options to reduce peak energy demand and adverse public health impacts. Bottom-up regional studies are planned to consider impacts from multiple climate change factors on the natural gas system. Communicating climate risks to stakeholders in California's electricity infrastructure is being enhanced through improvements in the Cal-Adapt visualization tool.³¹

The Energy Commission is also funding research targeted to specific adaptation strategies. These include innovative grid management and

³¹ <http://cal-adapt.org/>



operation strategies to overcome limitations or potential disruptions in power transmission as well as limitations to the grid’s ability to make use of intermittent renewable generation. A group of projects are developing long-term energy scenarios from the present to 2050 that include climate impacts on demand, generation, and transmission.

In addition, the Energy Commission is funding research to improve grid resiliency through efficiency and demand response; renewable energy, distributed generation, and energy storage; and clean fossil-fueled sources and infrastructure improvements. Complementing these technological innovations are investigations of consumer choice and civic engagement, as well as assessments of the cost-effectiveness of adaptation options.

The State of California has been supporting regional climate change research for more than a decade. These studies have complemented research at the national level and have been designed to inform climate policy deliberations and actions in California. The Energy Commission in collaboration with the Air Resources Board developed and supports the State Climate Change Research Catalog, which is now hosted through Cal-Adapt.³² The Research Catalog provides basic information about past and ongoing climate change-related studies that state agencies have conducted or commissioned since the early 2000s. The purpose of this catalog is to document California’s research efforts and to facilitate

the exchange of information. This new version provides improved user interface and search capabilities, including graphical summaries.

Data access by researchers has been an ongoing challenge for climate vulnerability and adaptation studies. Utilities have often been naturally reluctant to share data that is either proprietary about their operations or could affect customer privacy. For example, studies have been hampered by lack

of access to data on grid disruptions caused by wildfire, operations of hydropower units, or the precise locations of coastal energy infrastructure. Nevertheless there have been successful examples where arrangements were made to provide such data to researchers under a nondisclosure agreement under which aggregated results could be reported (Auffhammer and Aroonruengsawat, 2012; Radke et al., 2015). The agencies and utilities need to continue working out procedures by which sensitive data can be accessed by researchers without compromising privacy, security, or business interests.

The CPUC created the EPIC in 2011 to ensure that sufficient investment would be made in research and development of emerging energy

Data access by researchers has been an ongoing challenge for climate vulnerability and adaptation studies. Utilities have often been naturally reluctant to share data that is either proprietary about their operations or could affect customer privacy.

³² <http://cal-adapt.org/research/>



technologies. Funding for the EPIC program is set at approximately \$162 million per year from 2012-2020, and is to be used to support each of the following areas: Applied Research and Development, Technology Demonstration and Deployment, and Market Facilitation. Proposals for investment in various research areas are

included in three-year investment plans created by each of the administrators (Energy Commission, SCE, PG&E, and SDG&E) with input from the public and submitted to the CPUC for approval. The IOU investments are focused on technology demonstration and deployment and market facilitation.

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Next Steps

It is clear from the prior sections that there is already a great deal of initial work on adaptation. However, these actions are more related to developing new information via research projects and less oriented towards the substantial investments that implementation of adaptation measures will require. This focus is due in part to the fact that decision makers in the energy sector must feel comfortable with their investment decisions, and action will require careful collaboration and dedicated funding by public and private entities. Energy utilities may not be willing to invest substantially in adaptation unless the investments also make sense under current climate conditions and the climate of the next 30 years. It may make sense in some cases to delay implementation of adaptation options because the risks are not imminent and/or there is time to implement adaptation measures when new major investments are required. For example, an analysis conducted by RAND Corporation for the Port of Los Angeles suggested that sea level rise in the next decades should not be a problem, but that it would be wise to start implementing adaptation measures in the next major improvement program for the port when it will be less costly (Lempert et al., 2012). As with this specific study, future adaptation studies for the energy sector will include consideration of costs. The end result will compare the cost of doing nothing with the cost of different adaptation measures.

The CPUC and the Energy Commission via their EPIC and Natural Gas Research and Development programs are supporting adaptation research for the electricity and natural gas sectors, respectively. There is now a one-time source of funding for the Energy Commission to start analyzing the climate

vulnerabilities of the petroleum sector, but a steady stream of research funds for the petroleum sector is needed.

The following are the next steps that California will take to substantially increase its climate resilience



activities for the energy sector:

- Establish a Working Group between the Energy Commission and the California Public Utilities Commission to design, implement, and monitor the actions listed below. This group met for the first time by January 15, 2016 and will create a work plan by April 29, 2016.
- Work with the DOE, the IOUs, and the publically-owned utilities (POUs) on the vulnerability assessments and resilience plans that they have agreed to produce as part of their membership in the DOE Climate Resilience Partnership (see schedule for vulnerability assessments above). This collaborative effort will facilitate development of robust documents that can be the cornerstone of efforts to incorporate adaptation planning and measures into utility operations and relevant CPUC proceedings and Energy Commission research.
- Work with other California IOUs and POUs

and other energy utilities and entities that are part of natural gas (CPUC and Energy Commission) and transportation fuel systems (Energy Commission only) to implement a program similar to the DOE Climate Resilience Partnership, when necessary.

- Collaborate on research needs and efforts within the Commissions to ensure that research produces actionable science and investment and operational parameters
- Formalize the Energy Commission climate and sea level rise scenarios as part of an effort to foster science-driven decisions by June 1, 2016.
- Encourage cooperation and collaboration among all utilities and the various regional climate resilience collaboratives.

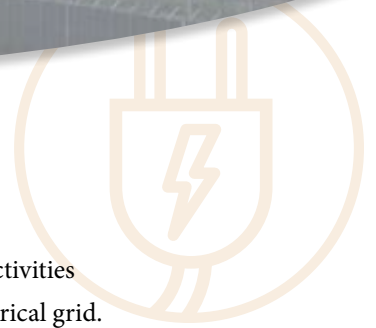
The two Commissions will report progress on the above action items to the California Natural Resources Agency by June, 2016, as required by Executive Order B-30-15.

Monitoring and Evaluation

Energy indicators should: 1) be able to track progress on mitigation and/or adaptation while taking into account non-climatic features; 2) be easy to understand; and 3) be relevant at different levels of geographical detail from local to statewide levels.

Some of the energy indicators will be similar to the indicators needed for other sectors. For example, an indicator that tracks the fraction of winter precipitation that falls as snow will be very useful for hydropower operators but also for the water supply sector. For brevity this

section does not discuss these indicators here but, obviously, local and regional indicators by hydrological units would be preferable than statewide indicators because the situation tends to be different in different regions in California (Franco, 2015).

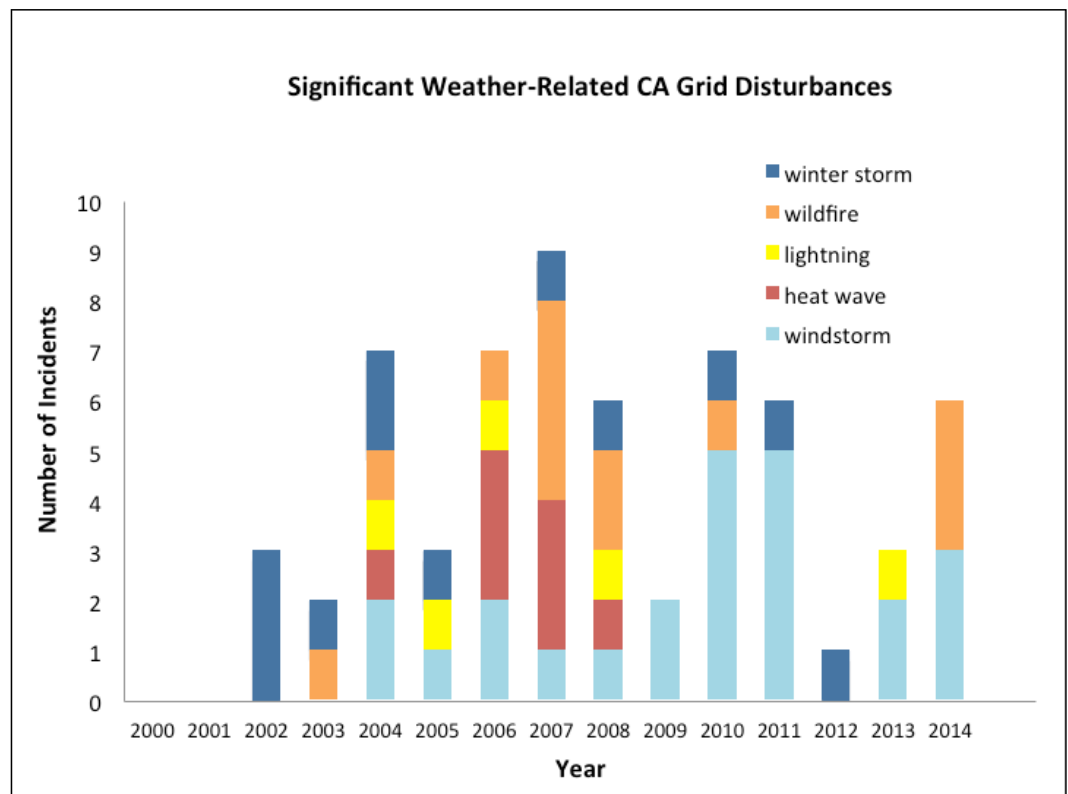


Cooling degree days (CDD) and HDD are excellent indicators for the energy system. However, the definition of these indicators must be made relevant for California. For example, NOAA uses 65° F as the baseline temperature for the definition of HDD. This basically assumes that if ambient temperature falls below 65° F, people start to warm their homes and buildings, increasing energy demand for space heating. In practice, data from PG&E suggests that 60° F is a more realistic baseline temperature for their service territory (Franco, 2015). HDD and CDD data are available via NOAA but at a highly aggregated geographical resolution. Cal-Adapt will make this information available using a grid resolution of 3.5 miles using appropriate baseline temperatures for both historical data and climate projections.

Weather-related energy disturbances can become more frequent and damaging under a changing climate.

For example, an increase in wildfire activities could increase disruptions of the electrical grid.

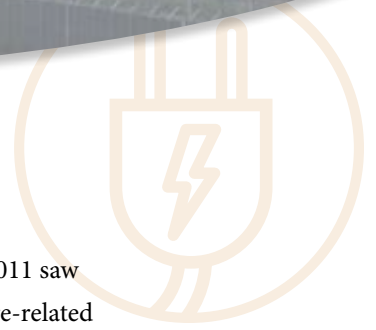
However, the modernization of the electricity grid may reduce these events if this modernization is done considering climate change. The figure below shows the number of weather-related grid disturbances per year in California. This figure does not show a clear trend, but this may



Data Source: Energy Information Administration

To develop meaningful indicators, it will be necessary to create a repository of information about future disturbances, while at the same time trying to examine the historical record to see how far in the past trends can be tracked. For example, it may be possible to extend the historical period before 2002 in the above figure if information is available from governmental and/or energy entities.

³³ A unit of measure that indicates how heavy the air conditioning needs are under certain weather conditions



be due to the relatively short timeframe covered (12 years) and the fact that the electricity system is changing. However, some notable weather patterns are reflected in the length of the bars in the graph for particular weather-related sources of disturbances. As noted above, 2006 had an extreme heat wave, and heat waves caused a large fraction of the grid disturbances that year. Likewise, 2007 and 2008 were extremely bad years for wildfire, corresponding to larger than average number of

grid disturbances. In contrast, 2009-2011 saw relatively small area burned and no fire-related outages. Regardless, it would be important to develop indicators of weather-related energy disturbances such as the one shown below to examine if the protective measures implemented for the energy system are effective.

Forestry Sector Plan



AGRICULTURAL SECTOR PLAN



BIODIVERSITY AND HABITAT SECTOR PLAN



EMERGENCY MANAGEMENT SECTOR PLAN



ENERGY SECTOR PLAN



FORESTRY SECTOR PLAN



LAND USE AND COMMUNITY
DEVELOPMENT SECTOR PLAN



OCEANS AND COASTAL RESOURCES
AND ECOSYSTEMS SECTOR PLAN



PUBLIC HEALTH SECTOR PLAN



TRANSPORTATION SECTOR PLAN



WATER SECTOR PLAN



Forestry Sector Plan



Introduction

Forests are our key life support system on this planet, and one that occupies a significant portion of the state: about 33 million acres of California’s 100 million acres. They provide a multitude of key benefits — clean air and water, wildlife habitat, building materials, renewable energy, and recreation. Climate change in California forests is affecting tree survival and growth, forest composition, forest health and productivity, and has increased the intensity of ecosystem disturbances from wildfire, insects and spread of invasive species and land type conversion. These impacts result in less capacity to store carbon and more risk of greenhouse gas emissions.

Climate change suggests a continuing and even accelerated risk of wildfire and a trajectory of more frequent drought (Diffenbaugh et al., 2015) and higher fire severity in some portions of the state (Fried et al., 2004). Some plant communities cannot adapt fast enough to increasing drought stress, resulting in large scale mortality from insects, fire, and disease (Grant et al., 2013).

Increased fire extent, intensity, and severity can affect aquatic habitats (Bisson et al., 2003) and water quality (Ice et al., 2004). These future climate scenarios combined with continuing projections

of residential growth into the wildland (Mann et al., 2014) suggest that the current wildfire-related problems are poised to become even larger and more costly in the near future. For the purposes of this chapter, climate impact discussion and adaptation strategies focus on ecosystems supporting tree cover, forests and oak woodlands.

The Forestry Sector plan categorized actions into 6 actions: 1) Forest Health; 2) Urban Forestry; 3) Biomass Utilization; 4) Watershed Health; 5) Research; 6) Monitoring.



Vulnerability Assessment

CALFIRE is in the process of updating the 2010 California’s Forests and Rangelands Assessment. In 2008, the U.S. Farm Bill directed the U.S. Forest Service (under the Department of Agriculture) to coordinate with states on forest and rangelands assessments. The first coordinated report for California was completed in 2010. The process for developing the 2010 Assessment was based on looking at the location of forest and range resource assets in the context of potential threats across the state. This information



was used to determine priority landscapes that have high asset values that are likely to be threatened — this Assessment will help guide efforts to acquire and direct funding that can enable programs and other tools that create desired future landscape conditions.

There is also the Southwest Regional Climate Hub and California Subsidiary Hub Assessment of Climate Change Vulnerability and Adaptation and Mitigation Strategies (Elias et al., 2015). The report addresses climate issues related to forests and agriculture, including specialty crops.



FOREST CONDITIONS

An undisputed fact is that wildland fires burn across landscapes without regard for political jurisdictions, property lines, governing laws, or land management goals. Furthermore, with the increasing threat and prolonged impacts of four years of drought in California and expansive acres of insect and disease outbreaks, these realities have heightened the importance of implementing forest health projects for carbon sequestration and climate benefits.

Both the United States Forest Service and CAL FIRE have collected forest land spatial data exhibiting the exponential increase in insect attack,

disease, and moisture-stress related tree mortality. These areas are more prone to high severity fire and the dead, decadent, and dying trees emit methane and lose carbon storage capacity. The southern Sierra Nevada Region is entering an epidemic of pine bark beetles and fir engraver beetles. Estimates in some areas are that 20 to 25 percent of the pine trees are already dead or dying.

The negative impact of GHG emission is exacerbated when landowners remove these trees to prevent disease spreading and reduce fire risk, but are then unable to convert the trees and biomass into long term-carbon storage as harvested wood products or bio-feedstock for

Wildland fires burn across landscapes without regard for political jurisdictions, property lines, governing laws, or land management goals.



electrical generation, heat energy, or other co-products (bio-char, landscape mulch, biofuel). The lack of capacity to manage the biomass and trees for a higher value use results in this wood being left in the forest, and in many cases open-pile burned. Both of these activities undermine the objectives of GHG emission reduction goals.

When managing forested landscapes for GHG benefits, CAL FIRE, Air Resources Board, and the Natural Resources Agency are concerned about the increasing emissions of short-lived climate pollutants (SLCPs) associated with the growing number, size and severity of catastrophic wildfires. SLCPs are more recently recognized climate change drivers that remain in the atmosphere for a much shorter period of time than other targeted climate pollutants, mainly carbon dioxide (CO₂); however, their potency, in terms of warming effect, is tens, hundreds, or even thousands of times greater than that of CO₂. They are responsible for about 40 percent or more of global warming experienced to date. SLCPs relevant to forests include black carbon (soot) and methane (CH₄), with about 64 percent of black carbon emissions sourced from wildfire. Given this, the amount of black carbon can be significantly reduced by reducing the frequency of catastrophic wildfires. Methane emissions can be reduced by removing the downed trees and biomass from the forest to avoid emissions from aerobic and anaerobic activity before or after a wildfire. The worst option, from a GHG emissions perspective, is a no-treatment strategy.

INCREASED TEMPERATURE AND EXTREME EVENTS

Temperature rise affects plant species behavior, including seed production, seedling establishment, growth and vigor. It also reduces moisture availability for plants, threatens seedling and plant survival, increases the risk of wildfire, and enhances the survival and spread of insects and possibly pathogens.

With warmer temperatures, certain tree species in California have responded by migrating to higher altitudes. Recent research concluded that upslope movement of pine forests and oak woodland conversions to grassland have already occurred due to climate change (Thorne et al., 2006). As the rate of climate change increases some tree species may not be able to adapt to changed conditions. Species with currently restricted ranges will probably be most vulnerable, while species with broader climate tolerances may be able to adapt more easily. Alpine forests and associated plant species are particularly vulnerable, because they have little room to expand. Ecologists also no longer assume that

With warmer temperatures, tree species in California may respond by migrating both northward and to higher altitudes (Shugart et al., 2003). Recent research concluded that upslope movement of pine forests and oak woodland conversions to grassland have already occurred due to climate change (Thorne et al., 2006).



plant communities will migrate intact, so forest and range communities may change in species composition as they move.

Researchers modeled interactions of temperature, wildfire, carbon dioxide, and other climate effects. The results have predicted declines in conifer forests, oak woodlands, savanna and chaparral, but increases in hardwood forests and grasslands (Lenihan et al., 2006).

PRECIPITATION CHANGES AND EXTREME EVENTS

Climate change is affecting precipitation and hydrology, which are critical drivers in forest ecosystems, in several ways. Recent winters have been warmer, have had less precipitation and snowmelt has begun earlier (Westerling et al., 2006). According to the California Climate Tracker, the winter average minimum temperature of 2014-15 for the Sierra Nevada region was 32.1 degrees Fahrenheit, the first time this value was above water's freezing point in 120 years of record-keeping.

In addition, a greater percentage of precipitation is already falling, and will continue to fall, in the form of rain rather than snow. Less snowpack and the temporal changes in snowmelt and spring runoff can lead to longer dry periods in summer months, reducing available moisture for forest plants. Moisture deficits may, however, be somewhat offset by increases of atmospheric carbon dioxide which generally cause plants to increase their water use efficiency. Since 2009,



California has experienced several of the most extreme natural events in its recorded history: severe drought, an almost non-existent Sierra Nevada winter snowpack, five of the top 20 largest forest fires in terms of acreage burned, and two years in a row of the hottest average temperatures.

Healthy forests help anchor soil and absorb rain and snowmelt, so flooding and landslides are less severe.

Healthy forests help anchor soil and absorb rain and snowmelt, so flooding and landslides are less severe. Forests also help regulate the timing and magnitude of water runoff and water flows; and they have very significant impacts on water quality, because they provide a filtering function that prevents impurities from entering streams, lakes, and groundwater.



For the purposes of this chapter, climate impact discussion and adaptation strategies focus on ecosystems supporting tree cover, forests and oak woodlands.

FIRE HISTORY AND MANAGEMENT

Wildfires are an intrinsic part of California’s forest and rangeland ecosystems. Our native habitats have evolved with and adapted to periodic wildfire disturbance. However, fire activity in California has undergone many changes over time. In the past 20 years we’ve experienced 14 of the 20 largest forest fires in recorded history³⁴. Larger and more frequent wildfires will impact California’s economy by increasing fire suppression and emergency response costs, damages to homes and structures, interagency post-fire recovery costs, and damage to timber, water supplies, recreation use and tourism. As climate change continues these costs are expected to increase. In 2015, for the first time in history, U.S. Forest Service spent over half their budget on fire suppression by the end of August.

Management options for adapting to the threat of increased fires must address public health, public safety and ecosystem protection. Fire protection measures, including suppression, prevention and building codes, can reduce the occurrence, extent and damage of wildfires. Fuel reduction by manual, mechanical and prescribed burning can reduce the size and severity of wildfires. Vegetation and wildfire management may be used to reestablish conditions that support historic or more ecologically beneficial and socially acceptable

fire regimes. In significantly altered ecosystems and developed areas, this may take many steps and treatments.

Fuel loads have increased with fire suppression practices. Strategically placed, fuels reduction work involving mechanical removal and prescribe burning is the most effective means to reduce hazard and risk and help restore vegetation conditions that are more resistant to wildfire damage. The effectiveness is best seen when wildfire burns into areas where fuel treatments have taken place. As an example, the Lanes Fire, in the Fresno-Kings Unit, burned into the Beal Fuelbreak and, as a result of fuel reduction treatments the spread of the fire was slowed. This allowed resources to more efficiently take suppression action on the fire (CAL FIRE and Board of Forestry and Fire Protection State Fire Plan, 2010).

Removing biomass from the forest and using it to develop products and generate energy production as a fossil fuel alternative is another important strategy to store carbon and reduce emissions. The USDA Forest Service manages over half of all California

Larger and more frequent wildfires will impact California’s economy by increasing fire suppression and emergency response costs, damages to homes and structures, interagency post-fire recovery costs, and damage to timber, water supplies, recreation use and tourism.

³⁴ http://www.fire.ca.gov/communications/downloads/fact_sheets/20LACRES.pdf



forests so their land activity is significant for the overall health of the State watersheds. In 2014, the Forest Service conducted fuels treatments and forest health improvement on about 160,000 acres of their lands. Regional leadership has expressed the need to treat two to three times more acres annually to address the backlog of fuels reduction needs and forest restoration (USDA Forest Service Region 5, 2015).

Based on the area of ecosystems that historically supported frequent low-severity fire regimes, the potential need for prescribed burning or other

treatments that restore fire resistant ecosystem conditions may be estimated at over a million acres per year. While prescribed burning treatments can be less expensive to conduct, in many cases reintroduction of fire is not prudent until heavy understory and ladder fuel hazards have been treated through alternative means (e.g., mechanical treatments). Additional research, monitoring and information sharing on the effectiveness of all treatments to reestablish desired conditions for supporting wildland fire will also be very important.

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Forestry Adaptation Strategy

1 Improve forest health, resiliency and co-benefits by implementing forest management practices on public and private lands


- Coordinate efforts to reduce wildfire risks and severity to reduce associated emissions and avoid risk of landscape conversion to invasive species
- Manage the forest in such a way that increases overall carbon storage and provides multiple co-benefits such as water and biodiversity protection.
- Identify priority landscapes to invest resources to demonstrate greater benefits
- Better understand the tradeoffs between different climate responses to forest management actions.
- Incentivize voluntary landowner measures, such as conservation easements, in areas of high risk

for conversion to more intensive uses.

- Provide funding to support, maintain, and expand seed banks and revive state tree nurseries.
- Qualitatively and quantitatively evaluate co-benefits to better understand opportunities and trade-offs
- Provide long term stable investment in forest health in order to incentivize planning and public and private investments.

2. Continue investing in urban forestry

- Expand tree canopy and vegetative cover in urban areas where appropriate to reduce heat



island effects, provide natural cooling, and realize many other benefits.

- Improve local understanding of policies, strategies and actions that optimize urban forest benefits for residents. This includes encouraging local governments to establish optimal tree canopy cover targets.
- Manage and maintain the urban forest to increase tree survivability, maximize carbon storage and provide multiple co-benefits.
- Improve and expand use of urban biomass that is removed for valid management purposes including but not limited to pests and disease.
- Maximize use of trees and vegetation as infrastructure in cities for multiple benefits such as reducing energy use, capturing storm water, and improving water and air quality.

3. Improve management practices and market conditions for biomass utilization

- Help retain current levels of biomass power generation in the state, revitalize currently idle facilities and expand facilities in strategically located regions.
- Retain current levels and expand uses of biomass for wood product development.
- Consider end use opportunities for biomass as part of forest management project design
- In the pricing, account for the societal value of bioenergy and other end uses of biomass.

4. Implement forest management for the overall health and protection of watersheds

- Manage California's forested landscapes to safeguard the state's water supply reliability and quality.
- Manage forests to reduce soil erosion and protect water quality.
- Account for the value of healthy watersheds and their ecosystem services and consider the avoided costs of investing in protecting and restoring these services.

5. Implement Priority Research Agenda

- Coordinate with key agencies, University of California and other research entities to identify and fill knowledge gaps related to climate adaptation and evaluate the most effective strategies.
- Improve methods, models and equations for estimation of carbon storage and greenhouse gas emissions.
- Research working forests and forest management actions as a means to increase forest health, increase carbon storage and mitigate climate change.
- Research fuels reduction as a means to reduce wildfire emissions and increase carbon storage.

6. Implement Forest Health Monitoring in an Adaptive Management Context

- Establish a comprehensive monitoring and adaptive management program to quantify the



effects on climate change and the effectiveness of adaptation strategies.

- Research species migration responses to climate change.
- Identify robust forest management strategies that will be successful best management

practices over a wide range of plausible future climate situations.

- Investigate the feasibility of creating a cooperative network of research forests across the State, including universities, federal agencies and State agencies, to monitor climate change.



Current Actions and Next Steps

In response to the current epidemic of tree mortality, Governor Brown issued a State of Emergency on Tree Mortality Proclamation in October 2015 ([insert link to gov.ca.gov/docs/10.30.15 Tree Mortality State of Emergency.pdf](http://gov.ca.gov/docs/10.30.15_Tree_Mortality_State_of_Emergency.pdf)). It requires State agencies to identify high hazard zones for wildfire and falling trees and prioritize tree removal in these areas, and calls for several actions to enable removal of hazardous trees. It also calls for expanding the practice of prescribed burns, to reduce wildfire risk and avoid pollution from major wildfires. The Proclamation also calls for facilitating power contracts for new facilities and extending operation of existing biomass power plants that receive feedstock from high hazard zones. To implement the Proclamation, in November 2015, the Governor launched the State Tree Mortality Task Force ([insert hyperlink to www.treetaskforce.org](http://www.treetaskforce.org)) comprising of state and local government agencies, and key stakeholders, to implement the numerous directives, including monitoring tree removal efforts to assess their effectiveness in protecting forest health and strengthen forest resilience.

The Forest Carbon Plan will provide forest carbon targets and an array of strategies to promote healthy forests that protect and enhance forest carbon and the broader range of forest environmental services for all forests in California. The vision of forest protection and enhancement includes:

- Sustainable forests that are net sinks of carbon.
- Healthy forests that are resilient to anticipated climate change effects, including volatile weather

and changing precipitation regimes; increased forest insect and disease threats; and higher wildland fire risks.

- Protection of watersheds and water supplies (quality, quantity, and infrastructure).
- Forests that provide management opportunities that generate long-term economic benefits for landowners, workers, and communities.



- Working forests that produce wood products and biomass for energy and are managed to maintain forest health and biodiversity.
- Forests that are protected from fragmentation and conversion, and that provide a diversity of quality, interconnected habitat types for terrestrial and aquatic wildlife species, including listed and non-listed species.
- Forests that provide an abundance of outdoor recreational and tourism opportunities.

As part of the forest carbon plan, a Resource Economic Study will be drafted by UC Berkeley academics. The study will evaluate several different management actions and investment choices identified in the Forest Carbon Plan.

ACTION 1: FOREST HEALTH

Through CAL FIRE’s new Forest Health Initiative, investments will be strategically targeted to achieve net greenhouse gas emission reductions into areas that have high rates of carbon stock, but currently face heightened wildfire risk from dead, dying, and diseased trees attacked by insects and other pathogens. Projects will be planned across large landscapes, in coordination with adjacent land owners, resulting in more efficient planning and a greater impact to forest health and carbon benefits. Where feasible, these projects will also include a biomass use component to ensure that as the volume of woody biomass removed increases, there is infrastructure to use the forest residue, thereby avoiding GHG emissions from open pile

burning or natural decay. The targeted investments will also take into account rural communities in need of local economic development and job creation, and those communities where there is active support of forest management and biomass use. CAL FIRE will also make urban forestry investments prioritized toward disadvantaged communities. CAL FIRE will also continue to secure working forest conservation easements through its Forest Legacy Program, focused at reducing the increasing pressure on landowners to convert their forestlands to other uses such as housing subdivisions, rural lots and vineyards.

Projects which are facilitated through special funds like cap and trade auction revenues — or the Greenhouse Gas Reduction Fund (GGRF) — cannot solely address the magnitude of the threats facing California forests as they function to help sequester carbon and offset the negative impacts of GHG emissions. However, as a partial solution, CAL FIRE will institute a process to further refine the identified high-priority landscapes to concentrate GGRF investments in areas that can reap the largest direct benefit for forest resiliency and co-benefits, such as increased carbon sequestration, improved water quality and

CAL FIRE will strategically target investments that will achieve net greenhouse gas emission reductions into areas that have high rates of carbon stock, but currently face heightened wildfire risk from dead, dying, and diseased trees attacked by insects and other pathogens.

quantity, diversity of wildlife habitat, and rural economic stability.

GGRF Awards – Fiscal year 14 - 15 was the first year CAL FIRE administered Greenhouse Gas Reduction Funds (GGRF) for forest-related projects. A total of about \$27 million was competitively awarded and distributed in the form of grants. An estimated \$15 million was awarded in grants for urban forestry, about \$5 million for watershed reforestation and restoration, just over \$4 million for forest legacy in the form of conservation easements, \$1.5 million for pest control and nearly a million for other activities.

CAL FIRE's Forest Improvement Program (CFIP) will continue to work with the US Forest Service, University of California Extension, Resource Conservation Districts (RCDs), Natural Resource Conservation Service and others to prevent and minimize catastrophic wildfire and restore fire resistant conditions in fire adapted vegetation types through mechanical and prescribed fire treatments, and to assist with post-fire recovery.

Allocated funding in fiscal year 14-15 was approximately \$1.5 million. CAL FIRE has been awarded over \$6 million (\$2.9 million in 2015 and \$3.4 million in 2016) from the Timber Regulation and Forest Restoration Fund for CFIP grants.

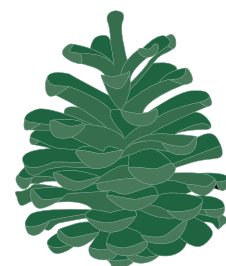
Seedbank and Nursery Support – CAL FIRE will work with the Forest Service and private sector to improve long-term seedbanks and nurseries in order to secure genetically appropriate varieties for future plantings and to preserve genetic legacies.

The L.A. Moran Reforestation Center (LAMRC) seedbank catalogues and stores approximately 42,000 pounds of primarily native conifer seeds which are available for replanting forest stands after fires, insect or disease outbreaks, or other catastrophic events but have gone unused for seven years due to inadequate funding. LAMRC continues to collect and process conifer cones for deposit to the seed bank to both replace exhausted stocks and to increase the natural genetic library.


Adaptive approaches to forest regeneration can increase resilience in the short and long-term by adjusting silvicultural practices to establish forests that are more tolerant of future climate conditions. This includes planting genetically appropriate species that will be better adapted to changed climate conditions than the genotypes currently on site.

The nursery facility in Magalia is currently out of use and being converted to a CCC camp. The LAMRC located in Davis could be reopened if needed.

Land Conservation – CAL FIRE is actively working to acquire approximately 13,000 acres of PG&E properties that will broaden the diverse landscapes and vegetation types on the Demonstration State Forests to better represent those found across the state and will provide new opportunities for research and



Approximately
**42,000
POUNDS**
of primarily native conifer
seeds are stored and
available for replanting
forest stands.



demonstration on those landscapes. Each of these acquisitions will include a conservation easement to ensure that these properties remain forestland and are not converted to other uses. Along with the existing State Forests and federal and University research forests, these new properties can form a network of climate change monitoring stations across the State.

Review Regulatory Framework 1504 – Assembly Bill 1504, 2010 requires that Board of Forestry and Fire Protection (BOF) and CAL FIRE guarantee its regulations governing commercial timber harvesting take into account the capacity of forests to sequester 5 million metric tons (MMT) of carbon/year, consistent with California’s climate change mitigation goals for the forest sector established under Assembly Bill 32.

Structure Protection Exemption – In May 2015, the BOF adopted emergency regulations allowing specified forest management activities, including exempting cutting or removal of trees between 150 and 300 feet from an approved and legally permitted habitable structure for the purpose of reducing flammable materials and maintaining a fuel break. The previous exemption allowed for removal of fire hazard trees within 150 feet of a structure.

Protection of the Beneficial Uses of Water and Riparian Functions – The BOF adopted emergency water drafting regulations in August 2015. The water drafting emergency regulations affect all Forest Districts and require Registered Professional Foresters planning timber operations to consider beneficial uses of water including the

potential impacts to drinking water. These emergency regulations were necessary to recognize the severity of the drought and highlight potential impacts to fisheries and wildlife as well as domestic water supplies from timber harvest related drafting operations.

AB 1492 Timber Regulation and Forest Restoration Fund

The Timber Regulation and Forest Restoration Fund (TRFRF) Program is a component of Assembly Bill 1492 (2012). The major elements of the TRFRF Program provide a funding stream via a one-percent assessment on lumber and engineered wood products sold at the retail level, seek transparency and efficiency improvements to the State’s timber harvest regulation programs, provide for development of ecological performance measures, establish a forest restoration grant program, and require program reporting to the Legislature.

Program Timberland Environmental Impact Report for Carbon Sequestration and Fuel Reduction (PTEIR)

CAL FIRE has developed the PTEIR report to meet the goals of the Global Warming Solutions Act of 2006. The Program is designed

The CAL FIRE PTEIR report is designed to have the combined benefit of increasing the carbon sequestration potential of California’s nonindustrial timberlands, while decreasing carbon emissions from wildland fires.



to have the combined benefit of increasing the carbon sequestration potential of California’s nonindustrial timberlands, while decreasing carbon emissions from wildland fires. Over one-half of the privately owned, commercial timberland in California is owned by nonindustrial landowners. Long-term uneven aged management of these lands and the retention of large, old trees can increase the ability of timberlands to sequester carbon through increased growth and inventory and to convert carbon dioxide to oxygen through photosynthesis. Prudent timberland management can decrease the potential for large wildland fires that release greenhouse gases by creating forests that are less susceptible to ignition and that reduce the intensity of wildland fires, thereby allowing for more successful fire suppression efforts. The Program will provide grant funds for the development of PTEIRs to facilitate these declarations.

Vegetation Treatment Program Environmental Impact Report

The BOF has initiated the Vegetation Treatment Program as part of a comprehensive fire prevention strategy. This statewide program provides a framework for vegetation treatment projects that reduce fire risk through strategic fuels management on SRA lands and supports federal and local non-SRA fuel reduction projects.

State Fire Plan

The State Fire Plan provides overall statewide goals and objectives, with individual Unit Fire Plans that compliment this with the on the ground fire plan

specifics. Work to begin updating the plan is just beginning and the target to complete this is 2016. The updated plan will have a stronger focus on climate change by integrating strategies to address anticipated impacts.

State Responsibility Area Program

This is a local assistance grant program for fire prevention activities designed to benefit habitable structures within state responsibility areas, including public education, that are provided by counties and other local agencies, including special districts, with state responsibility areas within their jurisdictions.

The program provides grants to a qualified nonprofit organization with a demonstrated ability to satisfactorily plan, implement, and complete a fire prevention project applicable to the state responsibility areas. The department may establish other qualifying criteria.

ACTION 2: URBAN FORESTRY

Currently funded through the Greenhouse Gas Reduction Fund, CAL FIRE’s Urban and Community Forestry

CAL FIRE’s Urban and Community Forestry Program assists local entities with tree planting, utilizing trees and other vegetation to create infrastructure solutions, and improving urban forest management.





Program will continue to assist local entities with tree planting, utilizing trees and other vegetation to create infrastructure solutions, and improving urban forest management. This is accomplished by providing technical assistance, education, policy consultation, and grants (CAL FIRE Urban and Community Forestry Program Strategic Plan 2013-2018). Accomplishments will help protect and expand urban forests that serve to provide cooling, carbon sequestration, protect air quality and water quality, improve public health outcomes, and habitat co-benefits.

The cross-sectoral nature of urban forestry is recognized in the California Urban Forestry Act of 1978 (PRC 4799.06-4799.12) and cannot be underestimated when it comes to climate resilience and adaptation. Some cross-sector benefits of urban forests include: In the energy sector, reductions associated with tree canopy cover via direct shading and evaporative cooling are well documented and understood. In the water sector, the ability to use trees and vegetation to capture stormwater and reduce water pollution are undeniable. This leads to less energy expended to treat stormwater and pump water long distances. Urban forests provide opportunities for diverse habitat for many species of birds and animals and can provide opportunities for urban agriculture (community gardens and orchards) in the places where they are most needed. Nothing creates a sense of place in a community like a robust, healthy and diverse urban forest of trees and other plants. From a public health perspective, people are more likely to be active with adequate

shade and pleasant places to recreate. In addition, people are more likely to use active transportation more when their routes are shaded. As climate change progresses, it is likely that California will warm in many, if not all, of its urban areas. Urban heat island effects will increase in extent and severity without interventions. One effective intervention is to expand urban tree canopy cover

and use vegetation wherever possible as an infrastructure solution. Local governments should implement and achieve tree canopy cover goals. Public health outcomes are improved during extreme heat events with the addition of tree canopy (Preparing California for Extreme Heat: Guidance and Recommendations October, 2013. P. 12). Current research demonstrates two important trends: 1) increases in vegetation and reflectivity result in fewer heat-related deaths, and 2) urban heat islands disproportionately impact low income communities of color (“Assessing the Health Impacts of Urban Heat Island Reduction Strategies in the Cities of Baltimore, Los Angeles, and New York.” Vanos, J., L. Kalkstein, D. Sailor, K. Shickman, and S. Sheridan, (2014). Not only are these interventions proven to be effective, but

As climate change progresses, it is likely that California will warm in many, if not all, of its urban areas. Urban heat island effects will increase in extent and severity without interventions. One effective intervention is to expand urban tree canopy cover and use vegetation wherever possible as an infrastructure solution.



they are relatively low-cost in comparison to other interventions.

Urban Forestry Carbon Protocols

These are the second iteration of the protocols, and are currently voluntary protocols through the Climate Action Reserve (CAR). The protocols include a tree planting project protocol (version 2.0) and an urban forest management protocol (version 1.0).

The first version of the urban tree planting protocol is fully adopted by ARB and can be found on their web site and the CAR website.

Urban Forestry's Role in Biomass, Carbon and Avoided Emission

The report by UC Davis, (Bjorkman, J., J.H. Thorne, A. Hollander, N.E. Roth, R.M. Boynton, J. de Goede, Q. Xiao, K. Beardsley, G. McPherson, J.F. Quinn. March, 2015. Biomass, Carbon Sequestration and Avoided Emission: Assessing the Role of Urban Trees in California. Information Center for the Environment, University of California, Davis.), advances the scientific knowledge of carbon sequestration and avoided emissions by urban forests. Statewide tree canopy cover data by bio-region and urban land use was acquired for all urban areas of the state. In addition, transfer functions were developed using data provided by past CAL FIRE funded inventory and data projects that allow land managers in an urban setting to determine, by identifying the tree canopy cover, how much carbon is being stored and emissions avoided by their urban forest, and

how much more could be stored and avoided by expansion and better management of the urban forest.

Funding Awards — During Fiscal Year 2014/15, CAL FIRE allocated \$17.8 million for the Urban and Community Forestry Program (\$15.7 million for local assistance grants) and received \$1,062,000 in federal funding for the program. A total of 29 projects were funded with GGRF funds and were distributed throughout the state in disadvantaged communities from Yuba City in the north to National City near the border with Mexico. Additionally, 6 projects were funded with federal funds. These were projects that were educational or research oriented. Such projects cannot be funded with GGRF funds.

ACTION 3: BIOMASS UTILIZATION

The BOF and CAL FIRE will work with other agencies and the private sector as appropriate to encourage policies and strategies that help maintain utilization infrastructure (bioenergy, veneer plants, etc.), incentivize modernization of existing facilities and development of new facilities. A diversified industry infrastructure is necessary to allow different species and size of biomass to be used for its highest and best use. Co-locating biomass businesses can provide clean bioenergy power and heat to support wood products development such as fence posts, pellets, and timber.

The California Forest Biomass Working Group consists of diverse individuals and organizations committed to retaining and expanding woody



biomass infrastructure. The vision involves biomass harvesting and utilization serving as tools to accomplish collaboratively developed public land management restoration objectives based in forest ecology and focused on enhancing the resilience of forest ecosystems. Furthermore, woody biomass utilization infrastructure should be developed around rural forest communities and be focused on appropriately-scaled, diverse, and integrated facilities that sort woody materials for their highest and best use-values to make a suite of durable wood products and thermally efficient energy, optimizing returns to forest stewardship activities, businesses and communities. At the local-level, these facilities should provide a means of economic diversification and development for rural public lands communities while supporting ecological restoration, hazardous fuels reduction, and community wildfire protection.

The Statewide Wood Energy Team is a subgroup of the Forest Biomass Working Group. This group works directly with wood energy businesses and community-led wood energy projects to provide expertise, technical assistance, and small grants. The team also produces work to effectively develop the California wood energy industry.

The BioMAT Program, established by SB-1122, has inspired many communities to pursue planning and building biomass energy facilities 3 MWs or smaller in fire threat areas. The program allocates 50 MWs to forest-based bioenergy seeking to support further deployment of small scale distributed bioenergy by requiring higher prices be offered for purchase of the power. The price is

established between the facility and local investor owned utility, through an auction process. The auction requires three projects be in the queue in order for the price to increase. Currently about 12 projects are in various planning stages in the Sierra Nevada and North Coast. Three of these projects are on the trajectory to be ready to participate in the auction process in the next year.

A bioenergy facility located in North Fork, Madera County has secured the majority of the funds, through public funding sources, needed to construct the facility. This was substantially helped through a \$4.9 million grant awarded by the California Energy Commission. Funding will support the construction of a 1 MW gasification facility. Since this is a new industry, a dedicated funding source to support several demonstration projects is needed. To date, project proponents have cobbled together primarily state and federal grants to fund projects. This is very challenging as each grant program has its own requirements and timelines making it challenging to keep project development moving consistently forward.

Although this program is helpful in triggering facility development, the 50 MW allocations will only serve to manage a small portion of the State's woody biomass. Furthermore, concerns

The California Forest Biomass Working Group consists of diverse individuals and organizations committed to retaining and expanding woody biomass infrastructure.



exist about specific components of the program making it difficult for the forest sector to succeed and renewable energy policies in general can be a barrier. For example, given the public safety issues associated with fire, an accelerated interconnection process for forest biomass would be very helpful, especially to secure private funds.

Fuels contracts – Although there is an abundant amount of woody biomass available as feedstock for facilities, there are variables that can make the supply uncertain. For example, projects on public lands can be delayed due to project appeals and other unanticipated actions during the project planning process. Private investors need long-term contracts to ensure a certain quality and volume of supply over a minimum of 10 years. Forest Service has multiple contracting tools that they have underutilized in Region 5 but that are necessary to build an end use for their high volume of biomass.

Thermal Heat Demonstration Projects – CAL FIRE will complete feasibility studies to consider converting boilers to wood burning in two Conservation Camp Studies to be completed by the end of 2016. The new units would replace the existing propane units however, the propane units will remain as backup. The new units will supply space and water heating and will receive biomass locally.

ACTION 4: WATERSHED HEALTH

A healthy watershed provides valuable goods and services, including but not limited to water, forest and agricultural products, hydropower energy, recreation, wildlife habitat and carbon

sequestration. A comprehensive watershed evaluation was conducted on the Mokelumne Watershed, located in the central Sierra Nevada and the primary water source for the San Francisco Bay Area. Using state-of-the-art models for fire, vegetation and post-fire erosion, the potential impacts of a landscape-scale fuels treatment to modify wildfire behavior and post-fire erosion was analyzed. Financial costs and benefits of the treatments were assigned to those elements that can be valued such as homes, infrastructure, timber, biomass energy, carbon and employment.

The avoided losses in terms of both costs and lost income opportunities include the value of structures saved from wildfire and the costs of fire suppression and post-fire restoration, as well as potential revenue from carbon sequestration, merchantable timber

and biomass that could be used for energy. The value of benefits ranges from \$224 to \$126 million and results in a benefit-cost ratio for the fuel treatments of 3 to 1, and a minimum of 2 to 1 applying the more conservative benefits value estimate (Buckley et al, 2014).

Focusing in on the water benefits of healthy watershed, it is important to maintain existing water storage capacity to reduce the need for new

A healthy watershed provides valuable goods and services, including but not limited to water, forest and agricultural products, hydropower energy, recreation, wildlife habitat and carbon sequestration.



reservoirs which are costly to build and maintain. Soil loss following high severity fire negatively affects tree growth and carbon sequestration. The increasing trend in severe fires will lead to higher sediment accumulations in many Sierra reservoirs, particularly the smaller ones at middle elevations. Considerable losses in storage capacity has been documented at the Englebright Dam on the Yuba River with about one third of its storage capacity lost, and Lake Shasta with an estimated 10 percent filled with sediment (Kondolf, UCB 2014), equivalent to a 400,000 acre foot loss.

ACTION 5: RESEARCH

Improve Scientific Knowledge Base – CAL FIRE programs, such as the Fire and Resource Assessment Program, will work with Scripps, UC, FOREST SERVICE, Energy Commission and others to refine climate models for CAL FIRE’s Fire Protection and Resource Management Programs. CAL FIRE’s Demonstration State Forest Program will also work with the FOREST SERVICE Pacific Southwest Research Station, the University of California and other landowners to establish research reserves, studies and demonstrations across geographic and elevation gradients that inform climate change forest

Boggs Mountain Demonstration State Forest – Illustrative of the challenge of improving forest health in advance to reduce wildfire risk, in 2015 the Valley Fire burned through CAL FIRE’s Boggs Mountain Demonstration State Forest and left devastating impacts. This is one of eight of CAL

FIRE managed demonstration state forests, sized at nearly 3,500 acres. Within the first 24 hours the fire had burned through the entire state forest. An estimated 90 percent of the trees were either killed or substantially damaged by the intensity of the fire and very little to no understory vegetation survived the fire. A plan has been developed that identifies three phases to restore the site: 1) rehabilitation/site preparation 2) reforestation including about 500,000 seedlings and, 3) vegetation control. This effort will be monitored for experimental, research and demonstration purposes.

Forest and Rangeland Resource Assessment

– CAL FIRE is required by statute to periodically assess the condition and availability of the state’s forest and rangeland natural resources. The update will expand upon the previous climate change chapter to inform the BOP’s climate policy, strategic plan and climate change actions. The draft plan will be developed and is expected to be released late in 2016.

FRAP has a contract with UC Davis to model expected range shifts for a number of forest and shrub species, results expected in early 2016.

This year the Valley Fire burned through CAL FIRE’s Boggs Mountain Demonstration State Forest and left devastating impacts. This is the one of eight of CAL FIRE managed demonstration state forests, sized at nearly 3,500 acres.



ACTION 6: MONITORING

Monitoring programs for detecting climate change, effects on vegetation and management results are needed to support adaptation planning and management. CAL FIRE will work with the California Natural Resources Agency and others to determine and implement key monitoring needs, including forest health trends, land use and management change, and effectiveness of adaptation actions.

Indicator Development – CAL FIRE developed candidate draft indicators to report on in the Forests and Rangelands Assessment, 2016. Public input has been solicited and supported through a UC Davis website (www.indicators.ucdavis.edu/forest).

Drought Monitoring – CAL FIRE is mapping dead, dying and diseased trees affected by the current drought. A Web Map Application was developed to assist Units to prioritize areas with high levels of tree mortality that need to be mapped. These areas will be submitted to the USGS National Disaster Coordinator and they will acquire current, one foot satellite imagery that can be provided to Unit staff to map dead trees.

Establish Monitoring Criteria – Establish a network of long term monitoring plots that are implemented across both longitudinal and elevation gradients to detect climate change impacts

Continue and Expand Pest Detection – Support existing programs that can provide early detection of insects, disease, and drought in forest and range lands.

Establish Adaptive Management Criteria – Identify feedback process to inform and, as necessary, adjust policy, strategies, and regulatory approaches.

Monitor Changes in Land Use – Track acres of growth and loss of forest cover as well as resulting carbon stock effects. This information is part of Forest Inventory Analysis data (FIA).

Interagency Cooperation – Collaborate with local, state and federal agencies to leverage limited monitoring resources.

Land Use and Community Development Sector Plan



AGRICULTURAL SECTOR PLAN



BIODIVERSITY AND HABITAT SECTOR PLAN



EMERGENCY MANAGEMENT SECTOR PLAN



ENERGY SECTOR PLAN



FORESTRY SECTOR PLAN



LAND USE AND COMMUNITY DEVELOPMENT SECTOR PLAN



OCEANS AND COASTAL RESOURCES AND ECOSYSTEMS SECTOR PLAN



PUBLIC HEALTH SECTOR PLAN



TRANSPORTATION SECTOR PLAN



WATER SECTOR PLAN



Land Use and Community Development Sector Plan

Introduction

In looking to implement the broad spirit of *Safeguarding California* and Governor Brown’s Executive Order B-30-15, it was clear that the role land use and community development policies play in bolstering the state’s resilience to climate impacts needed to be addressed in a distinct document. While *Safeguarding California* includes chapters on relevant sectors like public health, transportation, emergency services, and energy, there is the need to address how state government can help develop policies that protect people, their homes, and their communities from the effects of climate change. After all, climate change affects people, and adaptation needs to happen where they live; this plan reflects the policy response to that reality.

This plan addresses state policies and programs related to land use and community development together because the two issues are linked in the way they shape social and spatial environments. The key for state policy is to ensure that communities can be located in places and developed in ways that make them more able to withstand and recover from climate threats. On one hand, land use decisions can ensure that communities and infrastructure are located to minimize the effect of climate impacts like sea-level rise, wildfires, and flooding. On the other hand, community development policy can help create sustainable and efficient communities with better access to transit options and other resources that will make residents more able to respond to disasters. In conjunction with each other, these two policy areas can spur communities that are more self-sufficient, more tightly knit, and more sustainable.

Given the uniqueness of communities throughout California and variety of climate impacts,

grassroots adaptation actions for communities will be essential. Actions must be tailored to local conditions and involve residents, neighborhoods, businesses, and local and regional governments. Land use decisions, a crucial contributor to developing resilient communities, are well suited at the local and regional level. The State can play a variety of roles in building regional, local, and grassroots capacity for climate adaptation. This plan considers the capacity of three state entities to promote adaptation in the area of land use and community development: the Department of Housing and Community Development, the Governor’s Office of Planning and Research, and the Strategic Growth Council.

The key for state policy is to ensure that communities can be located in places and developed in ways that make them more able to withstand and recover from climate threats.



The Department of Housing and Community Development (HCD) is a key player and leader in the Land Use and Community Development sector. Its mission is to “provide leadership, policies and programs to preserve and expand safe and affordable housing opportunities and promote strong communities for all Californians,” which will require an increasing focus on guarding against worsening climate impacts. HCD can shape statewide housing policy, mobile home regulation, and community development grant programs to promote climate adaptation across California.

The Governor’s Office of Planning and Research (OPR) engages in long-range planning and research, taking on the role as the state’s comprehensive planning agency. OPR takes on important roles regarding the California Environmental Quality Act (CEQA), guidelines for general plans, and other policy support for local governments. OPR plays an important role in developing tools and guidance for local governments while helping articulate and implement Governor Brown’s vision for the environment and land use.

The Strategic Growth Council (SGC) is chaired by the director of OPR and made up of the secretaries of the Business, Consumer Services and Housing Agency, the Natural Resources Agency, the Transportation Agency, the Health and Human Services Agency, the Environmental Protection Agency, and three public members; it plays an important role in coordinating environmental,

public health, transportation, housing, and climate policy. The SGC has invested over \$150 million to support sustainable community planning and urban greening, and its Affordable Housing and Sustainable Communities Program is on the cutting edge of land use and community development policy in the state.

These three actors, in conjunction with leading agencies in other sectors, show how state decision makers are making important strides in land use and community development policy and pursuing a broader vision of sustainable resilient communities. This plan provides an overview of the vulnerabilities that make adaptation action in land use and community development policy necessary, and proposes a series of principles that can guide ongoing and future work in this sector.

Three important priority areas for state action then serve to classify current adaptation initiatives while structuring a framework for concrete next steps. Safeguarding California focuses on adaptation according to many sectors, but the elements of this plan illustrate how state policy can empower local and regional efforts to achieve holistic resilience against climate impacts.

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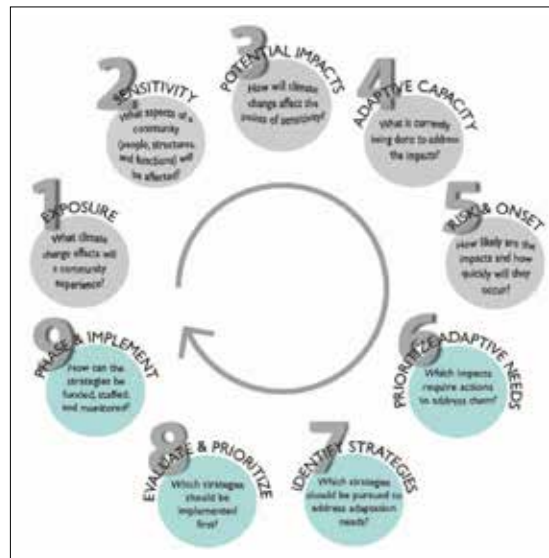


Vulnerability Assessment

California’s population is vulnerable to many harmful effects of climate change. Our communities are beginning to understand these issues and many are acting in order to mitigate potential effects. However, the diversity of people and places in our State poses great challenges to safeguarding against climate impacts. Almost every city, county, or town is vulnerable to at least one, if not several, effects of climate change, and planning and being equipped to handle all of them is a daunting task. Many climate change impacts will exacerbate existing hazards. Modifying or expanding on existing policies and programs will address some of these hazards, while others will require institutional changes to address the impacts of climate change. Leadership at the local level has resulted in significant improvements in state policy and program implementation over time. The issue of climate change necessitates state, regional and local leadership more than ever.

While other sectors examine the impacts climate change will have on a specific issue area like agriculture or transportation, this plan encourages looking at the ways that climate will affect places, structures, and people. To address the unique challenges to land use and community development policy formation from climate change, robust vulnerability assessments are needed at a local, regional and state level. Accordingly, the Adaptation Planning Guide (APG)¹ —a tool developed by the Natural Resources Agency and the Office of Emergency Services—serves to help regional and local communities in proactively addressing the unavoidable consequences of climate change. The companion document “Defining Regional and Local Impacts” provides step-by-step guidance in assessing and addressing vulnerabilities. These steps are presented here:

¹ http://resources.ca.gov/climate_adaptation/local_government/adaptation_planning_guide.html



These steps break down the complex and considerable issues at hand for local and regional authorities, and make action manageable. Vulnerability assessments and adaptation strategies should also be scalable from the regional level down to a local and neighborhood level to best assist in identifying needs and prioritizing actions. The State will continue to provide guidance on vulnerability assessments and climate adaptation strategies for local jurisdictions. Increased thought and planning must be given to where and how we locate our growing population, and how our existing communities can become resilient to climate impacts. A commitment to working with vulnerable populations and disadvantaged communities will be particularly important to build towards a more equitable and resilient California.



Principles for Adaptation

This plan looks at the concrete steps that are underway and planned for the future, but bold actions for adaptation should reflect a set of principles.

Safeguarding California offers recommendations for natural resources management, infrastructure, emergency services, and public health that build on state agencies’ missions to protect California’s people, property, and environment. This plan broadens the foundation created by *Safeguarding California* by presenting principles to guide creating resilience through land use and community development in a way that is also consistent with other ongoing objectivess.

There are already numerous examples of principles of adaptation such as those offered by the Alliance of Regional Collaboratives for Climate Adaptation (ARCCA). For the State of California to outline specific principles of adaptation one must look at the larger picture of how state actions interact with other efforts underway and support the state’s most vulnerable communities.

The principles outlined below are derived from existing goals and priorities to create “exciting, safe places to live” where “people live in harmony with the land,” can help guide and assess ongoing and future efforts to reduce climate impacts and prepare for climate risks through land use and community development³⁶:

Equity, Sustainability and Choice: Promote vibrant and safe communities that have an

affordable mix of safe and decent housing choices for different income categories

Economic Development: Retain and expand a diversity of jobs and businesses to improve and sustain economic prosperity and community resiliency

Location and Connectivity: Seek to address barriers and promote housing and communities with access and connectivity to decent infrastructure, natural infrastructure, mobility choices, education, jobs, open space and other community needs in a manner that seeks to preserve environmental resources and avoid or ably adapt to climate change

Resilience in Existing and New Communities: Improve housing conditions, choices, and community development deficiencies that especially impact disadvantaged and special needs populations while mitigating displacement and creating opportunity to minimize or avoid the impacts of climate change

Innovation: Collaborate on innovative models that will help California’s communities and environment be sustainable, equitable and adaptable under changing climatic conditions.

Community-Led Capacity: Provide resources and assistance to catalyze communities to improve their capacity and be resilient to the impacts of

³⁶1978 Environmental Goals and Policy Report, page 8



climate change, especially in disproportionately affected areas such as disadvantaged communities or vulnerable and special needs populations

Awareness and Responsiveness: Increase awareness of climate risks through improved social cohesion and communication tools

Collaboration: Promote regional collaboration between local, state, and federal government, NGOs, local action collaborative, environmental

groups and academics for climate adaptation options and implementation.

Improved Data: Support the integration of climate science, sector-based state activity, and meaningful adaptation activities in California communities.

The above principles help lay the foundation for what the State is striving to implement, allowing for open evaluation of current actions and the steps that need to be taken next.

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Current Actions

While setting policy goals and statewide planning objectives related to land use and community development is important, where the State’s greatest impact may be felt is in the development of funding programs, coordinated planning and requirements and targeted technical assistance to local and regional partners. Each of these three areas helps build local and grassroots capacity for adaptation.

Analyzing how ongoing policies and programs address the effects of climate change, while still providing locals with needed resources, is an increasing area of focus. Communities often lack the resources they need to implement comprehensive policies that promote resilience against climate impacts; in this section, the highlights of State efforts to facilitate and enable local climate adaptation illustrate an ongoing effort to change that fact. For a more complete list of State actions, see Appendix A.

COORDINATE PLANNING, POLICY, REQUIREMENTS AND REGULATIONS

The state carries out a variety of planning, policies and requirements related to land use and community development. Major functions related

to planning include the Environmental Goals and Policy Report, General Plan Guidelines, State Housing Plan, California Transportation Plan and California Water Plan. Other important functions related to land use and community development include review of housing elements of the general plan and state housing law. The following plans and processes show the concerted effort to articulate the State’s holistic and coordinated vision for resilient and sustainable communities.

Environmental Goals and Policy Report (EGPR): Enacted along with various other environmental statutes in the early 1970s, the EGPR examines a 20-30 year statewide future and consists of goals and policy statements to achieve those goals. Recently, the EGPR was amended with



the State Planning Priorities (Government Code Section 65041.1). OPR prepares the report, and is currently revising a draft update that will look at how California can achieve its climate and environmental goals in a coordinated and holistic way.

General Plan Guidelines: Local general plans are the fundamental document guiding the physical development of communities and consist of seven mandated elements (e.g., land use, circulation, housing, conservation). Local land use decisions must be consistent with the general plan. OPR prepares and is currently updating the general plan guidelines which will include resources, data, tools and model policies. Local governments' general plans must also address adaptation in several ways. For example, among other things, a general plan must include:

- A “safety element for the protection of the community from any unreasonable risks associated with ... flooding; and wild land and urban fires.” (Gov. Code, § 65302(g)(1).)
- A land use element that addresses flood hazards, and that is reviewed annually with respect to flood-prone areas. (Id. at subd. (a).)
- A conservation element that addresses water supply and may cover “[p]revention, control and correction of the erosion of soils, beaches and shores”. (Id. at subd. (d).)
- An open space element that provides for “long-range preservation and conservation of” open

space lands “for public health and safety, including, but not limited to, areas which require special management or regulation because of hazardous or special conditions such as ... unstable soil areas, flood plains, watersheds, areas presenting high fire risks, areas required for the protection of water quality and water reservoirs and areas required for the protection and enhancement of air quality.” (Id. at §§ 65560(b)(4); 65563.)

Using these elements as a starting point, the general plan guidelines update will include a specific set of recommendations for incorporating climate change discussions into a community’s general plan. This guidance is crucial for providing specific guidance to local governments on how they can plan in ways that will create a more resilient region.

Housing Element Reviews: The housing element State law requires each city and county to adopt a general plan containing at least seven mandatory elements including housing. Unlike the other general plan elements, the housing element is required to be updated every four, five or eight years, when it is subject to detailed statutory requirements and mandatory review by HCD. A housing element update may trigger a revision to other parts of the general plan to

The Governor’s Office of Planning and Research is currently updating the general plan guidelines which will include resources, data, tools and model policies.



ensure consistency between the elements. Such revisions are a good opportunity to incorporate consideration of climate impacts in affected parts of the general plan. Housing elements have been mandatory portions of local general plans since 1969. This reflects the statutory recognition that housing is a matter of statewide importance and cooperation between government and the private sector is critical to attainment of the State’s housing goals. Work is ongoing to ensure that climate considerations are incorporated more holistically in housing elements.

IMPROVE ALIGNMENT OF EXISTING PROGRAMS AND INVESTMENTS

The state administers a variety of funding programs related to land use and community development. Many of these programs have eligible activities related to climate adaptation or have evaluation criteria providing incentive for actions, activities and outcomes related to climate change and sustainability. For example, many programs promote infill development or development targeting greenhouse gas reduction. State and federal funding sources are absolutely critical levers for developing bold solutions to threats posed by climate change in California’s communities; the following programs are a few programs that help highlight the opportunity to align investments with climate adaptation goals.

Affordable Housing and Sustainable Communities Program (AHSC): SGC develops and oversees the implementation of this innovative program that funds housing, transportation,

infrastructure, and land conservation projects. These investments are a key player in shifting the dynamics around land use and community development, as they show the transformational success that holistic projects can have on regions. HCD implements the interagency effort to fund projects that reduce greenhouse gas emissions through transit-oriented housing and infrastructure, while the Department of Conservation implements the Sustainable Agricultural Lands Conservation Program to preserve prime working lands and promote compact development. AHSC incorporates climate resiliency as a threshold item that all applicants must prove in order to be considered for funding, but many of the projects address deep vulnerabilities to climate impacts; for example, they incorporate green infrastructure to cool urban heat islands, efficiently use water and energy, and provide resilient housing for vulnerable populations.

Community Development Block Grant Program (CDBG): The State and some smaller, non-entitlement jurisdictions administer federal funds through CDBG for a variety of housing and community development activities, including housing rehabilitation, public infrastructure, public facilities and economic development.

State and federal funding sources are absolutely critical levers for developing bold solutions to threats posed by climate change in California’s communities.



Existing grants were reprogrammed to address urgent drought needs, and \$5 million was made available for temporary subsistence payments to prevent or mitigate homelessness due to the drought. This funding is one example of utilizing flexible funding sources to address urgent climate impacts, but efforts are ongoing to make CDBG more effective in realizing a long-term vision for resilience in communities across California.

Multifamily Housing Program: The Multifamily Housing Program and other state housing programs assist the new construction, rehabilitation and preservation of housing for lower income households. Program criteria typically include points for adaptive reuse, infill, proximity to amenities and sustainable building methods. These grants—typically administered cyclically—build resiliency by providing vulnerable populations with resilient housing. HCD is working to align these investments with adaptation principles more explicitly.

National Disaster Resiliency Competition (NDRC): California received \$70.3 million through the NDRC, an innovative new competitive grant program administered by the US Department of Housing and Urban Development. The NDRC was designed to provide grants to communities to rebuild in a more resilient way following major disaster.

California’s NDRC application was undertaken through an incredibly broad collaborative effort led by Tuolumne County, OPR, the U.S. Forest Service, the California Environmental Protection

Agency, the Governor’s Office of Emergency Services, CalFire, HCD and the Sierra Institute, but involving many other federal, state, regional, and local entities. It seeks to address the devastation left by the Rim Fire, the third largest wildfire in California’s history by recovering resiliently according to a novel definition of resilience. The NDRC application proposed that “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 resilience is being implemented through a broad range of initiatives that can serve as a model for sustainable natural resource management and economic development by linking forest ecosystems and rural communities more tightly.



The National Disaster Resiliency Competition is a **\$1 BILLION** program designed to provide grants to communities to rebuild in a more resilient way following major disasters.



ENHANCE OUTREACH, CAPACITY, IMPLEMENTATION AND OUTCOMES

Local capacity to implement planning and administer funding programs is essential to state planning, regulatory and funding functions. Without local capacity, planning is not successfully carried out and program goals are not achieved or maintained. At the same time, many local governments may have dwindling to no resources to handle the increasingly complex nature of state planning, regulatory and funding functions. To address this need, the state and other are building planning and implementation capacity for local governments and others through more readily usable tools such as utilizing existing human resources and robust training to complement local governments efforts and strengthening regional coordination and collaboration. The following efforts represent a sampling of outreach efforts undertaken by the State, though these only presage more robust and engaging initiatives.

Regional Action: Local, regional, state government and many other organizations are mobilizing to create collaborative partnerships that address climate adaptation at a local scale. The Alliance of Regional Collaboratives for Climate Adaptation (ARRCA) (see www.arccacalifornia.org) was developed in 2012 to help prepare the many unique regions around California for the potential extreme events such as flooding, heat waves, and fires. Groups like ARCCA support the development of policies and programs at the State level and help create a more collaborative relationship between local governments and the State.

Adaptation Planning Guide (APG): While the APG was released in 2012, it continues to be an instrumental resource in supporting local government planning. It has helped dozens of jurisdictions go through the planning process and better understand potential policies and programs available to address climate change impacts and the vulnerability of their communities. Together with the Cal-Adapt (www.cal-adapt.org) visualization tool, the APG is a decision support tool that can be used to create vulnerability assessments, outreach plans, adaptation plans, climate change policy and metrics for monitoring success. Efforts to update the APG and ensure its continued use, especially in local hazard mitigation planning, are underway.

CivicSpark: CivicSpark is Governor Brown’s AmeriCorps program dedicated to building capacity for local governments to address climate change. Each year, in 9 regions throughout California, 48 CivicSpark members work closely with local governments to implement climate, energy, and sustainability projects, supporting over 90 cities, schools, and other public agencies. In its first year, CivicSpark assisted over 86 local government agencies, completing mitigation and adaptation projects on topics including sustainable transportation, energy efficiency, solar procurement, urban forestry, sea level rise, climate action plan implementation, and GHG inventories.

Many local governments may have dwindling to no resources to handle the increasingly complex nature of state planning, regulatory and funding functions.



Next Steps

To better address climate adaptation objectives, the state must continue to evaluate the progress and effectiveness of action to revise steps forward appropriately. The Land Use and Community Development sector necessitates a broad approach across planning and regulation as well alignment of state resources and expanding state, regional and local capacity to carry out planning, regulation and funding resources. This plan lays out key suggestions and commitments for State action. The comprehensive list of next steps for the State can be found in Appendix B; this section highlights a selection—not all—of the determined actions to implement adaptation in the Land Use and Community Development sector.

COORDINATE PLANNING, POLICY, REQUIREMENTS AND REGULATIONS

Current planning and requirements should reflect climate change adaptation in a more coordinated manner. State agencies are working to improve guidance and support for local governments to enhance resilience through land use planning and community development. Below are examples of how the State will build on key elements presented in the preceding “Current Actions” section to guide future work.

General Plan Guidelines Update Coordination with SB 379 Implementation: OPR is currently preparing a comprehensive update to the General Plan Guidelines. The update will include the state’s recommendations on how local governments can plan for climate change. A key effort moving forward will be making sure that the update supports the implementation of Senate Bill 379 (SB 379). Signed by Governor Brown in 2015, SB 379 requires local jurisdictions to address climate adaptation and resiliency strategies in

their local hazard mitigation plans or in the safety element of their general plans by 2022. OPR and the Office for Emergency Services (CalOES) will coordinate with other state agencies to help support local government integration of climate change vulnerability, adaptation, and hazard mitigation discussions. By making sure that CEQA and general plan guidance are compatible and consistent, the State will make sure local decision-makers have resources for the development of comprehensive strategies to address potential climate change impacts.

Other efforts include collaborating with local governments, across state agencies, federal government, and stakeholders to address aspects of the building code that might be changed to make California housing more resilient and evaluate housing element law for additional adaptation benefits.

A key focus in the coordination area will be to build on cross-sector relationships to deal with sea-level rise, wildfires, drought, and flooding. The



lead agencies in the Land Use and Community Development sector are committed to working together with agencies making contributions to the Ocean and Coastal Resources and Ecosystems sector, the Forestry sector, and the Water sector.

IMPROVE ALIGNMENT OF EXISTING PROGRAMS AND INVESTMENTS

Greater alignment will enable state to leverage its experience and statewide perspective gained through delivering local assistance programs, planning and other work. State agencies can evaluate programs, propose changes and share solutions that work to improve adaptation to climate change. Organizations like the Alliance of Regional Collaboratives for Climate Adaptation (ARCCA) and convenings such as the California Adaptation Forum (CAF) support the internal conversation by providing case studies of where certain programs and investments are working well. Currently many departmental programs are designed in response to statute and from public participation processes with various immediate competing needs and issues that lack a comprehensive and coordinated approach. Future steps will focus on an evaluation of existing programs, coordination among state agencies, coordination with select external partner organizations, research and policy development on salient topics and recommendations for alignment to improve efficiency and effectiveness from the perspective of climate adaptation.

HCD is committed to aligning its investments and programs discussed in “Current Actions” with the principles discussed in this plan. Appendix B

details the processes that HCD will undertake to promote resilience in its ongoing work.

ENHANCE OUTREACH, CAPACITY, IMPLEMENTATION AND OUTCOMES

The state cannot achieve its long term climate change adaptation and safeguarding priorities without deep involvement by local and

regional interests throughout the state. Local planning, policy and implementation efforts aligned with State goals will be crucial for California to achieve its desired policy goals.

Associated funding can also increase the potential for success in aligning local and

State policy goals. The State can expand its support of local efforts by providing technical assistance, funding and capacity building resources. Appendix B details the many next steps that the State will take; the following items represent highlights from that table:

Support Capacity Building Through Innovative Programs:

CivicSpark has proven to be a major success in providing local governments the ability to address climate change. This year, CivicSpark has innovated this year by placing fellows at the Air Resources Board and the High Speed Rail Authority to improve communication and collaboration with local governments. New practices to enhance outreach will be identified and expanded upon. Exploring expansions of

Local planning, policy and implementation efforts aligned with State goals will be crucial for California to achieve its desired policy goals.



the CivicSpark model, as well as building off the incredible work done by the California Conservation Corps for resilience, can inform future efforts to build local capacity.

Develop Regional Strategies: Regional working groups (state agencies, regional organizations, local jurisdictions, advocates, and other stakeholders) like ARCCA can better identify barriers to the implementation of State planning priorities and climate adaptation, and identify key areas of regional concern. The 2017 update to Safeguarding California offers a great opportunity to mesh State policy with local and regional visions for resilience. Research from California’s Fourth Climate Change Assessment can inform and strengthen these efforts.

Enhance the Clearinghouse of Best Practices and Strategies: As part of implementing Senate Bill 246, OPR will establish a clearinghouse for adaptation plans and guides from across the state. The clearinghouse, called the Integrated Climate Adaptation and Resilience Program (ICARP) will also serve as the point of contact for climate change adaptation issues and work with other state agencies, federal partners and local/regional partners to develop, update and maintain the tools necessary to plan for the impacts of climate change across the state. This effort will be informed by the information gathered from annual reports on general plan implementation, the OPR Annual Planning Survey, other State actions, federal partnerships, local assistance, and regional working groups.

Better Coordinate and Implement Sustainable

Communities Strategies: Around the state, Metropolitan Planning Organizations (MPOs) must prepare a “sustainable communities strategy” (SCS) as an integral part of its regional transportation plan (RTP). The SCS contains land use, housing, and transportation strategies that, if implemented, would allow the region to meet its GHG emission reduction targets. Better coordination can occur with the regional councils of governments and state agencies to incorporate climate change vulnerability and adaptation measures and associated implementation of the SCS for each region in the state. For example, monitoring RTP, SCS, Housing Elements, and other land use documents for their progress in implementation would be a key state to assess progress. Also, the state can play a coordination role in expanding vulnerability assessments for incorporation in future growth scenarios. Additionally, a process to establish and maintain key contacts and develop and implement strategies to align state, regional and local policies and resources could be created.

Develop Rural Strategies: Rural communities have housing, transit, and economic development needs that differ from those of cities and other urbanized areas. State agencies will work with rural communities and regions to take these differences into account and address them in a robust, comprehensive manner in state adaptation guidance and policy.



Develop and Pursue Outreach Strategies for Vulnerable Populations: Utilizing partnerships with local and regional organizations, the state can play a role in improving community engagement and education about climate adaptation with vulnerable populations, including disadvantaged communities and special needs populations. Outreach can consider innovative partnerships, equitable access to information and advanced technologies. The state can play a role in developing a demonstration project for outreach and disseminate tools and lessons learned among regional partners.

Better Coordinate and Communicate with Tribal Governments: Tribal governments in California are making important strides in climate change adaptation, as many have successfully undertaken important initiatives with the help of federal funding from the Department of the Interior. OPR and CNRA are committed to establishing more formal and regular processes to communicate, coordinate, and consult with tribal governments to promote resilience. OPR will include tribal representation in an advisory council it forms for adaptation purposes, while CNRA will also establish an advisory body for the update to *Safeguarding California*.

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Monitoring and Evaluation

The Adaptation Planning Guide companion document “Defining Local and Regional Impacts” overviews questions that can help localities evaluate their own adaptive capacity. These questions illustrate how the State can work with local governments to track the local and regional progress of adaptation efforts. Selections from “Defining Local and Regional Impacts” below show a possible approach for this monitoring effort:

- **Collaboration of efforts:** To maximize efficiency and efficacy, have local planning efforts related to addressing climate change impacts been linked with efforts to address public health, economic, and social equity efforts in the community? Is there local involvement with state and federal agencies to promote support?
- **Community-wide involvement:** Has a local network/committee been formed, or an existing committee used, to work on climate change impacts and adaptation efforts? Does this committee include representation from a broad array of agencies, organizations (local and regional, public health, emergency responders, non-profits), community members (residents, employers, and business owners), and members of groups who may be most sensitive to climate change? Are local employers and business associations participating in local efforts to address climate change and health and socioeconomic impacts upon employees?



- **Education:** Are public education and community outreach efforts related to climate change impacts and adaptation underway and are they accessible to diverse groups and through a diversity of agencies and media? Can they be combined with public education and community outreach efforts on other issues? Are special efforts made to address the participation of disadvantaged communities? Are there educational programs available to familiarize these communities with governmental functions and to empower them to participate in their own governance?
- **Use of other agencies' information:** Does the local health department or department responsible for emergency preparedness have community-wide assessments of the location of the most sensitive populations, such as the elderly, persons with disabilities/special needs, immigrants and non-English speaking residents, and others who might lack material resources and or have physical limitations?

In addition, metrics can also be used to indicate the effectiveness of actions at a state synoptic level. While they are not as comprehensive as the approach suggested in the APG document, they provide key starting points for a similar monitoring of adaptation progress. These metrics fall largely into one of two distinct categories:

Sustainable Communities: Strategically addressing the needs of existing populations and accommodating future growth is important

to climate adaptation. State, regional and local policies and programs are increasingly directed toward avoiding hazard areas or encouraging priority areas such as infill, near transit and disadvantaged communities. Evaluating the results and effectiveness of these efforts is essential to increasing awareness and improving future strategies.

Outreach and Capacity Building: Effective implementation maximizes the state's planning, regulations and programs. Actual outcomes of technical assistance and collaboration can be monitored through performance measures such as local adoption of plans, regulations and funding applications.

Metrics in these two categories also provide an opportunity to broadly assess progress in working to implement the proposed principles for land use and community development.

State, regional and local policies and programs are increasingly directed toward avoiding hazard areas or encouraging priority areas such as infill, near transit and disadvantaged communities.



Table: Metrics for Monitoring and Evaluating Adaptation Progress

	Sustainability and Choice	Economic Development	Location and Connectivity	Existing Communities and Resiliency	Innovative	Community Led Capacity	Awareness and Responsiveness	Collaboration	Improved Data
Sustainable Communities									
Units produced and preserved by Type/density, affordability in targeted growth areas (infill, TPA, PDA, etc)	X	X	X						
Units approved by location/hazard area (e.g., SB 1241 subdivision in fire hazard areas, AB 162 Flood)			X	X	X				X
Amount of Converted/preserved agricultural, open space and natural resource land	x	x	x						
Percent of state resources invested in disadvantaged communities	x	x	x	x	x	x			
Percent of state resources invested within a ½ mile of transit	x	x	x	x	X				
Percent of vulnerable populations in hazard areas/change over time	x		x	x					
Outreach and Capacity Building									
# of Jurisdictions that have climate adaptations measures (or elements) in their general plans	X			X	X	X	X	X	X
# of Jurisdictions updating land use, safety and conservation elements to address DAC, Fire and Flood	X		X						X
# of rural jurisdictions applying for climate adaptation related funding	X		x	x	x	x			

Oceans and Coastal Resources and Ecosystems Sector Plan



AGRICULTURAL SECTOR PLAN



BIODIVERSITY AND HABITAT SECTOR PLAN



EMERGENCY MANAGEMENT SECTOR PLAN



ENERGY SECTOR PLAN



FORESTRY SECTOR PLAN



LAND USE AND COMMUNITY DEVELOPMENT SECTOR PLAN



OCEANS AND COASTAL RESOURCES AND ECOSYSTEMS SECTOR PLAN



PUBLIC HEALTH SECTOR PLAN



TRANSPORTATION SECTOR PLAN



WATER SECTOR PLAN

Oceans and Coastal Resources and Ecosystems Sector Plan



Introduction

California's coastal agencies³⁷ have a long history of successfully protecting, maintaining, and enhancing the health of coastal and ocean areas by addressing issues such as pollution, unsustainable resource use, and rapid urban development. This work is crucial considering that California's ocean and coast contribute \$39.1 billion annually to the state's GDP. (National Ocean Economics Program (NOEP) 2014). Climate change stressors, including but not limited to, sea-level rise and changing ocean conditions, are likely to escalate longstanding challenges such as unsustainable resource use, which present new governance and management challenges. The obstacles do not come from a single stressor, but the cumulative impacts. For example, it is not only sea-level rise that causes concern, but it is the long-term sea-level rise coupled with extreme storms, high tides, and seasonal fluctuations (e.g. El Niño Southern Oscillation, Pacific Decadal Oscillation, etc.).

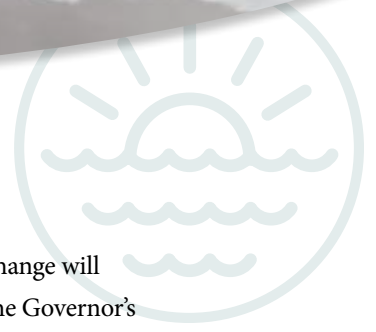
State coastal agencies are striving to meet all of these challenges and prepare for the uncertainties that each obstacle presents both individually and cumulatively. They are applying a climate change adaptation³⁸ lens to their planning and decision-making, testing and implementing actions to reduce the impacts of climate change on coastal ecosystems, communities, economies and infrastructure, and supporting local adaptation efforts.

Through these efforts, state coastal agencies have already taken important steps to implement the coastal and ocean recommendations in *Safeguarding California: Reducing Climate*

Risk [California Natural Resources Agency (CNRA) 2014]. However, in most cases, the implementation of adaptation measures will be a long-term, multi-phase, iterative process, rather than a near-term, discrete one. For instance, initial planning, including Local Coastal Program (LCP) updates, vulnerability assessments, and adaptation plans, rely on up-to-date applied research. These assessments and plans then inform detailed project planning, design, engineering, and permitting, which can take many years to complete before on-the-ground projects can be implemented. Thus, climate change adaptation is ongoing, and state agencies are taking into account the need for continuous adaptive management in the face of a

³⁷ State coastal agencies include: a) the coastal zone management agencies – the California Coastal Commission (regulatory agency), the San Francisco Bay Conservation and Development Commission (regulatory agency), and the State Coastal Conservancy (implements multi-benefit projects to protect and enhance coastal resources), b) agencies that own and/or manage coastal lands – the State Lands Commission and the Department of Parks and Recreation, and c) agencies with direct interests in coastal and ocean resources due to their mandates – the Ocean Protection Council (state adaptation lead for coastal and ocean ecosystems and resources).

³⁸ The National Climate Assessment (2014) defines adaptation as “actions to prepare for and adjust to new conditions, thereby reducing harm or taking advantage of new opportunities.”



changing climate. In some cases, new alternatives to actions recommended in *Safeguarding California* may emerge given continually improved information about climate, the role of humans in influencing it, and the effectiveness of various adaptation measures.

In this Implementation Plan, state coastal agencies have identified ways to reduce coastal and ocean climate change vulnerabilities and impacts using available capacity and resources and leveraging existing programs, projects, and forums. However, making further progress on adaptation requires a commitment to:

- **Allocate adequate funding and capacity** to improve the understanding of climate change vulnerabilities and impacts and to formulate, implement, and monitor adaptation measures that support the overarching goal of coastal and ocean health.
- **Coordinate and align efforts across agencies, levels, and sectors** to achieve a shared vision of coastal and ocean health.
- **Learn continuously** to inform the development and adjustment of flexible adaptation approaches that effectively and efficiently respond to changing conditions.
- **Leverage existing legal, policy, and institutional structures** to govern and manage coastal and ocean areas and resources for short- and long-term health.

While state coastal agencies have demonstrated their commitment to collaborating on climate

change adaptation, transformational change will also require continued support from the Governor's Office and the Legislature, commitments by local and regional entities, and efforts by other state agencies. This is especially true when it comes to fully implementing adaptation policies to address risks from sea-level rise, particularly in relation to infrastructure planning and investment and water quality management.

1.1 STATE COASTAL LEADERSHIP GROUP ON SEA-LEVEL RISE

This Implementation Plan for Ocean and Coastal Ecosystems and Resources was coordinated by the Ocean Protection Council (OPC) on behalf of the member agencies of the State Coastal Leadership Group on Sea-level Rise, with support from the California Ocean Science Trust (OST) and inputs from a broad range of state and non-state entities. The State Coastal Leadership Group, which is convened by the OPC, consists of senior management from the California Coastal Commission (CCC), Department of Parks and Recreation (DPR), OPC, State Coastal Conservancy (SCC), State Lands Commission (SLC), and San Francisco Bay Conservation and Development Commission (BCDC). The group's shared mission is to maintain the natural beauty, accessibility, economic power, ecological richness, and social diversity of the California coast by reducing risks from sea-level rise, storms, erosion, and other coastal climate change-related hazards by:

- Sharing information between member agencies to strengthen competencies, reduce redundancy, and increase synergy;



- Strengthening partnerships among member agencies to enable strategic, coordinated actions and provide leadership on coastal and ocean adaptation;
- Promoting dialogue on priority issues, such as those related to the Public Trust, to ensure that member agencies have a shared understanding that informs their interactions with other agencies, local governments, and tribes;
- Identifying needs and implementing actions to promote adaptation and resilience in coastal areas throughout the state; and
- Gauging collective progress and determining shared agency needs to present to the legislature and other relevant entities to inform policy and funding processes.

Photo by J. Sutton
 Submission to the
 2015 Amateur
 Photography Contest
 sponsored by Thank
 You Ocean and CCC.
 The photographer's
 notes indicate that
 it was taken during
 a king tide on 3-1-
 2014 in Half Moon
 Bay in front of the
 Miramar Restaurant.

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Vulnerability Assessment³⁹: Changing Ocean and Coastal Conditions

California's ocean and coastal areas are currently subject to a range of climate change-related stressors that are expected to worsen over time. These include an increase or increases in ocean temperature, sea-level rise, extreme storm events, changes in storm patterns, and ocean acidification and hypoxia. In most cases, it will be the combined impacts of multiple stressors that will pose the greatest risks to coastal and ocean health. While research funded through California's Climate Change Assessments has improved the state's understanding of the potential impacts of individual climate change stressors, additional research is needed to understand their combined impacts.



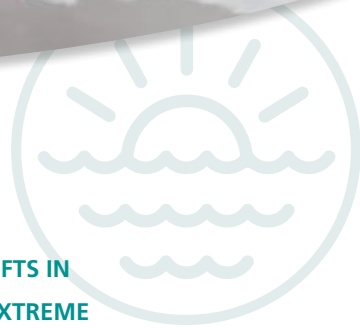
It is important to note that the extent and timing of the climate change-related vulnerabilities of coastal areas and the ocean will be site-specific and shaped by the degree to which assets

(e.g., communities, ecosystems, property, and infrastructure) are subject to stressors such as sea-level rise and storms⁴⁰ (exposure), the internal qualities that make them susceptible to these

³⁹ Unless otherwise noted, the information in this section is based on the coastal and ocean resources and ecosystems section of Safeguarding California.

⁴⁰ In its report, *Sea-level Rise for the Coasts of California, Oregon, and Washington: Past, Present and Future* (2012), the National Research Council notes that sea-level rise will vary regionally. The factors that contribute to these differences include local differences in water density, variations in sea levels due to winds, contributions from land-based ice, and vertical land motions along the coast.

⁴¹ For instance, intertidal habitats in North Central California that have been subject to pollution from agricultural and livestock wastes, wastewater, sewage outfalls, mining, and industrial wastes are likely to have low resilience to climate change (Hutto et al., 2015).



stressors⁴¹ (sensitivity), and the capacity to adjust and respond to these stressors (adaptive capacity). Thus, while Safeguarding California and other summaries of general vulnerabilities and impacts are useful starting points, identifying adaptation measures will require conducting thorough locally or resource specific vulnerability assessments that build upon work-to-date, such as BCDC's Adapting to Rising Tides Program.

A number of coastal jurisdictions have begun to assess climate change vulnerabilities⁴² to understand how valued assets could be affected by sea-level rise. The state has supported these efforts through the State Climate Change Assessments and grant programs, such as the OPC's LCP Sea-Level Rise Grants and Coastal Commission's LCP Local Assistance Grants. There are also several tools for conducting local vulnerability assessments, ranging from from the *California Adaptation Planning Guide* (California Emergency Management Agency and CNRA 2012), which describes a framework for assessing vulnerabilities and planning for adaptation, to data on and maps of sea-level rise vulnerabilities found on *Cal-Adapt* and Climate Central's *Surging Seas* websites.

The remainder of this section summarizes the vulnerabilities and impacts highlighted in *Safeguarding California* (CNRA 2014).

2.1 INCREASED TEMPERATURES, SHIFTS IN PRECIPITATION, AND CHANGES IN EXTREME EVENTS

Each of the past three decades has been warmer globally than during all previous decades on record (Hartmann et al. 2013), and average global temperature is estimated to increase by 0.54-1.26 °C for the period 2016-2035 relative to 1986-2005 (Kirtman et al. 2013). For every 1.8-degree increase in average global temperature, the volume of moisture that the atmosphere can hold increases by 7%. Increased levels of atmospheric moisture will raise levels and intensity of precipitation (Carey 2011). Rainfall patterns are also expected to change and vary regionally, with increased winter and spring rainfall in the northern U.S. and decreased rainfall in the Southwest, including California, particularly in the spring. Even as overall precipitation in the Southwest is projected to decrease, the number of heavy rainfall events is anticipated to increase (Walsh, et al. 2014).

Each of the past three decades has been warmer globally than during all previous decades on record (Hartmann et al. 2013), and average global temperature is estimated to increase by 0.54-1.26 degrees for the period 2016-2035 relative to 1986-2005 (Kirtman et al. 2013).

Climate change is also expected to alter the frequency and severity of extreme events. In California, today's version of a 100-year storm

⁴² Additional information on local vulnerability assessments can be found at <http://www.georgetownclimate.org/adaptation/state-information/overview-of-californias-climate-change-preparations>.



(i.e. a storm that has a 1% chance of occurrence in a given year) could take place annually by the year 2050 (Moser, Ekstrom, and Franco 2012). If the maximum tide levels that were recorded during the major El Niño of 1982-83 were to recur by 2050 during an extreme storm on a 100 to 200-year return period, including ≤ 12 inches of rain plus a week of high creek and river flows, the combination would likely cause \$10.4 billion in damages from structural and material losses, as well as transportation delays and interrupted electricity (Bay Area Council Economic Institute 2015).

2.2 SEA-LEVEL RISE AND STORMS

Another consequence of global warming is sea-level rise. Figure 1 shows sea-level rise projections for the west coast of the U.S. from the National Research Council’s (NRC) 2012 sea-level rise report.

Figure 1. Sea-level rise projections for the West Coast relative the year 2000

TIME PERIOD	NORTH OF CAPE MENDOCINO	SOUTH OF CAPE MENDOCINO
2000-2030	-4 to 23 cm (-0.13 to 0.75 ft)	4 to 30 cm (0.13 to 0.98 ft)
2000-2050	-3 to 48 cm (-0.1 to 1.57 ft)	12 to 61 cm (0.39 to 2.0 ft)
2000-2100	10 to 143 cm (0.3 to 4.69 ft)	42 to 167 cm (1.38 to 5.48 ft)

The differences in sea-level rise projections north and south of Cape Mendocino are due mainly to vertical land movement. North of Cape Mendocino, geologic forces are causing much of the land to uplift, resulting in a lower rise in sea level, relative to the land, than has been observed farther south.

2.2.1 Flooding and inundation of people, buildings, and infrastructure

Sea-level rise can increase flood risks in low-lying coastal areas and areas bordering rivers. A 5 ft increase in water levels due to sea-level rise, storms, and tides is estimated to affect 499,822 people, 644,143 acres, 209,737 homes, and \$105.2 billion of property value in coastal California areas (Climate Central 2014).

An increase of 5 ft in water levels would threaten a wide range of buildings (including 60 fire and emergency medical service stations, 3 hospitals, 57 medical facilities, and 126 schools) and infrastructure (including 2,634 miles of roads, 26 miles of railroads, 32 rail stations, 2 airports, and 17 power plants). Impacts on transportation operations and infrastructure such as sea- and airports, roads, passenger and cargo rail, and bridge supports, would affect critical emergency evacuation routes and impede the movement of economic goods.

The impacts on sea- and airports in particular will have important economic implications. For instance, the San Francisco Airport accounted for \$5.4 billion in business and 33,580 jobs in 2012. Inclusion of off-site activities that rely on air service (e.g. cargo deliveries, customer visits) increase the airport’s economic contribution to \$31.2 billion and 153,000 jobs (Bay Area Council Economic Institute 2015). The San Francisco Airport is already vulnerable to floods; sea-level rise is anticipated to exacerbate future floods, placing the airport at greater risk.



As water levels increase by 5 ft, the number of sites listed by the U.S. Environmental Protection Agency (e.g. Superfund sites, brownfields, and hazardous waste sites) is expected to increase to 1,354 because the flooding or inundation of facilities or land containing hazardous materials can lead to polluted runoff containing fertilizers, sewage, and other toxic materials. These can contaminate drinking water supplies and ocean-based food sources. Many marine species suffer morbidity or mortality when polluted runoff causes algal blooms, because the algae tend to produce toxins and reduce oxygen levels in the water. Swimming in these polluted waters can cause impacts to public health, including earaches, sinus problems, gastrointestinal problems, fever, and rashes.

2.2.2 Flooding and inundation of groundwater resources

The combined impacts of sea-level rise and storms may worsen saltwater intrusion of groundwater caused by over-pumping, which already poses challenges in coastal aquifers in Central and Southern California, including in Pajaro and Salinas Valleys and Los Angeles and Orange Counties. For communities that use groundwater for all or a portion of their water supply, saltwater intrusion from sea-level rise is likely to decrease fresh water availability and force them to consider potentially costly alternatives such as surface water transfers. For farmers who irrigate with groundwater, unless they are able to access alternative sources of water at reasonable prices, they may no longer be able to cultivate their land (Heberger et al. 2009).

2.2.3 Flooding and inundation of wetlands

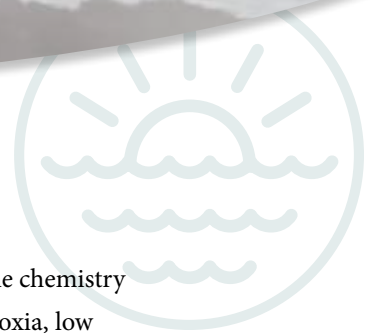
Wetlands, marshes, and other critical habitats will erode and face inundation. It is estimated that wetland habitats will require 150 square miles of open space for inland migration if they are to be maintained as sea levels rise by five feet (Heberger et al. 2009). Sea-level rise is also expected to convert some freshwater wetlands into salty tidal wetlands by altering the elevations of freshwater-saltwater interfaces. Modeling and efforts to monitor changes in marsh and water levels at the Elkhorn Slough National Estuarine Research Reserve indicate that sea-level rise is likely to cause extensive marsh loss. The update to the 1999 Baylands Ecosystem Habitat Goals, released in October 2015, offers new recommendations for promoting healthy baylands in light of climate changes that are projected to occur by 2100.



Wetlands, marshes, and other critical habitats will erode and face inundation. It is estimated that wetland habitats will require 150 square miles of open space for inland migration if they are to be maintained as sea levels rise by five feet (Heberger et al. 2009).

2.2.4 Erosion of sea cliffs, dunes, and beaches

California's beaches and recreational resources provide tremendous benefits to the state, including recreation and tourism revenues, habitat for commercial fish species, enhanced water quality, and increased quality of life. The tourism and recreation of California's ocean and coast has been calculated at roughly \$16.9 billion annually (NOEP 2014). Sea-level rise is expected to



exacerbate the erosion of seacliffs, bluffs, and dunes along the coast and lead to the losses of public beaches and recreational resources. For every foot that sea level rises, 50-100 feet of beach width could be lost. Seawalls and other coastal armoring structures worsen the impacts of sea-level rise by hindering ecosystems' landward migration, which can reduce beach width and result in beach loss. The loss of beach could decrease public access, reduce recreational opportunities and affect local economies by disrupting the tourism and coastal dependent industries.

lowering of the pH and changing of the chemistry due to elevated levels of CO₂, and hypoxia, low dissolved oxygen water, (OAH) are often coupled stressors due to chemical, biological, and oceanographic processes and are unprecedented on the West Coast. (See Figure 3 for an overview of the processes driving these changes.)

Current research on OAH on the West Coast makes it clear that the oceans will change and while the suite of direct and indirect impacts of OAH are uncertain, they are expected to be

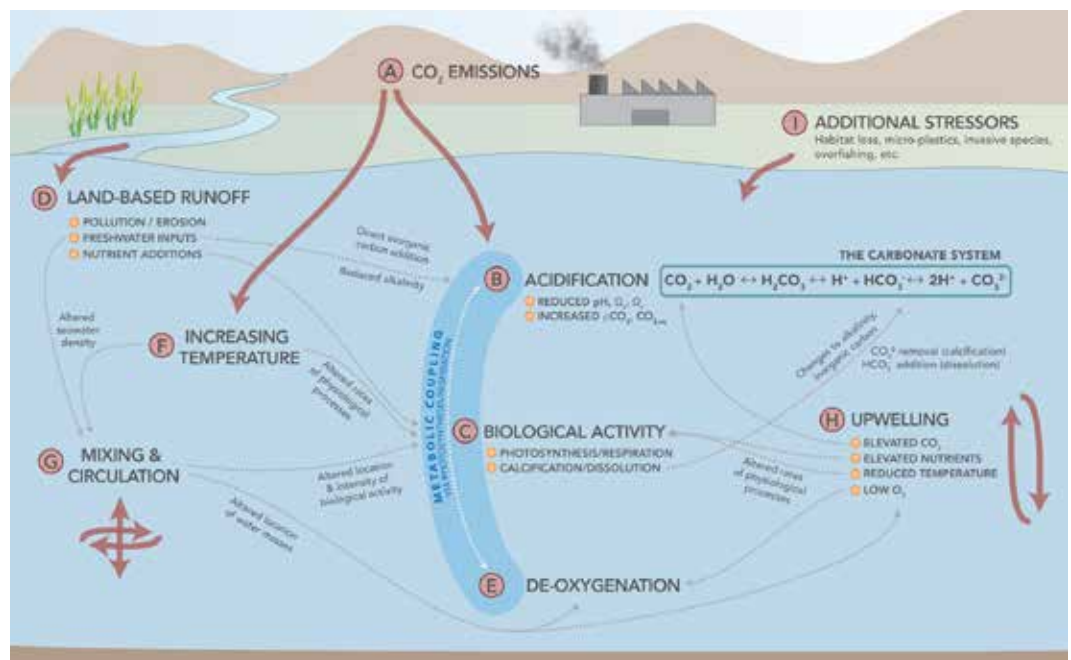
2.3 OCEAN ACIDIFICATION AND HYPOXIA

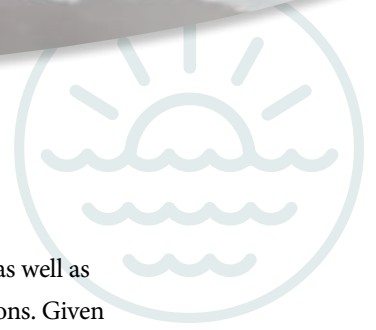
The ocean absorbs about a third of the carbon dioxide that is released into the atmosphere each year from the burning of fossil fuels and other human activities. As the CO₂ levels in the atmosphere increase, so do the levels in the ocean, changing the chemistry of the water and threatening marine ecosystems and coastal communities dependent on the health of the sea. Ocean acidification, this

Figure 3. Overview of the major driving processes (and associated linkages among them) in coastal oceans.

(A) Atmospheric CO₂-driven (B) acidification occurs against a backdrop of additional drivers of change in ocean conditions, including (D) land-based runoff, (E) deoxygenation, (F) warming, (G) mixing and circulation, (H) upwelling, and (I) other additional stressors. Processes can be accentuated in bodies of water with low circulation and mixing, for example tidal flushed bays and estuaries, as well as tidepools. source: West Coast OAH Science Panel product, "Multiple stressor considerations: ocean acidification in a deoxygenating ocean and warming climate"

Note: Location of processes relative to one another does not denote actual location in the water column.





profound. For example, ocean acidification may cause declining harvests and revenues from shellfish and their predators, with negative consequences for coastal communities, including food insecurity, and declining fisheries and aquaculture industries. Hypoxia can have profound effects on marine ecosystems leading to large-scale die-offs, local damage to fisheries, and over the long-term reduced biodiversity. While some areas of hypoxic waters – particularly in the deep ocean – are natural and important parts of marine ecosystems, climate change and other human activity may now expand hypoxic waters into areas closer to the ocean surface.

In addition to the widely-documented impacts of OAH on shell-building, calcifying organisms, changes to ocean chemistry may have consequences for marine organisms' physiology, reproduction, growth, population dynamics, overall ecosystem structure, and biodiversity. When OAH is coupled with other changing ocean conditions, such as temperature, the combination could cause complex and wide-ranging impacts that could exacerbate or mitigate the effects of OAH. Although the scale and magnitude of OAH remains uncertain, laboratory studies, mesocosm studies, and ocean environments with naturally acidified water (such as volcanic carbon dioxide seeps) (Hall-Spencer et al. 2008) can help us begin to plan for and manage for future scenarios and ecosystem impacts. Changing ocean conditions on the West Coast and beyond require a coordinated strategy and investment across boundaries. This includes coordinating monitoring,

data dissemination and interpretation as well as assessing policy and management options. Given the importance of West Coast fisheries, it will be particularly important to understand how changing ocean conditions may affect fishery resources and management strategies in the future. Further vulnerability and risk assessments are needed to understand better the socioeconomic implications of OAH for organisms and ecosystems and the level of risk posed to different communities.⁴³

A driving force in strengthening our collective knowledge of this west coast-wide challenge has been the West Coast Ocean Acidification and Hypoxia Science Panel, a collaboration of 20 scientists from leading institutions across California, Oregon, Washington and British Columbia. Convened by the California Ocean Science Trust in 2013 at the request of the OPC, the Panel is addressing these issues at a coast-wide scale by building a new body of scientific knowledge to inform decision-makers at multiple levels of government. The Panel's products and recommendations for next steps in research and management have and will continue to inform local and regional efforts, and serve as a unifying framework to drive collaboration and policy action. As the Panel concludes its work, and releases its final recommendations in the spring of 2016, the OPC will continue advancing the conversation in multiple decision-making venues based on the salient scientific findings and recommendations of the Panel.

⁴³ Mathis et al. 2015 analyzes the risks posed by ocean acidification to the shellfish, salmon, and other finfish sectors in Alaska and the communities that rely on these sectors for their economic well-being.



Current Actions to Prepare for Climate Change Impacts

State coastal agencies have undertaken important steps to address the vulnerabilities and impacts summarized in the previous section and to implement the four categories of ocean and coastal recommendations identified in *Safeguarding California*:

- Improve management practices for coastal and ocean ecosystems and resources, and increase capacity to withstand and recover from climate impacts;
- Better understand evolving trends that may impact ocean and coastal ecosystems and resources;
- Better understand climate impacts on ocean and coastal ecosystems and resources; and
- Share information and educate.

These categories were identified as priority areas in which action was needed to facilitate progress on adaptation. State coastal agencies' adaptation efforts encompass the full cycle of adaptation planning from assessing vulnerabilities to identifying, evaluating, implementing, and monitoring adaptation measures. These agencies have focused on providing policy leadership on issues such as those related to the Public Trust, developing guidance to assist state agencies and local and regional planners understand and respond to climate change impacts, assessing the vulnerabilities of communities and ecosystems, and implementing adaptation measures. This section presents highlights of the adaptation efforts led by state coastal agencies; additional details can be found in Appendix C.

3.1 IMPROVE MANAGEMENT PRACTICES FOR COASTAL AND OCEAN ECOSYSTEMS AND RESOURCES, AND INCREASE CAPACITY TO WITHSTAND AND RECOVER FROM CLIMATE IMPACTS

Safeguarding California provides several broad recommendations for improving management practices to address the coastal and ocean climate change vulnerabilities and impacts highlighted in the previous section. State coastal agencies have responded with agency-specific initiatives and cross-agency efforts through mechanisms such as the State Coastal Leadership Group on Sea-level Rise and the California Collaborative on Coastal Resilience.

The State Coastal Leadership Group on Sea-level Rise has served as a forum for member agencies to discuss topics of shared relevance pertaining to adapting to sea-level rise, including

The State Coastal Leadership Group on Sea-level Rise has served as a forum for member agencies to discuss topics of shared relevance pertaining to adapting to sea-level rise, take stock of adaptation activities to date, and identify potential cross-agency adaptation priorities.



the review of adaptation activities to date, and identification of potential cross-agency adaptation priorities. For instance, the SLC is leading ongoing discussions about the Public Trust Doctrine and the implications of changing boundaries between public and private lands due to sea-level rise. Also the OPC is leveraging the State Coastal Leadership Group to inventory existing sea-level rise preparedness actions, as per California Assembly Bill (AB) 2516, with the intention of facilitating using lessons learned to inform state and local adaptation efforts. As part of this effort, the OPC is developing online resources, including a database of sea-level rise information and a catalogue of funding opportunities related to sea-level rise and other coastal climate hazards.

Established in 2014, the *California Collaborative on Coastal Resilience* is a multi-agency initiative to provide coastal communities with effective and efficient state support in becoming resilient to sea-level rise. Comprised of the CCC, OPC, SCC, and SLC, the agencies seek to understand resilience planning needs at the regional level and improve collaboration to support local communities. Efforts to date have focused on a pilot study in the low-lying Humboldt Bay region, where sea-level rise poses an imminent threat. As a multi-agency initiative, the Collaborative is gaining insight into the opportunities and mechanisms by which state coastal agencies can cooperate on sea-level rise adaptation activities locally, regionally, and statewide.

As a means to promote *hazard avoidance for new development*, DPR has adopted a coastal erosion



policy to discourage development, including new permanent structures, facilities, and structural protection, in sites subject to wave erosion, seacliff retreat, and other impacts. To *study and support cost-effective green infrastructure to reduce flood risk and stormwater runoff and maximize co-benefits*, the SCC has been implementing the South Bay Salt Pond Restoration Project, a 15,000-acre wetlands restoration project that will build multi-benefit flood protection for Silicon Valley. The California Department of Fish and Wildlife (DFW) is also supporting a number of projects to restore or enhance wetlands and salt marshes through the Wetland Restoration for Greenhouse Gas Reduction Grant program.

In terms of *supporting pilot projects for innovative shoreline management techniques*, the SCC has been working with the City of Ventura to implement one of the first managed retreat projects in California at the popular surfing beach of Surfers Point. The project addresses the severe erosion (up to 60 feet inland in some areas) that

March 2015
California
Collaborative on
Coastal Resilience's
Humboldt Bay Pilot
Workshop



was damaging the beach and dune habitat as well as a bike path and parking lot by removing existing improvements and relocating them inland to allow for retreat and continued public access even with anticipated sea-level rise. The project restored and enhanced the shoreline’s ecological structure and function, including widening the sandy beach, restoring the sand dune habitat, and improving water quality. In addition, BCDC has recommended regional and local adaptation measures to reduce the vulnerabilities of multiple asset categories in the San Francisco Bay Area through its Adapting to Rising Tides Program. The OPC and SCC also anticipate supporting relevant pilot activities with Proposition 1 funds. They have incorporated sea-level rise into their Proposition 1 guidelines and expect to make infrastructure investments with these funds.

Development of the State Sediment Master Plan and sediment management activities continues with key state and federal agencies meeting regularly to discuss upcoming sediment projects and provide support for and technical review of regional sediment management plans. The BCDC is also assessing changing sediment dynamics in the San Francisco Bay and potential management options.

State coastal agencies have also provided guidance and financial resources to assist local governments *address climate impacts*. For example, the CCC developed and adopted the Sea Level Rise Policy Guidance: Interpretive Guidelines for Addressing Sea Level Rise in Local Coastal Programs and Coastal Development Permits

(2015), which presents a framework for local planners and decision-makers to integrate sea-level rise into LCPs and coastal development permits. Furthermore, the CCC and OPC have provided funding for updating LCPs with sea-level rise considerations through the LCP Planning Assistance Grant Program and the LCP Sea-level Rise Grant Program, respectively. The two agencies are coordinating these grant programs on an ongoing basis through an interagency agreement.

In addition, the CCC, through its LCP planning and regulatory program, has facilitated the implementation of numerous sea-level rise adaptation projects that protect coastal resources while increasing the capacity to withstand and recover from sea-level rise impacts. For example, the CCC approved a project to relocate inland three miles of coastal Highway One at Piedras Blancas in San Luis Obispo County; the project is anticipated to protect this portion of Highway One from erosion for 100 years. The realigned highway eliminates the need for damaging shoreline armoring in the future and creates space for DPR to implement

a new section of the California Coastal Trail for the public to enjoy this beautiful part of the California coast. The CCC also recently approved a multi-modal transportation and resource management plan for the 27-mile

The CCC developed and adopted the Sea-level Rise Policy Guidance (2015), which presents a framework for local planners and decision-makers to integrate sea-level rise into LCPs.



North Coast Corridor in San Diego. The project will allow for enhanced transportation and coastal resource protection, and includes planning for pedestrian and bicycle access, as well as wetland restoration at six coastal lagoons and the incorporation of sea-level rise considerations.

3.2 BETTER UNDERSTAND EVOLVING TRENDS THAT MAY IMPACT OCEAN AND COASTAL ECOSYSTEMS AND RESOURCES

Effectively responding to the impacts of climate change in coastal and ocean areas necessitates anticipating emerging issues. *Safeguarding California* draws attention to *improving understanding of the potential impacts and opportunities of offshore renewable energy development and supporting federal flood insurance reform* as two trends that could be important to promoting healthy coastal zones and oceans.

The SLC is conducting forward-thinking research and facilitating the advancement of offshore renewable energy; through its participation in the Marine Renewable Energy Working Group, which is comprised of relevant state agencies. The OPC, CCC, and SCC have been working with the Federal Emergency Management Agency to influence flood hazard mitigation policy and identify priority needs and actions to reduce flood risk in California’s coastal counties. While shifts in national, international, and technological factors can be unpredictable, California’s coastal agencies are actively tracking and responding to evolving trends that may affect their work.

3.3 BETTER UNDERSTAND CLIMATE IMPACTS ON OCEAN AND COASTAL ECOSYSTEMS AND RESOURCES

California has a long history of drawing on the scientific community to inform coastal and ocean policy, planning, and management. The structures that have been put in place, including the State’s Climate Change Assessments, the Climate Action Team (CAT) Research Working Group’s Research Plan, and the West Coast OAH Science Panel, have facilitated an improved understanding of climate change vulnerabilities and impacts as well as possible adaptation measures. However, more work still needs to be done. *Safeguarding California* calls out three priorities to enhance this understanding: *further vulnerability assessments and cost analyses, continued modeling, and continued support and investment in monitoring.*

While shifts in national, international, and technological factors can be unpredictable, California’s coastal agencies are actively tracking and responding to evolving trends that may impact their work.

Effective adaptation requires understanding climate change vulnerabilities and impacts at appropriate scales, and state coastal agencies are implementing a number of programs that provide technical and financial support for regional and local *vulnerability assessments* and cost analyses. For instance, in addition to evaluating the vulnerabilities of different asset



categories under its Adapting to Rising Tides Program, BCDC is examining the social, equity, governance, environmental, and economic risks and ramifications of these vulnerabilities in the San Francisco Bay Area. The CCC is providing technical and financial support for 22 local vulnerability assessments through its LCP Grant and LCP Planning Programs, and is reviewing and compiling vulnerability assessments of urban and rural areas statewide to identify priority areas for adaptation planning. Through its Climate Ready Program, the SCC supports vulnerability assessments in a number of coastal counties and cities including Humboldt Bay, Marin County, San Mateo County, Benicia, Monterey, Santa Barbara, Ventura, Los Angeles, and San Diego. These local and regional vulnerability assessments result from collaborative efforts across sectors and jurisdictions. For instance, in Humboldt Bay, the Adaptation Planning Working Group (a locally organized effort) has brought together state coastal agencies, the DFW, the California Department of Transportation, and a number of local and federal government entities.

To assess the coastal and ocean vulnerabilities resulting from a changing climate, it is necessary to factor in information about future climate conditions at relevant scales, and climate change models provide credible estimates of future conditions. Important state efforts related to *modeling* include the SCC's support for development of the Coastal Storm Modeling System (CoSMoS) for California, which provides meter-scale predictions of storm-related coastal flooding, erosion, and cliff failures to inform

adaptation planning. Other modeling efforts help to explain how different factors contribute to processes that are related to climate change. One example is a joint UCLA/University of Washington/Southern California Coastal Water Research Project (SCCWRP)/National Oceanic and Atmospheric Administration (NOAA) model that was initially funded by the OPC and examines the role of nutrient pollution on ocean acidification and hypoxia in the California Current System (which stretches from British Columbia to Baja California). NOAA recently provided additional funding to support this activity.

Vulnerability assessments and modeling require data and information that enable an understanding of changes over time, and *monitoring* of California's extensive network of marine protected areas presents a unique opportunity to track how climate change is affecting ocean resources and how these resources respond to different adaptation measures. The OPC currently works with a broad range of partners to support monitoring of the state's marine protected areas. It is collaborating with the DFW, Fish and Game Commission, and OST to create a comprehensive long-term monitoring strategy to aid in better managing the protected areas for climate resilience. Other monitoring activities undertaken by the State in coastal and ocean areas include long-term data gathering, monitoring, and modeling by the DPR's Division of Boating and Waterways.

California is also providing leadership on monitoring in a wider context through the West Coast OAH Science Panel and the Pacific Coast



Collaborative (PCC) in coordination with the federal Interagency Working Group on Ocean Acidification (IWG-OA). The PCC, which also involves policy leadership in Washington, Oregon, and British Columbia, will implement a coast-wide and integrated monitoring program that links biological and chemical data collection based on the recommendations of the West Coast OAH Panel. This effort leverages various state and federal efforts to understand the magnitude of OAH and, through improved alignment and prioritization, will enhance the impact of the OAH activities funded by different entities. The PCC is working with NOAA, the U.S. Environmental Protection Agency, and the IWG-OA to understand the extent of the resources that state and federal agencies have used to monitor, model, and study OAH along the West Coast. These efforts, which build on the scientific grounding of the Panel and other efforts, ensure that we are exercising comprehensive research and monitoring in order to take appropriate management and regulatory action to combat OAH.

3.4 SHARE INFORMATION AND EDUCATE

Safeguarding California prioritizes outreach to raise awareness and improve understanding of the impacts of climate stressors on valuable coastal and ocean resources. Awareness and capacity building efforts throughout the state are wide-ranging and numerous. Specifically, *Safeguarding California* highlights *investing in risk communication efforts, developing sustainability modeling tools for fishery managers, and improving maps and tools and providing training to incorporate climate science*

into planning, operations, and management for assets at risk from sea-level rise.

To help state agencies *incorporate sea-level rise science into their planning and decision-making*, the OPC, in collaboration with the Coastal and Ocean Resources Working Group for the CAT, developed the *State Sea-level Rise Guidance Document* (2013). State coastal agencies have also developed guidance to inform agency-specific work. For instance, the DPR has developed guidance for assessing new and current projects in consideration of projected sea-level rise; the document also includes descriptions of relevant tools and resources. In relation to its draft *Sea Level Rise Policy Guidance* for LCPs and Coastal Development Permit applicants, the CCC carried out more than 30 outreach meetings and presentations and 6 webinars for local governments and other stakeholders. With its document now adopted, the CCC is continuing to conduct outreach and provide training to staff and local governments, and is planning additional next steps to facilitate sea-level rise planning and adaptation statewide.

State coastal agencies have complementary outreach activities targeting other state agencies and their partners with *risk communication efforts* to raise public awareness of coastal and ocean adaptation issues. For instance, through the California King Tides Initiative several state (SCC, CCC, and OPC) and federal agencies and non-profit organizations, has been using photographs to educate the public about sea-level rise.



In regard to *fisheries management*, the OPC and OST are working with the OPC Science Advisory Team and DFW to produce information that will improve state management of fisheries in the face of climate change.

In partnership with the NOAA Office of National Marine Sanctuaries, OPC coordinates the Thank

You Ocean campaign, which seeks to educate the public about ocean conservation issues and informs on actions to help protect California’s coast and oceans. Through a variety of social media platforms, Thank You Ocean reaches a broad segment of California residents and shares information about climate change and other threats.

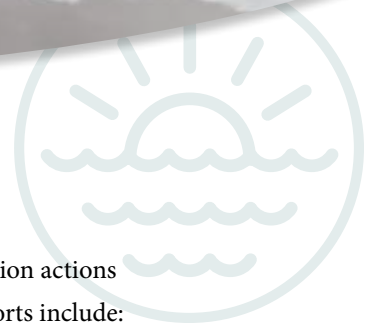
.....
Next Steps

State agencies have demonstrated a commitment to protect, restore, and enhance coastal and ocean ecosystems and resources in the face of a changing climate and have effectively leveraged existing resources to promote coastal and ocean adaptation throughout the state. However, much of this work has been limited by agency resource constraints. To make significant progress on implementing climate change adaptation measures, additional funding and staff resources are needed to allow these agencies to broaden their capacities to support adaptation in a strategic, coordinated manner. Providing staff devoted to climate change work will allow for specialized and rapidly-emerging knowledge to be effectively incorporated into adaptation planning and implementation.

Successful adaptation will also require deepening current efforts to coordinate and collaborate across agencies, sectors, and levels of government , as well as continued engagement with disadvantaged communities that lack adequate resources to prepare for, respond to, and recover from climate change impacts. State coastal agencies will continue to leverage mechanisms such as the State Coastal Leadership Group on Sea-Level Rise, the Coastal and Ocean Working Group of the Climate Action Team, the West Coast OAH Panel, the California Collaborative on Coastal Resilience, and the California Coastal Sediment Management Workgroup to further adaptation

in ways that promote a shared vision of coastal and ocean health in the near- and long-term, in specific locales and broader geographies. State coastal agencies will also continue to seek out adaptive, flexible responses to climate change that are informed by sound science, and refine these approaches based on collective learning.

State coastal agencies have already begun to respond to the recommendations provided in *Safeguarding California*. Nonetheless, efforts are still nascent for: understanding the impacts and opportunities presented by offshore renewable energy development, supporting reform of the



Federal Flood Insurance Program, developing sustainability modeling tools for fishery managers, and communicating public health risks.

Appendix D lists the activities state coastal agencies have identified to further progress on implementing the recommendations in *Safeguarding California*. Their planned adaptation efforts include:

- Taking on climate change adaptation by updating policies, regulations, and guidance, to reflect new information as needed; promoting broad coastal and ocean health priorities by factoring in all climate change considerations (including sea-level rise, ocean acidification, and hypoxia) into regulatory and land use decision-making, planning, and investments, including those related to infrastructure; and reviewing the most recent science; specifically on sea-level rise to inform updates of the State Sea-level Rise Guidance Document (2013);
- Expanding support for regional and local sea-level rise adaptation, including vulnerability assessments, selection and implementation of adaptation measures, and monitoring;
- Testing innovative shoreline management techniques, cost-effective green infrastructure options, and existing techniques such as setbacks and transfers-of-development-rights; and
- Developing research and monitoring tools to improve resilience of ecosystems and coastal communities.

State coastal agencies' priority adaptation actions to support the planned adaptation efforts include:

- Supporting full implementation of state adaptation policies, such as Governor's Executive Order B-30-15, through agency-specific and cross-agency actions.
- Implementing AB2516 via surveys by OPC twice a year until January 1, 2018 to assess sea-level rise planning progress throughout the state. As part of this process, the OPC will provide an online database of sea-level rise planning information from state agencies, ports, airports and utilities, as per AB 2516.
- Improving state coastal agency websites to provide information on coastal and ocean climate change impacts and adaptation resources
- Conducting crucial research through the Fourth Climate Change Assessment to improve modeling, vulnerability assessments, and natural infrastructure adaptation measures for responding to sea-level rise and OAH by 2017.
- Increasing public awareness and community engagement in preparing for climate risks by conducting training and outreach on use of the CCC's Sea Level Rise Policy Guidance by December 2016, and on an ongoing basis.
- Developing an approach for integrating scientific advances into state sea-level rise guidance by December 2016.
- Updating the Southern California Wetlands Recovery Project Regional Strategy to consider climate change by autumn 2017.



- Releasing a vulnerability assessment for Contra Costa County under the Adapting to Rising Tides program by June 30, 2017, as part of BCDC’s and SCC’s work supporting county-level adaptation efforts.

agencies will build on their adaptation efforts to date to continue to address the coastal and ocean impacts of sea-level rise, storms, OAH, and other climate change stressors, and to support progress from vulnerability assessments and adaptation planning to implementation throughout the state.

Through these planned activities, state coastal

Monitoring and Evaluation

Effective monitoring and evaluation can help state coastal agencies understand the impacts of their adaptation investments and refine their strategies to promote ocean and coastal health. The climate change indicators compiled by the Office of Environmental Health Hazard Assessment (OEHHA) (2013) serve as a useful foundation for assessing climate changes in coastal and ocean contexts and their effects on physical and biological systems. Figure 4 summarizes those OEHHA indicators.

Figure 4. OEHHA indicators relevant to coastal and ocean areas

CLIMATE CHANGE DRIVERS	CHANGES IN CLIMATE	IMPACTS ON PHYSICAL SYSTEMS	IMPACTS ON BIOLOGICAL SYSTEMS
<ul style="list-style-type: none"> • Greenhouse gas emissions • Atmospheric greenhouse gas concentrations 	<ul style="list-style-type: none"> • Annual air temperature • Extreme heat events • Precipitation 	<ul style="list-style-type: none"> • Sea-level rise • Coastal ocean temperature • Chemical composition (including ocean acidification) • Changes in storm systems 	<ul style="list-style-type: none"> • Human heat-related mortality and morbidity • Sacramento fall run Chinook salmon abundance • Cassin’s auklet populations • Shearwater and auklet populations off Southern California • Sea lion pup mortality and coastal strandings • Ocean acidification: <ul style="list-style-type: none"> • Decreased calcification of shelled organisms • Reduced sensory function in fish • Increased photosynthetic rates in carbon-fixing organisms



The OEHHA indicators complement those used by state coastal agencies to evaluate their activities. For instance, the SCC has developed a set of draft indicators to gauge the impacts of the local vulnerability assessment and adaptation planning efforts supported by their Climate Ready Program Grants. Although the SCC metrics are largely focused on process, they also include outcome indicators, such as the degree of economic risk reduction achieved by adaptation (see Appendix E).

While OEHHA indicators, such as the effects of ocean acidification on marine organisms, are helpful for gauging broad impacts, there is a need to develop focused metrics (e.g., the impacts of ocean acidification on oysters), including those that capture the socio-economic implications of climate change (e.g., the impacts of ocean acidification on oyster industry revenues), to inform coastal and ocean management and decision-making. Additionally, given the numerous demands on coastal agencies' resources, it will be necessary to identify metrics that target priority coastal and ocean management issues and to formulate monitoring and evaluation frameworks that can be implemented easily.

With additional funding and position support, state coastal agencies would be able to:

- Identify key questions and issues, including agencies' overlapping concerns;
- Review existing indicators in the ecological, human health, economic, social, infrastructural, and disaster risk-reduction literature to identify and compile indicators to measure successful adaptation and resilience;
- Agree upon cross-agency indicators to understand baseline vulnerabilities and resilience, evaluate state planning initiatives, such as LCPs and general plans, and gauge and demonstrate the progress of state-supported projects; and
- Improve linkages between ecosystem protection and community resilience.

Public Health Sector Plan



AGRICULTURAL SECTOR PLAN



BIODIVERSITY AND HABITAT SECTOR PLAN



EMERGENCY MANAGEMENT SECTOR PLAN



ENERGY SECTOR PLAN



FORESTRY SECTOR PLAN



LAND USE AND COMMUNITY DEVELOPMENT SECTOR PLAN



OCEANS AND COASTAL RESOURCES AND ECOSYSTEMS SECTOR PLAN



PUBLIC HEALTH SECTOR PLAN



TRANSPORTATION SECTOR PLAN



WATER SECTOR PLAN



Public Health Sector Plan

Introduction

The task of public health is to promote and protect the health of people and the communities where they live, learn, work and play. While a doctor focuses primarily on treating individuals who are sick, the public health profession 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 about health 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 is one of the most significant threats to public health of the twenty-first Century. (2) Climate change impacts health through a variety of environmental changes including warming, more extreme heat and other severe weather events, frequent wildfires, and droughts, a decline in air quality, and increases in allergens, and communicable and other diseases. Climate change also threatens the basic life support systems on which humans depend – our water, 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) These challenges disproportionately impact the state’s most vulnerable populations and require local, state, and national strategies that reduce the risk of climate change to the health of Californians, and increase their resilience over the long-term.

In response to Governor Brown’s Executive Order B-30-15, which specifically addresses the need

for climate adaptation and “actions [that] should protect the state’s most vulnerable populations,” the California Department of Public Health presents this plan to implement the recommendations of California’s adaptation strategy document, *Safeguarding California: Reducing Climate Risk*. This is a living document that will be updated in view of forthcoming events and actions. This implementation plan articulates how the State of California can integrate climate adaptation into its public health planning and work, as well as how the work of other state non-health agencies and departments can improve public health.

The Governor’s Executive Order and leadership on climate change adaptation recognize that climate change does not affect all people equally, and that resources must be focused on supporting the resilience of the people most vulnerable to the effects of climate change. People experiencing historical and current disadvantage due to discrimination based on poverty, race, ethnicity,



gender, sexual orientation, disability, geography, immigration status, and age tend to experience worse health outcomes on average. When these worse health outcomes develop through systemic, preventable and unfair distribution of power and economic resources, they are called health inequities.(5)

People experiencing health inequities are also likely to have fewer resources to prepare for, adapt to and recover from the health effects of climate change, be they sudden storms or fires, or slower-moving effects such as changes to crop viability resulting in job loss or food insecurity.(6)

The capacity for resilience in the face of climate change is significantly driven by living conditions and the forces that shape them (e.g., wealth, education, housing, transportation, environmental quality) and access to resources and services (e.g., 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.

Communities on the front lines of the climate change crisis caution that the goal of climate adaptation should not be to simply help people “bounce back” after disasters and other climate effects, because the underlying conditions of inequitable political power, participation in decision-making, and access to opportunities and resources will need to be changed in order to improve democracy, health, and sustainability.

Instead, frontline communities seek to “bounce forward”, to a renewable, sustainable economy marked by inclusive democratic participation in the policy decisions that affect daily life.(7)

Responding to climate change provides opportunities to improve human health and well-being across many

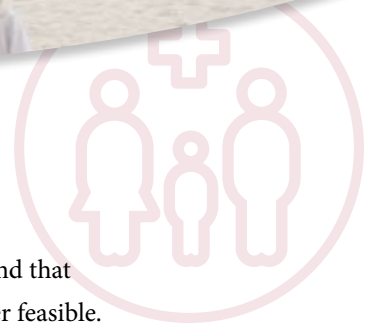
sectors, including energy, agriculture, housing, land use, and transportation. At the state and local agency level, public health agencies are investigating and addressing near-term health impacts, while

also pursuing long-term preventive strategies.

Many of these strategies offer a variety of benefits, often called health co-benefits, protecting people while combating climate change and providing other societal benefits.(9) These include promoting mitigation and adaptation policies and planning that provide health co-benefits and adaptive capacity, such as active transportation, urban greening, mixed use zoning, affordable, healthy, and energy-efficient housing, sustainable forestry and consumption of locally-grown produce. This approach includes enhancing local initiatives that are already building resilience to environmental threats to human health, including emergency preparedness and planning efforts.

Safeguarding California: Reducing Climate Risk relies on peer-reviewed scientific information

People experiencing health inequities are also likely to have fewer resources to prepare for, adapt to and recover from the health effects of climate change.



and expert judgment to identify vulnerabilities to climate change. For the Public Health Sector, it presents “actions needed for improved readiness for climate-related public health risks.” The actions are categorized into three priority areas:

- Improving Capacity of Communities to Prepare, Respond, and Recover from Climate-Related Health Risks
- Better Understanding of Climate Impacts on Public Health
- Information Sharing and Education

This implementation plan presents updates to the actions recommended in Safeguarding California, along with current and proposed high priority initiatives, and more developed emphasis on improving human resilience to climate effects by reducing underlying vulnerability. It introduces new priorities that will be addressed in the 2017 update of Safeguarding California. The recommended initiatives are intended to continue building and strengthening partnerships and capacity in the state, tribes, counties and local communities. They are informed by the mandate in Executive Order B-30-15 for state agencies to prioritize actions that simultaneously build climate preparedness and reduce greenhouse gas (GHG) emissions; are flexible and adaptive;

that protect vulnerable populations; and that utilize natural infrastructure¹ wherever feasible.

Recommendations and framing in the “Current Actions” and “Next Steps” sections were also informed by the following: state and external stakeholder feedback from 46 people working on public health and climate change; comments at six public workshops; and the documents *Preparing California for Extreme Heat* (20) and *Climate Change, Health, and Equity: Opportunities for Action*.(57).

This implementation plan prioritizes strengthening partnerships and ensuring the efficacy of public health vulnerability assessments, planning and implementation efforts. The local public health agencies, Disaster Health Care Volunteers (known nationally as Civilian Volunteer Medical Reserve Corps), the Alliance of Regional Collaboratives for Climate Adaptation, Building Healthy Communities Initiative sites, medical provider labor forces, nonprofits, tribes, and local communities are developing this emerging field of evidence-based practice in public health at the state, regional and local levels. Integrating local knowledge with scientific rigor will inform climate adaptation solutions that are effective for promoting health and equity in local communities and regions.

¹ Natural infrastructure is the concept of having healthy functioning ecosystems that provide important services to human populations. Examples of natural infrastructure include forested watersheds that naturally treat and filter water, or wetlands and floodplains that regulate water flow and control flooding. For more information, see the World Resources Institute’s publication, *Natural Infrastructure: Investing in Forested Landscapes for Source Water Protection in the United States*: http://www.wri.org/sites/default/files/wri13_report_4c_naturalinfrastructure_v2.pdf.



Vulnerability Assessment

Safeguarding California prioritizes identifying and addressing vulnerabilities to climate change. The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as “the degree to which a [person or community] is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of...[exposure], sensitivity and adaptive capacity”.(8) Climate change poses immense challenges for achieving health equity because, while all Californians are impacted by climate change, populations that are socially and economically vulnerable bear a disproportionate burden. People with low-incomes, some communities of color, those with existing health conditions such as chronic diseases and mental health conditions, young children and the elderly, people experiencing homelessness, outdoor workers and farmers, immigrants, some tribal nations, and socially or linguistically isolated people are most vulnerable to the impacts of climate change.(4) These are often the same communities where residents are less likely to have air conditioning, less likely to have trees in their neighborhoods, more likely to have one or more chronic medical conditions, and less likely to own cars to escape from natural disasters and extreme heat.(9)

Vulnerability to climate change is influenced by a complex interplay of a rapidly changing environment, drought, wildfire, extreme heat, sea level rise, air and water quality, the built environment (e.g., housing quality, affordability and availability; land use; transportation access and availability; neighborhood and workplace safety; etc.), and a host of socioeconomic factors.

These socioeconomic factors include the experience of racism and other forms of discrimination, employment, income, early childhood development and education, access to healthy foods, health insurance coverage and access to health care services, safety from crime and violence, culturally and linguistically

appropriate services, and institutional policies such as banking, insurance, and social services.(5)

California counties have varying and unique indicators of risk. The urban areas of California, such as Los Angeles, San Diego, and the San Francisco Bay Area have the largest absolute numbers of people vulnerable to heat such as children and the elderly. Yet, rural areas, especially counties with low socioeconomic status, have high proportions of socially isolated elderly and elderly living in nursing homes.(10) Rural communities have fewer resources to plan for and respond to health impacts of climate change, are suffering more severe effects of drought, wildfire, agricultural and food security impacts, and yet are



the primary source of the clean air (due to forests), drinking water and food on which all Californians depend.(11)

The most pronounced health challenges, including the social inequalities that elevate human vulnerability to climate change are complex, interrelated, and preventable. Many policies and programs that impact health are not under the authority of the public health sector. Because of this, solving the urgent problems intensifying human vulnerability to climate change necessitates State sectors working collaboratively to address the factors that impact health and vulnerability (e.g., income, education, transportation, housing, etc.). The Health in All Policies approach formalizes the systematic incorporation of a health, equity, and sustainability lens throughout government through cross-sector collaboration.

The most immediate and concerning impacts for vulnerable populations continue to be extreme heat and air quality (i.e. wildfire smoke, ozone, particulate matter, criteria air pollutants, and allergens), as well as intermittent years of extreme precipitation such as El Niño years that can cause coastal and riverine flooding, and extreme prolonged drought. Combinations of climate hazards can occur simultaneously, synergistically, cumulatively, or in sequence, such as landscapes denuded by wildfire later having landslides in wet seasons.

Increased incidence of heat events results in increased heat illness and death as well as exacerbation of chronic disease conditions. The increased frequency of wildfires is also occurring in California due to precipitation changes and rising temperatures, aided by development in the wildland-urban interface and high fuel-loads that accumulate over decades owing to fire suppression. Changes in temperature also affect air quality by promoting the formation of ground-level pollutants, such as ozone.(12) This increase could offset much of the potential air quality improvements achieved through air pollution control measures, a phenomenon referred to as the “climate penalty.”

Scientific evidence demonstrates that the climate is changing at an increasingly rapid rate, and that this change is outside the range to which society has adapted in the past.(13) Cal-Adapt² projects that urban and rural population centers throughout California will experience an average of 40 to 53 extreme heat days by 2050 and an average of 40 to 99 days by 2099. This compares to a historical average of four per year. Cal-Adapt defines extreme heat days as above the 98th percentile of the computed maximum temperature for locations

The most pronounced health challenges, including the social inequalities that elevate human vulnerability to climate change are complex, interrelated, and preventable.

² Cal-Adapt is a web portal developed in response to a key recommendation of the 2009 California Climate Adaptation Strategy. Cal-Adapt provides access to climate change data and scenarios, climate impact research, and visualization tools that can be useful for local decision-makers. For more information on Cal-Adapt, see: <http://cal-adapt.org>.



using 1961-1990 data for the May to October warm season.(14)

Human vulnerability to future heat events in the developed world, including California, is projected to include a future population that is collectively much more heat vulnerable than at present.(15) This is due to non-climatic factors such as an increasingly aging population and an increase in the prevalence of chronic disease, particularly among communities facing historic and current economic and social inequities. Californians age 65 and older are expected to more than double from 4.3 million in 2010 to 11.2 million in 2050, and those over 85 are expected to more than triple from 610,000 to 2.3 million.(16) Demographic changes account for the largest relative increases in heat-related mortality in the most vulnerable age groups.(17)

Cross-sector initiatives are underway to identify and respond to human health vulnerabilities attributable to climate-related exposures and socio-economic conditions, as well as strengthening adaptive capacity. Many local and regional initiatives and sectors have developed assessments that include indicators useful in determining vulnerabilities that impact human health. (See Appendix A for resources for California health vulnerability indicators, maps and information). Efforts to integrate public health considerations into climate adaptation planning across the State’s sectors are and must continue to prioritize the people and places that are most vulnerable to climate impacts. Equally important, those most vulnerable must have the power and mechanisms to lead planning and implementation of the strategies that will shape their lives.

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Current Actions

This section details the priority actions that are currently underway in California. They are organized under the sector-specific recommendations summarized in the *High-level vulnerability assessment and recommendations* section of *Safeguarding California*. To best illustrate the action being taken to protect Californians from climate impacts, the following initiatives were selected according to the following criteria:

- Did the initiative improve population health?
- Did the initiative create change in local living conditions?
- Were existing resources utilized to fill gaps?
- Was the initiative scalable and viable at the state-level and/or across sectors?
- Was the initiative viable and implementable across the public health sector?
- Did the initiative entail collaboration between different partners?

The following narrative is not exhaustive, but represents the broad efforts underway in California



to protect the health of its residents, organized by the recommended action they best fulfill from *Safeguarding California*. To get a fuller picture of California state government efforts that impact health, please see Appendix B.

1. IMPROVE CAPACITY OF COMMUNITIES TO PREPARE, RESPOND, AND RECOVER FROM CLIMATE-RELATED HEALTH RISKS

Communities need to have tools, resources, and information available to address climate challenges. Current actions focus on (a) planning for water-related public health risks and the vulnerability of California’s public water systems, (b) improving health care infrastructure resilience to climate impacts, including the ability to provide care in the case of an extreme event, (c) supporting implementation of recommendations in the State’s 2013 Extreme Heat Guidance Document, and (d) developing public health planning tools for local communities such as warning systems and surveillance of health conditions. These actions are further defined in *Safeguarding California* Public Health chapter.

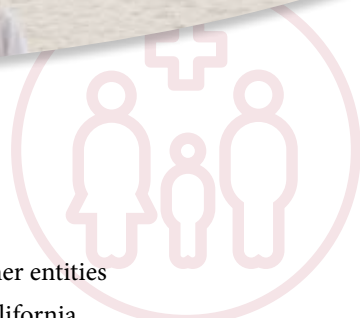
State and local public health agencies can assist planners and emergency responders with resources (such as data and assessments of climate-vulnerable populations), guidance (such as health-related policies and adaptation interventions for climate action plans and general plans), and literature on the co-benefits of climate action on public health and health-related policies.(18)

Key initiatives include actions to improve models, projections, and available tools for adaptation

options and decision-making; addressing legal, regulatory, and institutional barriers to prepare for and respond to climate risks; improving our understanding of California’s vulnerabilities and strengths in adapting to and responding to climate impacts; and implementing recommendations from previous adaptation plans and guidance documents (see Appendix B for details). A few highlights of these key initiatives include:

California Building Resilience Against Climate Effects (CalBRACE)

The federal Centers for Disease Control and Prevention’s (CDC) framework, Building Resilience Against Climate Effects (BRACE), is an evidence-based public health practice to integrate adaptation planning into existing public health and medical provider planning efforts. The CDC funded the California BRACE (CalBRACE) Local Health Department Partnership initiative in the Office of Health Equity of CDPH. The partnership is piloting climate adaptation planning in the public health sector at the local and regional levels using the BRACE Framework. This initiative is currently working with 10 local health departments, and with further funding, could include more counties in the future. CDPH developed county-level climate and health profile reports and vulnerability assessments, and provides technical assistance and small contracts to local jurisdictions to build capacity for adaptation. The reports can help local, regional, and state jurisdictions identify the locations and populations that most need resources to prepare for the health impacts of climate change (reports



available at <http://www.cdph.ca.gov/programs/Pages/CalBRACE.aspx>)

Climate Resilience Planning Among California Native American Tribes

Many California Tribes and indigenous communities are putting resources towards planning for resilience in the face of increasing climate impacts. As one example, the Blue Lake Rancheria Tribe of California is a federally recognized California Indian tribal government and community located in Humboldt County. Blue Lake Rancheria's government, elected leaders, and staff have made significant progress implementing GHG reduction measures while improving community resiliency. The Tribe has implemented a wide range of projects that work in concert to reduce GHGs and improve community security, including actions to ensure operations for critical infrastructure and resource security during emergency situations. A few of the Tribe's milestones include developing several emergency preparedness plans addressing adaptation, conducting training of staff and community, completing more than 15 energy efficiency programs, installing solar arrays for low-income residents on the Rancheria, and signing an agreement with the American Red Cross to act as a shelter-in-place.(19)

Local Sea Level Rise Planning

The Ocean Protection Council, California Coastal Commission and State Coastal Conservancy administer a Local Coastal Sea Level Rise Adaptation Grant Program. This program

encourages local governments and other entities responsible for planning under the California Coastal Act to adopt plans that conserve and protect coastal resources from future impacts from sea-level rise and related climate change impacts such as extreme weather events. This is an opportunity for local public health departments to get involved in planning for the health impacts of sea level rise.

Transportation and Health Impacts

The Integrated Transport and Health Impacts Model (ITHIM) is a tool to estimate the health co-benefits and potential harms from active transportation (walking and bicycling) and low-carbon driving scenarios in urban populations. It showed that increasing median daily walking and bicycling from 4 to 22 minutes in the San Francisco Bay Area reduced the burden

of cardiovascular disease and diabetes by 14%, increased the traffic injury burden by 39%, and decreased GHG emissions by 14%. Low-carbon driving reduced GHG emissions by 33.5% and cardiorespiratory disease burden by less than 1%. The health benefits of active transportation far outweighed the morbidity and mortality from increased pedestrian and bicyclist injuries, but measures are needed to minimize pedestrian and bicyclist injuries when active transportation is

Many California Tribes and indigenous communities are putting resources towards planning for resilience in the face of increasing climate impacts.



implemented. Virtually all (99%) of the health benefits were a result of increasing physical activity rather than from reductions in air pollution (shifting to low-carbon driving). Together, active transport and low-carbon driving could achieve emissions reductions sufficient for California to meet legislative mandates. Some Metropolitan Planning Organizations (MPOs) around the state are utilizing the ITHIM tool to guide transportation and land use planning decisions that reduce emissions while improving population health.

In addition to climate change mitigation, this strategy achieves adaptation goals through its reduction in chronic illnesses, which increase vulnerability to climate change effects.⁽²⁰⁾ Many state agencies are engaged in transportation and land use planning that fosters walking and biking. Among them are the State Transportation Agency, the Air Resources Board of CalEPA, the Strategic Growth Council, and the Office of Planning and Research. The Transportation section of this document also describes progress on smart growth, advanced clean car standards, low-carbon fuels, and high speed rail that will help lower emissions from transportation and provide related health benefits that will be important in the face of climate risks such as more extreme heat events and worsening air quality.

Urban Heat Island

On average urban temperatures are 1.8—5.4°F hotter during the day and as high as 22°F hotter at night than rural areas.

Urban Heat Island Index

Supporting implementation of recommendations in the 2013 Extreme Heat Guidance, the CalEPA released the Urban Heat Island (UHI) Index in September 2015. A

part of this work was to provide an UHI effect index for California that would allow cities to set quantifiable goals for heat reduction, including means to measure heat and GHG reduction benefits of

various cool or sustainable materials strategies. The study “Creating and Mapping an Urban Heat Island Index for California”, maps, and a fact sheet, available on the Urban Heat Island Index webpage (<http://www.calepa.ca.gov/UrbanHeat/>), were developed consistent with the Legislative intent in Assembly Bill 296 (Skinner, Chapter 667, Statutes of 2012).

Cool Pavements

The California Energy Commission (CEC) is conducting research on life cycle assessment and co-benefits of cool pavements, and with Lawrence Berkeley National Laboratory is substantiating models of the UHI effect to evaluate the efficacy of strategies to moderate the UHI effect

Healthy Soils

The Healthy Soils Initiative led by the California Department of Food and Agriculture offers promise in both reducing GHGs and promoting resiliency by storing water in soils, reducing

Together, active transport and low-carbon driving could achieve emissions reductions sufficient for California to meet legislative mandates.



agricultural water needs, improving nutritional value of crops, and reducing the need for chemical inputs such as fertilizers, thus lessening the risk of exposure among farmworkers. (See Agriculture chapter for more information).

Green and Energy Efficient Buildings

Green Building Research

The California Air Resources Board (ARB) conducts green building research focused on reducing GHG emissions while also addressing any increases to other criteria air pollutants that can impact public health. Recently completed research projects include quantifying the GHG co-benefits of green buildings, as well as studying residential energy use and GHG emissions benefits from compact land use types. ARB contracted with Lawrence Berkeley National Laboratory to quantify the potential benefits of widespread deployment of cool roofs (light-colored roofs that reflect heat rather than absorbing it) in cities, which can help with reducing the urban heat island effect as well as counteract increases in urban temperatures associated with climate change. The ARB report, *“Using remote sensing to quantify albedo of roofs in seven California cities”*, was published in March 2014.(21)

California Green Building Standards Code (CALGreen)

California’s Green Building Standards Code (Part 11 of Title 24, California Code of Regulations), also known as CALGreen, is overseen by the California Building Standards Commission (CBSC) and applies to new residential and commercial buildings throughout California. The

aim of CALGreen is to increase energy efficiency, and improve public health, safety, and welfare through the use of sustainable practices in the design and construction of buildings. CALGreen consists of mandatory and voluntary measures that fall within five categories related to sustainable construction: (a) planning and design, (b) energy efficiency, (c) water efficiency and conservation, (d) material conservation and resource efficiency, and (e) environmental quality. The construction measures included in CALGreen address indoor air quality (i.e. assuring indoor air quality through addressing chemical emissions from composite wood products, carpets, resilient flooring materials, paints, insulation, and other materials). Requirements for cool roofs are also included in CALGreen to reduce the urban heat island effect, increase building energy efficiency, reduce energy costs, and improve the comfort of building occupants through lowering roof temperatures and the amount of heat that is transferred into buildings. Vegetated/green roofs and roof areas covered by solar photovoltaic panels are exempted from the requirements.

Through the Governor’s Executive Order B-18-12, State agencies are directed to implement feasible voluntary measures from CALGreen to reduce energy use as well as ensure healthy indoor

The aim of CALGreen is to increase energy efficiency, and improve public health, safety, and welfare through the use of sustainable practices in the design and construction of buildings.



environments for building occupants.

California Building Energy Efficiency Standards

The California Energy Commission's (CEC) Building Energy Efficiency Standards apply to new homes and commercial buildings, and offer builders better insulation, lighting, ventilation systems, and windows that will help to reduce energy use in homes and businesses. The measures in the Energy Efficiency Standards aim to reduce energy costs on consumer utility bills, maintain comfort in homes and businesses, and reduce GHG emissions. Measures in the Standards include solar-ready roofs that allow homeowners and businesses to add solar photovoltaic panels at a future date, more efficient/high performance windows, and cool roof technologies. For a more detailed discussion of the State's efforts to develop and implement a climate-resilient energy system, please see the Energy Sector Chapter.

Residential Energy Efficiency and Energy Assistance

The California Department of Community Services and Development (CSD) offers California residents assistance in making homes more energy efficient as well as in helping to pay for home energy costs. The CSD's federal Weatherization Assistance Program (WAP) is designed to help low-income individuals and families increase the energy efficiency of their homes for rental or owned properties. WAP also provides assistance in reducing the total cost of heating and cooling bills and helps to improve the health and safety of families (i.e., through sealing cracks and holes around windows, doors, and pipes; fixing or

replacing windows; and ensuring proper insulation levels). To date, around 60,000 low-income homes have been made more energy efficient through WAP. The Low-Income Home Energy Assistance Program (LiHEAP) is another federal program administered by CSD that provides assistance to eligible low-income households to meet immediate residential heating and/or cooling needs. Through CSD's Solar for All California pilot program, more than 1,000 income qualified families throughout California were able to install photovoltaic solar systems on their homes at no cost.

The California Public Utilities Commission (CPUC) 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 2015 *draft 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 multi-family rental units. These are the families that most suffer from substandard housing and who most need energy efficiency upgrades to benefit from energy savings and reduce health risks such as poor indoor air quality, lead paint, mold, dust, cockroach allergens, extreme heat, and unsafe heating methods that increase risks of carbon monoxide poisoning and fire.

CDPH's Division of Environmental and Occupational Disease Control (DEODC) includes the California Breathing Asthma Program,



Childhood Lead Poisoning Prevention Program, Healthy Homes Program and Environmental Health Laboratories. The Environmental Health Laboratory Branch has an Indoor Air Section that provides technical assistance and information on Heating, Ventilation, and Air Conditioning systems, combustion safety, mold, and energy efficiency.

Urban Forestry

California Department of Forestry and Fire Protection (CAL FIRE) (through its Green Innovations, Green Trees for the Golden State, Urban Forestry Management, Urban Wood and Biomass, and Forest Legacy Programs) funded 17 applicants in 2014-15. This initiative addresses recommendations in the *2013 Extreme Heat Guidance* to promote and expand urban greening and the use of green infrastructure³ cooling strategies in public and private spaces. While funded through legislation to reduce GHG, the Urban Forestry Forest Legacy Greenhouse Gas Reduction Fund also provides adaptive co-benefits for human health by cooling urban heat islands in cities. Trees also reduce air pollution, calm traffic, reduce neighborhood violence, and reduce storm water runoff, decreasing flood risk and soil and hill erosion while improving water quality.(22, 23)

Healthy Watersheds through Multi-Jurisdictional Stewardship and Collaboration

The Feather River Stewardship Coalition is a diverse community of willing stakeholders working to improve the ecosystem health of private and

public lands within the Feather River Watershed, the headwaters of the state water project. In the Coalition, several agencies act together to mitigate wildfire, restore hydrological systems, as well as promote recreation and wildlife in the Feather River Watershed. The Coalition works to identify solutions that facilitate balance among community, economy, and environment. It integrates restoration of landscape-level ecological processes across jurisdictional boundaries while encouraging stewardship practices and socioeconomic development within the Feather River Watershed.

2. BETTER UNDERSTANDING OF CLIMATE IMPACTS ON PUBLIC HEALTH

Key initiatives include development of climate indicators to better monitor and prepare for climate change impacts; conducting assessments and mapping of communities most vulnerable to climate impacts; researching, monitoring, and tracking public health threats including wildfires and vector-borne diseases. A few highlights include:

Trees reduce air pollution, calm traffic, reduce neighborhood violence, and reduce storm water runoff, decreasing flood risk and soil and hill erosion while improving water quality.

Health Impacts of Wildfire Smoke Exposure Research

The CDPH Environmental Health Investigations Branch is researching the public health impacts of

³ 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: <http://www.epa.gov/green-infrastructure/what-green-infrastructure>.



wildfires, studying one or more large-scale wildfire events and existing datasets of medical events integrated with high-resolution modeled exposure data for particulate matter.

Bi-National Memorandum of Understanding to Enhance Cooperation on Climate Change

This 2014 memorandum between the State of California and the Ministry of Environment and Natural Resources and the National Forestry Commission of the United Mexican States aims to enhance cooperation on climate change and the environment. The purpose of this four-year agreement implemented by CalEPA is to carry out cooperative activities on climate change, human and environmental health, air quality, wildfires, heat, clean energy, and transportation based on principles of equality, reciprocity, information exchange, and mutual benefit.

Climate Change and Food-Borne Illness Outbreaks

According to the Division of Food, Drug, and Radiation Safety at CDPH, there are still no direct links from climate change to food-borne illness outbreaks. However, anecdotal evidence continues to indicate that this will be a much larger issue in the future as temperatures continue to rise. In 2015 there was an unprecedented algal bloom of *Pseudo-nitzschia*, which is a phytoplankton responsible for producing toxic domoic acid. Human consumption of bi-valve shellfish, anchovies, crabs, and other creatures that feed on the phytoplankton and concentrate the domoic acid in their digestive systems can lead to substantial injury and death.

The Environmental Management Branch and the Food and Drug Branch of CDPH worked collaboratively to scale up pre-harvest monitoring of harmful algal blooms (HABs) in the ocean and post-harvest seafood surveillance of potentially-impacted seafood products. CDPH worked closely with the Department of Fish and Wildlife to plan, map data, and discuss the most effective strategies for sampling, public risk communication, and regulatory actions needed based on results. Crab fishing in a significant portion of the state had to be closed in 2015-16 due to the risks. The unprecedented algal bloom was likely associated with the El Niño event, which some climate scientists believe will be an increased future occurrence due to climate change.(24)

3. INFORMATION SHARING AND EDUCATION

This priority area highlights the need to disseminate information at both an institutional and public level. Actions include: (a) capacity building to raise awareness and foster action to address climate risks to public health, and ensure that public health and medical professionals are equipped with appropriate information to share with the public, and (b) public education on how to reduce and prepare for climate health risks. It is essential to develop culturally and linguistically relevant educational materials

It is essential to develop culturally and linguistically relevant educational materials for diverse populations, to be disseminated via communication campaigns.



for diverse populations, to be disseminated via communication campaigns. These actions are more fully defined in *Safeguarding California*, page 213.

Key initiatives include collaboration for public health and climate action planning, including workgroup meetings, trainings, and partnerships with other agencies and local governments; as well as providing resources and educational materials to inform the public regarding the health and equity impacts of climate change.

Highlights in California around information-sharing and education include the following initiatives:

OutsideIn SLO Pilot Climate Change and Health Education Campaign

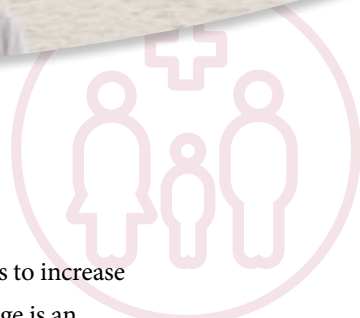
Outside In SLO: We Take Health and Climate Change Personally is a pilot climate change and health communications collaboration between the San Luis Obispo County Public Health Department and CDPH. It uses the framing that people can take action to improve both their own health and the climate by eating locally grown fruits and vegetables, walking, biking, taking transit, and advocating for policies that make it easier to engage in low-carbon lifestyles. Messages were delivered through Women, Infants, and Children Program (WIC) classes, at farmers' markets and other venues, through public service announcements, and written materials.

Climate Action Team Public Health Work Group (PHWG)

The California Climate Action Team (CAT) oversees 11 working groups, including the Public Health Work Group, which is co-chaired by CDPH and the Air Resources Board. The Work Group illuminates health and equity dimensions of activities to reduce greenhouse gas emissions as well as of actions to prepare for and adapt to the health challenges climate change brings. Quarterly public meetings are held in Sacramento and by webcast.

“BRACE-ing Ourselves for Climate Change: Making Every Step Matter”

The CDPH CalBRACE (California Building Resilience Against Climate Effects) program held a two-day workshop attended by 12 county health departments, Alliance of Regional Collaboratives for Climate Adaptation (ARCCA), Local Government Commission (LGC), West Oakland Environmental Indicators Project, Environmental Justice Coalition for Water (EJCW), and Building Healthy Communities representatives Urban Tilt and United Way-Merced. The participants discussed the health threats brought by climate change, and how to ensure meaningful participation and leadership by historically disadvantaged communities in planning to reduce vulnerability, prevent, cope with, and recover from health threats, and increase resilience. The CalBRACE program also initiated a national BRACE Communications Community of Practice online forum in collaboration with the Centers for Disease Control and Prevention and the Oregon, Arizona, and Illinois BRACE projects.



California Medical Association Foundation Climate Change Champions

The California Medical Association Foundation, in collaboration with the Network of Ethnic Physician Organizations, the Public Health Institute and the National Medical Association, is recruiting physicians and other providers to be Climate Change Champions. By mobilizing health provider

champions, this two-year initiative aims to increase public understanding that climate change is an important public health issue and to build public support for climate change solutions. The initiative also intends to increase the relevancy of climate change to the experience of communities of color and expand the diversity of voices speaking about the impacts of climate change on health.

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Next Steps

GAPS IN CURRENT EFFORTS AND RECOMMENDATIONS FOR ACTION

While existing efforts represent a comprehensive effort to protect the public health of the state and implement *Safeguarding California*, there are gaps in the current endeavor. CDPH, as the lead agency for climate change adaptation in the public health sector has identified additional actions where State leadership is needed to fill current gaps in the implementation of California’s adaptation strategy.

Policy, systems and environmental change strategies that generally improve community health and well-being are required to improve the capacity of communities to prepare, respond, and recover from climate-related health risks. Here we include a range of high-level recommendations and best practices for strategies that provide co-benefits for health and climate change. While CDPH is not always the lead agency or department in the following recommendations, CDPH can partner, provide data, technical support, and connections with local health departments to assist the lead agency in considering health outcomes and reducing impacts on sensitive populations. Many of these actions are aspirational, and dependent upon identification of new funding

sources, while some can be accomplished with existing resources.

In addition to the specific data sources suggested below, planners can access several sources of health data provided by CDPH. CDPH’s CalBRACE project developed county-level climate and health profile reports and vulnerability assessments that can help local, regional, and state jurisdictions identify the locations and populations that most need resources to prepare for health impacts of climate change. The CDPH Healthy Communities Data and Indicators Project (HCI) is an indicator list providing evidence for the social, economic, and environmental links to health outcomes, data sources, and provides the ability to create local maps. Health departments also have access to



local data that is occasionally available at a more granular level.

ACTION: TRANSPORTATION

- Implement formal incorporation of health co-benefits and co-harms (e.g. chronic illness, bike injuries) into transportation models used in planning (e.g. ITHIM) in local, regional, and state transportation planning.(20, 57)
- Identify populations with climate vulnerabilities (e.g. highways projected to be inundated in floods) or limited access to transportation (e.g. low level of service, low-income transit dependent, etc.) to assist climate adaptive transportation planning and real-time transportation response in climate-related emergency events.
- Support and promote active transportation through support of increased funding for pedestrian and bicycle infrastructure and non-infrastructure programs and approaches such as Complete Streets, Safe Routes to Schools, Active Transportation Program, and incentives (e.g. tax breaks, transit subsidies).(57) Strengthen language in state and regional transportation and land use grants guidelines to improve public health and community engagement, and direct resources to communities facing transportation-related health inequities, low levels of active transportation, and low levels of transit service.
- Support public transit use, by providing funding for public transit systems and infrastructure, and discount transit fees (e.g. free school bus passes). (57)

ACTION: LAND USE

- Promote integrated local and regional land use, transportation, and housing planning that reduces social, environmental, and economic harms such as sprawl, residential and small business displacement, traffic, noise, air pollution, and loss of agricultural land and natural habitat. (57)
- Support healthy neighborhood design that incorporates mixed-use, mixed-income infill and transit oriented development neighborhoods with access to transit, jobs, affordable housing, and key amenities, and protections against the social, environmental and economic harms previously mentioned.(57)
- Consider requiring climate resilience planning including climate-related health impacts in Housing Elements and updates to Housing Elements.
- Integrate information from CDPH CalBRACE vulnerability assessments in order to identify county-level climate change and health assets and risks that integrated land use and “Sustainable Communities” planning could address.
- Promote consideration of health in planning and infrastructure decisions and processes (e.g. General Plans, Environmental Impact Assessment, Climate Action Planning, zoning). (57) Support prioritization of climate-adaptive infrastructure funding in low-income and vulnerable communities, especially in areas where aging infrastructure is at risk from climate change.(25, 26)



ACTION: COMMUNITY GREENING AND URBAN FORESTRY

- Increase parks, gardens, and shade trees, prioritizing disadvantaged communities and communities with few trees and parks. Use trees to provide shade for parking lots, parks, walking and bike paths, and tracks.(57) Community greening based on information in Urban Heat Island maps from CalEPA and in tree canopy cover and impervious surfaces maps and charts in CDPH CalBRACE vulnerability assessments.
- While promoting infill, create minimum required space for urban parks and community gardens in order to improve opportunities for physical activity, local food systems, and community cohesion.
- Balance the need for drought-tolerant, flowering, and fruiting plants with the need for shade, food, fire resistance, and open space for physical activity, taking into account the prevalence of allergies and asthma.(57)

ACTION: HEALTHY ENERGY EFFICIENT BUILDINGS AND SITING

- Support new and additional research on the health and climate change adaptation and mitigation co-benefits of (a) energy efficiency policies and building standards and (b) “net-zero” energy and energy efficient buildings, looking at new and existing residential and commercial buildings.
- Collaborate with State agencies and departments focused on green buildings and energy-

efficiency to incorporate climate adaptation, health, and equity considerations into State initiatives, planning, and policies, including updates to the California Building Code and California Energy Efficiency Standards.

- Site buildings in locations with existing infrastructure and services to help reduce resource and energy use, while providing active transportation infrastructure and high level of public transit service connecting nearby locations, services, and amenities. (56)
- Facilitate greater collaboration between organizations that design and implement energy efficiency programs and those organizations that implement programs to improve health-related housing quality. Explore partnerships that combine funding for energy efficiency, indoor air improvements, and health improvement.
- Provide mitigation for poor indoor air quality for new and existing buildings sited within 500 feet of a freeway, including energy efficiency measures and high-efficiency particulate air filters and whole house ventilation systems. (27) Target residential energy efficiency funding and programs to populations with relatively higher ambient air pollution and ambient noise to reduce health inequities.(28) See Mitigating Negative Health Consequences of Strategies section below for more details.
- Develop funding or evaluative mechanisms to ensure that energy efficiency upgrades are installed and operate as intended and do not adversely affect building ventilation or other



indoor environmental quality factors and health consequences.

- Support implementation of California Energy Commission’s (CEC) *Existing Buildings Energy Efficiency Action Plan* in transforming California’s existing residential, commercial, and public buildings into ones that are high-performing and energy efficient.
- Increase funding and support for low-income energy efficiency upgrades and/or energy-efficient affordable housing. Make energy efficiency programs available for multi-unit housing through accessible financial mechanisms.
- Utilize green infrastructure, “low impact development”, and low-energy strategies to manage building site stormwater runoff, reduce the urban heat island effect, and cool indoor air. Examples include:
 - o Installing rain gardens, bioswales, and solar-reflective/light-colored permeable pavements.
- Plant trees, vegetation (such as green walls and green roofs), and use building shade to lower indoor temperatures and alleviate the urban heat island effect.(29, 57)
- Secondarily, improve access to and use of air conditioning, with attention to ways to offset the economic impacts on seniors and low-income groups and consideration of the energy use implications.(29)

- Consider the use of alternative green building standards/rating systems, such as the Living Building Challenge (LBC)⁴,(30) in addition to LEED and other systems currently being utilized in State green building policies and requirements.

ACTION: HEALTH CARE SYSTEM CAPACITY

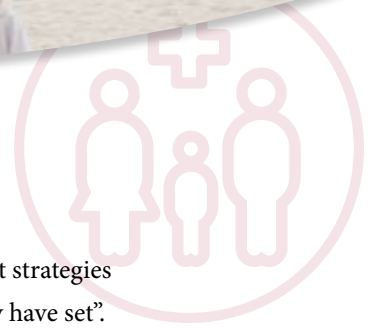
- Strengthen health care systems’ capacities to prepare and respond to climate change events (e.g. power outages and hospitals closures) and provide continuity of medical care following extreme events (e.g. access to medication and medical records).
- Strengthen health care systems’ capacities to respond to climate change health impacts (e.g. outreach to vulnerable populations during heat event or emergency response).

The State Water Resources Control Board and local water districts need resources to develop preventative and adaptation actions to protect drinking water.

ACTION: PLAN FOR SEA LEVEL RISE AND FLOODS

Currently most wastewater treatment systems operate with gravity feed and thus are likely to be impacted by sea level rise if in a coastal area that may experience up to 66 inches of sea level rise by 2100.(31) Inundation could damage pumps and other equipment, and lead to untreated

⁴ Per its website, the Living Building Challenge™ is a building certification program that “defines the most advanced measure of sustainability in the built environment possible today”.



sewage discharges. In addition to the flood risk to plants, higher water levels could interfere with treated wastewater exiting the facility if sited on the coast.(32) The State Water Resources Control Board and local water districts need resources to develop preventative and adaptation actions to protect drinking water. Wastewater treatment facilities could be encouraged to consider climate change impacts in their operations and facility upgrades by conditioning loans and funding on incorporating sea level rise and other climate change projections into plans. See the Water Chapter of this document for more information on this topic.

ACTION: COMMUNITY ENGAGEMENT AND CAPACITY BUILDING

The level of social capital or trust and connectedness in a community affects adaptive capacity.(33) Hurricanes Katrina and Sandy highlighted how important neighbors and local support networks can be in response to climate emergencies and disasters, when many residents were on their own for three days or longer before emergency responders arrived.(34) Community connectedness serves people year round, but particularly during emergencies when it can help people develop plans for mutual aid, or develop a system to check in on single, vulnerable or home-bound residents in the case of floods, storms, loss of electricity, etc. A community organizing model helps to build community capacity and social capital. Community organizing is “the process by which community groups are helped to identify common problems or goals, mobilize

resources, and develop and implement strategies for reaching the goals they collectively have set”. (35) Community organizing also builds the social, political, or economic power of community members to make changes to meet needs and improve health. Health professionals can support community organizers with resources such as funding, data, and technical assistance. There is evidence that civic participation improves health at the individual level, and improves the governmental systems and decision-making processes that impact climate change planning and health over the long-term.

CDPH should seek resources to develop a climate change and health program to work with a diversity of populations on climate change adaptation planning to reduce vulnerabilities and increase resilience. For example, *promotoras* are Latinas who act as culturally sensitive health educators for the Latino community. There are many *promotora* groups across California; support could be provided to develop curricula, train and compensate *promotoras* to carry out community resiliency-building activities.

To engage communities and improve community health, climate change adaptation solutions should:

- Strengthen the skills, knowledge, and abilities of communities to participate in and influence decision-making processes;(57)
- Facilitate learning that increases community members’ understanding of how to analyze and participate in decision-making around climate change, health, and equity, including the ability



to plan, organize, fundraise, and take action within the decision-making context;(57)

- Engage members of communities facing impacts of climate change to define what resources and training they desire, and collaborate with the communities to develop these self-defined community assets;(57)
- Support and strengthen community social networks and other assets to build climate resilience (e.g. partner with schools, faith-based communities, neighborhood-based groups and businesses in climate resilience planning);(57)
- Translate climate science to make it locally relevant and accessible for community members, and highlight health, climate, and equity impacts and opportunities.(57)

ACTION: INCREASED ADMINISTRATIVE AND TECHNICAL CAPACITY TO SUPPORT CROSS-SECTOR AND INTERNAL COORDINATION TO IMPLEMENT SAFEGUARDING CALIFORNIA

Prioritize implementation of adaptation strategies within the public health system, and build institutional capacity and mobilization through dedicated staff and resources within lead California Health and Human Services Agency (HHS) departments. CDPH will continue conversations with CDPH and HHS leadership to identify resources for staff to coordinate adaptation implementation, identify gaps and opportunities to inform strategic planning, and facilitate cross-sector collaboration and learning. A plan should be developed to provide dedicated funding to local health departments to lead community preparation

for the health impacts of climate change.

ACTION: LOW-CARBON OR NET-ZERO EMISSIONS STRATEGIES FOR KEEPING PEOPLE COOL IN EXTREME HEAT EVENTS.

Not having access to air conditioning has been shown to increase risk of illness or death in extreme heat events, which pose a higher risk to the elderly, people with mental illness, chronic conditions, low incomes, homeless, incarcerated, and other social or health-related vulnerabilities. Urban heat islands disproportionately impact low-income communities of color.(36) Thus, it is imperative to plan to keep vulnerable populations cool and safe in heat events. Yet operating air conditioning (AC) increases GHG emissions, increases heat immediately outside buildings running AC, can fail if peak demand causes power outages, and can be too costly for people with limited incomes to run. Thus, research is needed to provide methods of cooling that eliminate the need for increased AC. 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. Care must be taken

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to avoid tree limbs conflicting with photovoltaic arrays when siting trees. Green or living roofs and cool or light-colored roofs also provide cooling of neighborhoods, and significantly lower temperatures. Buildings can be made more resistant to heat waves with weatherization and energy-efficiency upgrades (see urban greening and green, healthy, and energy-efficiency buildings sections above for more detail). These techniques should be adopted into building codes and grant guidelines.

If the above cooling techniques are not sufficiently rapid or effective to protect health of vulnerable populations, personal cooling strategies should be used. 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. This involves ways to cool the hands and head area with little energy. However, these technologies are likely far from mass distribution. There may be a need to develop highly-efficient and inexpensive 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. Emergency responders and local health departments can partner to identify and outreach to vulnerable populations to access cooling centers or personal cooling resources.

ACTION: PREPARE FOR MOLD RESULTING FROM WATER INTRUSION INTO HOMES AND BUILDINGS

The Indoor Air Quality Program at CDPH

could compile existing published literature and best practices into a curriculum to prepare local environmental health departments to help residents prevent water intrusion and mold during and after severe storms and flood events, and to respond to questions and complaints about mold after flood and water intrusion events. The curriculum could include information on code enforcement, best practices, and resources for mold remediation, and be presented to all counties’ environmental health departments and to the building industry.

ACTION: INCREASE RESOURCES FOR SURVEILLANCE OF HEALTH IMPACTS OF CLIMATE CHANGE.

In partnership across state agencies and departments, collect the necessary data to understand the impact of climate-related illnesses and deaths. Conduct routine surveillance of the underlying health, social, and economic factors that affect climate change vulnerability and resilience. For example, during heat events, data collected on health, social, and economic factors, as well as accurate accounting of heat illness and death, can inform public health planning and real-time responses.

- Working with CalEPA’s Office of Environmental Health Hazard Assessment (OEHHA) and the Governor’s Office of Emergency Services (Cal OES), identify resources to implement recommendations of the *Preparing California for Extreme Heat* guidance. Recommendations include convening stakeholders in a work group,



reviewing CDPH’s Electronic Death Registration System to determine how it could be modified to include a heat report supplement during heat waves, considering whether other early detection surveillance programs might be expanded to include heat illness for statewide surveillance (e.g., BioSense), examining developments in the Health Information Exchange that may present opportunities to collect heat illness data from electronic medical records (e.g., use of the early-detection surveillance module), and continuing discussions with the national Council of State and Territorial Epidemiologists regarding making heat death and/or illness a reportable condition.

- The steps above for heat surveillance can be applied to wildfire smoke. Surveillance methods to detect health impacts from heat and wildfire smoke could be disseminated to medical providers with technical support and web-based training.
- In order to avoid human cases of food-borne illness there is a need for increased surveillance sampling of food commodities for pathogens and other toxins.

ACTION: DEVELOP CURRENT DIGITAL MAPS OF LOCATIONS OF COMMUNITY WATER SYSTEMS

There are approximately 8,000 water systems in California, many struggling, and they are not all mapped. Knowing the location of water systems would aid resiliency planning for water security, triaging water needs, and emergency preparedness as the climate changes. The

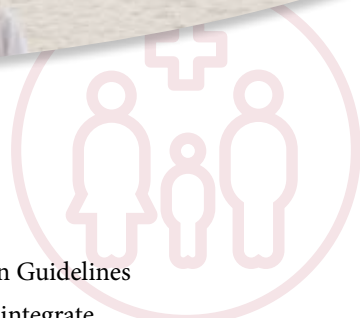
California Environmental Health Tracking Program of CDPH has been digitizing the spatial data on where community water systems exist in California (<http://catalog.data.gov/dataset/california-community-water-systems-inventory-dataset-2010>). However, this work is not complete and requires further funding to complete.

ACTION: PREPARE FOR MENTAL HEALTH IMPACTS OF CLIMATE CHANGE

In reviews of the literature on the relationship between disasters and mental health, post-traumatic stress disorder (PTSD) was most frequently observed and was considered to be “the most debilitating psychological disorder that occurs after traumatic events and disasters.”

Post-traumatic stress disorder (PTSD) was most frequently observed and was considered to be “the most debilitating psychological disorder that occurs after traumatic events and disasters.”

Other mental health outcomes experienced were depression, nonspecific distress, and anxiety.(37, 38) Social capital, also called social cohesion, has been associated with mental health resilience following a disaster. Prolonged drought was associated with increased suicides in Australia, and there is anecdotal evidence that the unprecedented California drought of 2015 was associated with increased suicides in the Central Valley of California as water dried up, and with it the livelihood of farm owners and farmworkers. (39) Recommended actions include providing information and resources to state and local mental health and behavioral health providers to



prepare to support people suffering mental health consequences of the effects of climate change, providing psychological interventions in the wake of acute impacts, reducing the vulnerabilities contributing to their severity, and training to improve mental health providers' competency in addressing climate change-related impacts.(40) Actions that help mitigate and adapt to climate change, such as urban greening and shifting driving to walking and bicycling also demonstrate improvements to mental health.(20, 41)

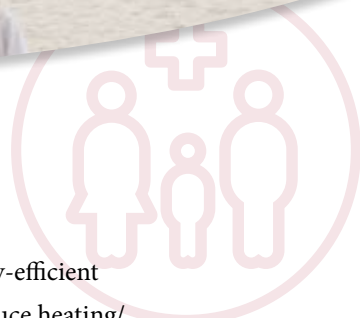
ACTION: COLLABORATE WITH CAL OES AND THE EMERGENCY PREPAREDNESS OFFICE OF CDPH TO SUPPORT CITIES AND COUNTIES TO INCORPORATE CLIMATE, HEALTH, AND EQUITY CONSIDERATIONS IN THEIR UPDATES TO LOCAL HAZARD MITIGATION PLANS AND GENERAL PLAN SAFETY ELEMENTS.

California has been a leader in incorporating climate change considerations into required plans and documents. Senate Bill 379, approved by the Governor in October 2015, requires local jurisdictions to address climate adaptation and resiliency strategies in their next revision of a local hazard mitigation plan (starting in 2017), 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. CDPH and local health jurisdictions can provide data on local health-related climate exposures and vulnerable populations. See Office

of Planning and Research General Plan Guidelines Updates for many examples of how to integrate climate change, health, and equity in general plans.

ACTION: PREPARE FOR CHANGING ENVIRONMENTAL CONDITIONS' IMPACT ON BASIC NEEDS, INCLUDING FOOD, AIR, WATER

- Strengthen local and regional food systems by supporting and creating incentives for establishment of urban and peri-urban agriculture, “farm to fork” programs, farmers’ markets, and school and community gardens, for example through zoning changes.
- Advocate for the preservation of agricultural land and natural habitat.
- Support and promote sustainable agricultural practices such as water conservation, better management of livestock production (e.g. manure ponds), and practices that reduce soil degradation and the use of fossil fuel-based inputs such as pesticides and synthetic fertilizers (e.g. a fee on nitrogen fertilizers).
- Develop and/or utilize modeling and projections that take into account future anticipated climatic conditions for precipitation and water distribution. Base policy decisions on these types of projections versus solely depending on historical data to help prevent and plan for water shortages and plan for flooding and other extreme weather events.
- Support continued research and programs addressing anticipated climatic conditions regarding temperature, air quality, pollutants



formation and dispersal, and other variables (e.g., higher temperatures leading to an increase in the formation of ozone and particulate matter).

ACTION: INCLUDE HEALTH, EQUITY AND RESILIENCE IN STATE FUNDING OPPORTUNITIES

CDPH should work with other state agencies to assure that public health, equity and resiliency are included as components or criteria on state funding opportunities for climate adaptation or mitigation. This has been accomplished for the Active Transportation Program and the Affordable Housing and Sustainable Communities Program.

ACTION: COLLABORATE TO PROMOTE RESILIENCE

CDPH should reach out beyond other state agencies and medical providers to 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.

MITIGATE NEGATIVE HEALTH CONSEQUENCES OF STRATEGIES

Certain climate adaptation strategies may negatively impact public health in unforeseen ways. For example, while buildings can be designed and constructed to be energy efficient, they may use construction materials and finishes that contain and release chemical toxins, which

can then remain trapped inside energy-efficient buildings that are tightly sealed to reduce heating/cooling loss. If proper ventilation is not part of design, indoor air quality may be compromised and changing climate conditions can exacerbate problems such as mold.

California’s Energy Efficiency Standards for New Residential and Nonresidential Buildings includes ventilation requirements that meet or exceed current minimum state and national ventilation requirements. These requirements are consistent with best practices for the design of ventilation systems for newly constructed buildings as well as remodels of existing buildings. (42)

Urban greening with certain species of vegetation can increase pollens and allergen exposure linked to asthma and respiratory diseases. This is a particular risk for vulnerable communities whose respiratory illness may be exacerbated directly by higher temperatures, as well as through heat-related increases in ground level ozone and particulate matter.(43)

Transit oriented development integrates housing, office, retail and other amenities into a walkable neighborhood located within a half-mile of quality public transportation. This can reduce

CDPH should work with other state agencies to assure that public health, equity and resiliency are included as components or criteria on state funding opportunities for climate adaptation or mitigation.



GHG emissions due to reductions in driving, while boosting physical activity, social capital, and overall health. However, care must be taken that housing is not situated right next to rail yards, major roadways or other sources of air pollution and noise without taking measures to protect the health of residents. Such health protective measures include requiring developers to face courtyards away from the roadway or rail line, installing high quality HVAC systems to filter air while maintaining ventilation, noise-proofing buildings, and planting trees and greenery to filter the air and buffer noise.(44) See Office of Planning and Research's General Plan Guidelines (final forthcoming).

Finally, 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. However, transit investments and other amenities may drive up median area income, mortgages, 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 there, and will be forced to move farther away. People with low

incomes and people of color are currently most affected by displacement, and we are seeing a trend in California towards the "suburbanization of poverty" and communities of color. Displaced residents may end up further away from quality employment opportunities, schools and health-promoting resources such as healthy food retail and parks.(45) Furthermore, wealthier people moving into neighborhoods tend to have more cars and drive more. 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. These effects increase GHG emissions and underlying vulnerability to climate effects.

To prevent displacement from climate change adaptation and mitigation investments, it is essential to cultivate resident empowerment, leadership, and decision-making through training programs, guided reviews of plans, neighborhood scans, and mapping activities. Resident-led planning will generate buy-in, political mobilization, and relevant ideas to minimize displacement. Public health departments can assist in these activities. Many community development experts recommend that anti-

Health protective measures include requiring developers to face courtyards away from the roadway or rail line, installing high quality HVAC systems to filter air while maintaining ventilation, noise-proofing buildings, and planting trees and greenery to filter the air and buffer noise.



displacement mechanisms and policies be put into place before development of transit oriented, “sustainable communities”, or smart-growth communities, so that existing residents can benefit from improvements. Some mechanisms that have been successful to ensure current residents are not displaced and can benefit from improvements include ordinances or community benefits agreements that result in affordable housing protection (at a deep level of affordability, for many decades), local hiring, guarantees that current residents get moved first into new housing units, and tax credits to control displacement. To help residents stay in their homes, municipalities can also consider code enforcement policies that assist residents with home improvements, rent controls, preservation of federally subsidized housing programs, and location-efficient mortgages that provide competitive rates and low down payments to those who want to live in “location-efficient communities” that are health-supportive, convenient, and reduce the need to drive.(46, 47)

RESEARCH NEEDS

To facilitate increased understanding of the health and equity impacts of climate change as well as mitigation and resilience measures, the following research topics are proposed:

- Provide data and technical expertise to local health departments and partners and facilitate asset mapping and climate vulnerability assessment.
- Evaluate the effectiveness of early heat warning systems geared toward working populations at high risk.
- Evaluate the extent of indoor heat illness among workers.
- Evaluate the feasibility of developing super-efficient air conditioning units that are inexpensive to operate and do not increase GHGs.
- Evaluate the past, current and likely future impacts of climate change effects on the mental health of Californians.
- Increase research on 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.
- Evaluate the effectiveness of cooling centers to reach the most vulnerable people and prevent heat illness and death.
- Evaluate how climate-induced changes to agriculture in California will impact health of both consumers and of farmworkers.
- Evaluate possible health effects of agroecology, or “carbon farming” through cover cropping, crop rotation, carefully managed grazing, using hedgerows to prevent erosion, minimizing tillage, and applying compost instead of chemical fertilizers.



- Evaluate the impact of climate change on water-borne illnesses such as cholera, cryptosporidiosis, campylobacter, and leptospirosis.
- Evaluate the likelihood and possible health impacts of forced migration and civil conflict due to climatic changes.
- Evaluate to what extent climate change is affecting the range and prevalence of disease-carrying vectors such as the Asian tiger mosquito and other mosquitos.
- Evaluate if there are differences in public health outcomes between prescribed burning days and on days when wildfires are burning.

Monitoring and Evaluation

The Public Health Sector is engaged in multiple cross-sector initiatives and there is currently no centralized process for monitoring and evaluating all projects. Progress and effectiveness of climate adaptation actions can be measured through climate impact and resiliency indicators with both quantitative and qualitative methods (see Appendix C for

a comparative list of selected indicators and screening methods).

As mentioned above, there is an immediate need for surveillance methods to determine the impacts of heat and wildfire smoke on human health in real time during events. Presently there is no unified system for collecting this data statewide. CDPH's Electronic Death Registration System could be modified to accomplish this. Surveillance will allow for a deeper understanding of vulnerabilities to heat and wildfire smoke.

The current OEHHA indicators could be expanded to include indicators for climate adaptive capacity that reduce injury and illness from heat and other climate exposures. This would include indicators that measure elements in the built environment

such as impervious surfaces, tree canopy in urban communities, air conditioning, and others more closely associated with resilience and mediating vulnerabilities.

In measuring progress toward implementing *Safeguarding California* and improving resilience, two categories of indicators need to be measured, on as local a scale as possible:

- Indicators of vulnerability or resilience
- Indicators of actions taken and capacity built

Indicators of vulnerability include many of the metrics listed in Appendix C that are tracked by organizations interested in identifying vulnerability, disadvantage, and exposure to climate-related risks. Relevant vulnerability



and resilience indicators to measure the recommendations in this document include:

- Poverty level
- Population living with mental illness
- Population with multiple chronic conditions
- Asthma diagnoses and emergency room visits
- Heat-related mortality and morbidity
- Wildfire smoke-related mortality and morbidity
- Food insecurity
- Years of potential life lost before age 65

INDICATORS OF ACTIONS TAKEN AND CAPACITY BUILT INCLUDE:

- Number of local jurisdictions with climate action plans, adaptation plans, general plans and hazard mitigation plans that address climate, health and equity
- Number of local ordinances adopted that incorporate climate, health and equity
- Number of low-income and senior housing units receiving weatherization and energy efficiency upgrades
- Number of cool roofs installed
- Number of green roofs installed
- Change in tree canopy coverage
- Change in impervious surface coverage
- Change in dark-colored, heat-absorbing surface coverage (e.g. asphalt)

- Number of local health departments funded to participate in climate resiliency planning
- Number of health care facilities incorporating climate and equity into emergency plans
- Number of community, neighborhood or nonprofit groups provided resources to engage in climate resiliency planning
- Expanded staffing capacity of CDPH to monitor and coordinate health-related adaptation activities at the state level, and provide support to local health departments engaging around climate change and health equity
- Number of forested acres sustainably treated for fire suppression
- Number of communities with evacuation plans

Transportation Sector Plan



AGRICULTURAL SECTOR PLAN



BIODIVERSITY AND HABITAT SECTOR PLAN



EMERGENCY MANAGEMENT SECTOR PLAN



ENERGY SECTOR PLAN



FORESTRY SECTOR PLAN



LAND USE AND COMMUNITY DEVELOPMENT SECTOR PLAN



OCEANS AND COASTAL RESOURCES AND ECOSYSTEMS SECTOR PLAN



PUBLIC HEALTH SECTOR PLAN



TRANSPORTATION SECTOR PLAN



WATER SECTOR PLAN



Transportation Sector Plan

Introduction

California’s residents rely on a robust multi-modal transportation system to gain access to destinations, goods, and services, but the ongoing and inevitable effects of climate change present challenges to managing the productive networks the state depends on.

California state government owns and maintains central components of this complex and crucial system. The State’s Department of Transportation (Caltrans) owns and operates 50,000 miles of roads and three of the busiest intercity rail lines in the country. The High-Speed Rail Authority has started construction on an 800-mile system that will link major metropolitan regions by 2030. The State also provides critical assistance and funding to support the 140,000 miles of roads, 500 transit systems, 245 public-use airports, and 11 major ports owned and maintained by local and regional governments.

California also relies on many airports, seaports, and pipelines owned by the private sector. While much of the transportation sector’s physical infrastructure is publicly-owned, vehicles and the freight they carry rely nearly completely on the private sector. Thus, at each stage of adaptation planning, coordination across modes of travel, as well as between the public and private sector, is imperative.

The state’s climate adaptation strategy, which was updated in July 2014 with the document *Safeguarding California: Reducing Climate Risk (Safeguarding California)*, details several recommended actions to enhance the state’s transportation system’s resiliency to climate impacts and improve its ability to provide access to places, goods, and services. This implementation plan builds on the foundation provided by *Safeguarding California* by describing climate-related vulnerabilities of the transportation sector, outlining current activities, identifying next steps, and proposing monitoring and evaluation metrics.

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Vulnerability Assessment

This overview of the future impacts that face the state’s transportation infrastructure highlights the ways that government agencies are proactively moving to assess the effects of climate change. California’s transportation infrastructure is increasingly vulnerable to climate change impacts such as sea level rise, flooding, erosion, extreme heat, extreme storm events, land subsidence, and energy and fuel disruptions, so careful study is needed to plan and prepare for these impacts, which can be categorized under three broad categories:

INCREASED TEMPERATURES AND EXTREME EVENTS

Rising global temperatures are projected to continue rising throughout the rest of the century even if greenhouse gas emissions are sharply curbed compelling transportation managers to understand the effects of heat on transportation infrastructure. Climate projections for California show that the rise in temperatures will be accompanied by more extreme hot days and prolonged heat waves as well (*Indicators of Climate Change in California*, OEHHA, 2013). In fact, by the end of the century the number of days with temperatures over 95°F will likely double or even triple (Rogers et. al. 2015).

While precise costs related to heat stresses on infrastructure are still unknown, many impacts of climate effects can already be estimated. Extreme heat events cause road surfaces to expand, creating pressure that leads to the pavement buckling. Asphalt pavements under higher temperatures typically age faster and develop ruts from wheel loads, while the expansion joints on bridges and

highways also suffer stress. Railroad tracks are more likely to buckle under higher temperatures as well (Schwarz et. al. 2014).

While current maintenance costs have proven to outstrip current allocated funds, climate change will certainly lead to greater infrastructure repair needs, especially if adaptive measures are not taken.

PRECIPITATION CHANGES AND EXTREME EVENTS

While California currently suffers from a historic drought that scientists have linked to anthropogenic climate change, climate impacts on transportation could also implicate the other side of changing precipitation patterns: heavier rainfall and extreme winter storms (Williams et. al. 2015). Flooding, landslides, and drought-related impacts could all have profound economic and public safety impacts on California’s transportation system.

The primary perils to roads by flooding are landslides and erosion that wash them away as well



as inundation that prohibits passage. A study by the United States Geological Survey found that a single extreme winter storm could cause all traffic to be cut off to Los Angeles from the north and east for 1 to 2 weeks, while Sacramento would be cut off from the north, south, and west for around 1 week. Some parts of the state would have to wait for at least one year for complete recovery (Porter et. al. 2011).

Increased wildfire risk—which is leading to more frequent, more intense, and larger wildfires—is related to rising temperatures and changing precipitation events. Heavy rainfall following the effects of drought and wildfire can lead to increased erosion and landslides, leading to extremely costly destruction to transportation infrastructure and the people who use it.

SEA-LEVEL RISE AND EXTREME EVENTS

Sea-level rise (SLR) will result from ongoing climate change even if greenhouse gas emissions are drastically reduced, driven primarily by melting polar land ice and the expansion of the world's oceans as they warm. Rising sea-levels will result in inundation of low-lying areas and their roads, but the complex climate-related interplay of SLR, coastal erosion, and more extreme storm events in coastal areas are likely to cause more sudden and risky impacts. A 100-year coastal storm event combined with the 1.4 meter sea-level rise that could be seen by the end of the century would leave 250 miles of highways, 1,500 miles of roads, and 110 miles of railways vulnerable

to flooding—a drastic increase from current coastal flood-prone infrastructure (Heberger et. al. 2009).

These vulnerabilities are extensive and complex and require coordination and planning. During emergencies, a safe and dependable network of airports, roads, transit, bicycle and pedestrian paths are necessary for evacuations.

A comprehensive vulnerability assessment of California's transportation assets – and how to redesign and prioritize more resilient infrastructure moving forward – is needed to safeguard Californians from natural disasters and other emergencies. Mobility needs of communities with limited transportation options is a measurement of vulnerability to climate change. Populations without cars and without access to reliable public transit are less likely to find safety in the event of a climate disaster; such was the case during Hurricane Katrina and Super Storm Sandy. As California experiences more extreme hot days and prolonged heat waves, those neighborhoods experiencing the heat island effect will be hit first and worst without adequate options for affordable mobility.⁴⁴



The primary perils to roads by flooding are landslides and erosion that wash them away as well as inundation that prohibits passage.

⁴⁴ https://dornsife.usc.edu/assets/sites/242/docs/The_Climate_Gap_Full_Report_FINAL.pdf



The departments in California government responsible for elements of the state's transportation system are on their way to understanding and addressing these crucial issues.

STATE EFFORTS TO ADAPT TO CLIMATE CHANGE

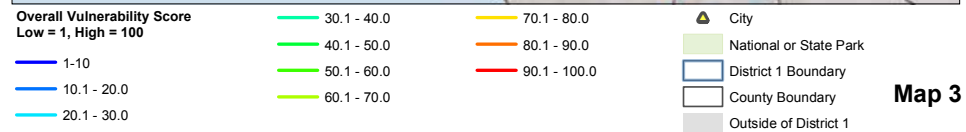
Caltrans

Caltrans is currently conducting a vulnerability assessment of the State Highway System infrastructure to impacts due to climate change and extreme weather events. The assessments will be conducted in each of the 12 Caltrans Districts, and completed by 2017.

District 1 Vulnerability Assessment (the north-west corner of the State) was the first to be completed in 2014. This assessment inventoried and analyzed over 16,000 Caltrans assets against years 2050 and 2100 climate change scenarios. Ninety-three road segments representing almost 980 miles were ranked for vulnerability using weighting and scoring criteria.

Roads were evaluated based on a number of factors, including "criticality" or the relative

importance of a facility considering Criticality Scoring Factors, which include:



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Miles 0 10 20 30 40 50

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Horizontal Datum: North American 1983
Grid: NAD 1983 California Teale Albers

North Arrow

GHD ESA

Caltrans District 1 and HCAOG
District 1 Climate Change Pilot Study

Climate Horizon 2050 A2
Overall Vulnerability Score Per TCR Segment

Job Number 84-11905
Revision A
Date 01 Jul 2014

718 Third Street Eureka CA 95501 USA T 707 443 8326 F 707 444 8330 E eureka@ghd.com W www.ghd.com
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- the degree to which a facility provides socioeconomic functions (e.g. access to major employment centers or business districts)
- use and operational characteristics (e.g. average daily traffic or functional classification)
- health and safety functions (e.g. access to medical facilities or evacuation routes)
- replacement costs (e.g. number of large bridges or length/width of highway segment)
- degree of redundancy (i.e. parallel assets that can provide similar functions)

A vulnerability map was created and each road evaluated. Adaptation strategies explored include “defend,” “accommodate,” “retreat” and policy changes (see Table 1).

Three primary actions identified to build on the results of this District 1 study were: 1) enhanced collaboration with other local and state agencies, 2) updating design and maintenance policies, and 3) more site-specific risk analyses.

Expanding this model to the rest of the state places California on the cutting-edge of assessing transportation infrastructure vulnerabilities. A sub-consultant for the vulnerability assessments is a team of climatologists who are further performing downscaling of Global Climate Models to develop cutting edge climate projections at a regional level. As appropriate, they are utilizing the same data sources as Cal-Adapt.

Table 1: CalTrans Adaptation Option Categories Developed from District 1 Vulnerability Assessment

APPROACH	ADAPTATION OPTION
Defend	Provide major structural protection Provide protection at existing elevations/locations
Accommodate	Elevate the infrastructure above the impact zone Enhance drainage to minimize closure time and/or deterioration levels
Retreat	Abandon infrastructure Relocate infrastructure (horizontally) Temporarily restrict use of infrastructure
Changes in policies or practices	Increase the infrastructure’s maintenance and inspection interval and continue to monitor/evaluate Modify land use and development policies to account for future impacts

High-Speed Rail Authority

The High-Speed Rail Authority (HSRA) has completed an identification of potential climate issues of relevance to the future system infrastructure. During 2015-2016, the HSRA will continue with a more detailed vulnerability assessment and integration of life-cycle cost adaptation measures into design, as well as into operations and maintenance as delivery progresses.

California Highway Patrol

The California Highway Patrol (CHP) participates in two of the Governor’s Office of Emergency Services (CalOES) California Emergency Function meetings monthly: 1) Transportation and 2) Resources. The Transportation Emergency



Function supports the coordination of transportation across various modes, including surface, maritime, railroad, aviation, and pipelines – and is tasked with monitoring and reporting the status of damage to the transportation system during an emergency. The Resources Emergency Function is charged with identifying, acquiring, allocating and tracking state and private sector resources that can be utilized during an emergency.

Regional and Local Transportation Agencies

In addition to state departments, regional transportation agencies have adopted climate action plans or are leading vulnerability assessments, such as the Bay Area’s Adapting to Rising Tides and Climate Change & the Future of Southern California. Regional entities receive federal and state formula funds for the development of their regional transportation plans. Caltrans’ sustainable planning grant program further supports regional and local entities in adaptation planning. HSRA’s station-area grants to jurisdictions along the network also support planning climate resilient communities. Some local governments are also studying adaptation options to address their vulnerabilities. For example, Marin

County has identified their assets vulnerable to sea level rise, and is creating an adaptation plan. The Alliance of Regional Collaboratives for Climate Adaptation (ARCCA) is compiling lists of local and regional adaptation efforts, and has a focus on transportation in 2016.

National and International Collaboration

California further collaborates with US federal government agencies and international entities to gain information, tools, and lessons learned from elsewhere that will provide efficiencies in meeting climate change challenges in California. For example, Gulf Coast conducted studies and utilized tools developed by the FHWA. The Dutch Rijkswaterstaat (Ministry of Infrastructure and the Environment), where 20% of the territory is below average sea level, has extensive experience with sea-level challenges and extreme events. For example, the 1953 North Sea flood and storm surge killed nearly 2,000 people and caused widespread damage in the Netherlands. Other European member countries also are preparing for impacts from climate change that might benefit California.

Current Actions to Prepare for Climate Impacts

Safeguarding California lays out five primary recommended actions to move towards a more resilient and adaptive transportation system: 1) Understand Climate Trends that Impact Transportation, 2) Improve Transportation System Reliability, 3) Further Enable Incorporation of Anticipated Climate Impacts in Transportation Plans, 4)



Inform Transportation Planning, and 5) Information Sharing and Education. Together, these recommendations create a framework for understanding the State’s progress in making transportation systems more resilient to climate change.

At Caltrans, the High-Speed Rail Authority, and the California Highway Patrol, many actions are being taken that build adaptive capacity and promote resilience against climate effects in the transportation sector. These actions are presented here.

1. UNDERSTAND CLIMATE TRENDS THAT IMPACT TRANSPORTATION

Using the best available climate science gives decision-makers actionable information to help plan the transportation infrastructure of the future, but those future systems will also certainly evolve in a myriad of ways due to California’s world-renowned innovation and entrepreneurship. Adaptation policy must be forward-looking to anticipate the unknowns and uncertainties that might affect transportation.

For example, anticipating how emerging technologies can transform transportation over the next century can allow for better adaptation options in both the energy and transportation sector. Caltrans is engaged in helping spur innovation and implementation of clean vehicle technology. This effort will make mobility in California less dependent on volatile fossil fuels, have important public health and air quality benefits, and promote the integration of renewable energy sources into the grid; Caltrans is ensuring

that these key goals for climate adaptation are paired with infrastructure that is itself resilient to climate change.

Safeguarding California also highlights land subsidence issues as a critical trend to understand, as increasing subsidence from heightened groundwater use during the current drought has emphasized. The High-Speed Rail Authority is following up an initial literature review of subsidence issues in the Central Valley with further study carried out with the United States Geological Survey. Caltrans is also partnering with other state agencies on CalEPA’s mapping of urban heat island index for California.

While future technological advances and geophysical phenomena are hard to predict, it is important to ensure that the studies on the trends of tomorrow—like driverless cars and a changing physical environment—are incorporated into a holistic effort to transform transportation systems.

Anticipating how emerging technologies can transform transportation over the next century can allow for better adaptation options in both the energy and transportation sector.



2. IMPROVE TRANSPORTATION SYSTEM

RELIABILITY

Action is needed to translate vulnerability assessments into reasoned, validated, cost-effective and environmentally-sound actions that reduce climate-related risks. Much of this work is already underway.

Through various programs, Caltrans is investing in transportation modes that reduce fuel dependency and serve disadvantaged communities in a changing climate, including an annual investment of over \$120M for Active Transportation Program projects to increase biking and walking. Through the GHG Reduction Fund (GGRF), Caltrans invested in Low Carbon Transit Operations Program (LCTOP) expenditures of over \$22M in 2015. These investments target state of the art improvements; examples include:

- **Expanded Service for the 38-R Geary and 44-O’Shaughnessy Lines:** \$2,592,022 to the San Francisco Municipal Transportation Agency to expand transit service and make transit more convenient and comfortable for customers across San Francisco, including those living in nearby or adjacent disadvantaged communities
- **Perris Valley Line Feeder Bus Service – Operating Assistance:** \$460,410 to the Riverside Transit Agency to implement feeder bus service for seamless transfers between bus and commuter rail and the Metrolink service in the cities of Perris, Moreno Valley and Riverside.

- **Fresno Area Express System Capacity Increasing Tripper Service:** \$249,311 to the City of Fresno Department of Transportation to help Fresno Area Express (FAX) expand bus service via tripper services to relieve overcrowding on key routes during peak service periods.

Caltrans further provides staff support for other GGRF transportation related program investments, including the Strategic Growth Council’s Affordable Housing and Sustainable Communities (AHSC) and CalSTA’s Transit and Intercity Rail Capital Program (TIRCP). These investments totaled nearly \$350M in 2015.

Caltrans is also working with ARB, CEC, GO-Biz, and others to comply with Governor Brown’s Executive Order B-32-15 by developing an action plan to meet a goal of zero and near zero emissions freight system that is more resilient to the effects of climate change. Both industry leaders and the California Freight Advisory Committee (CFAC) are providing input to Caltrans on methods to achieve efficiencies that will be included into the action plan. Caltrans has set an internal sustainability goal of 10% increase in freight system efficiency by 2020.

In some transportation infrastructure projects, Caltrans is incorporating natural systems such as allowing for tidal flow and facilitating wildlife connectivity. [EXAMPLE]



Caltrans is making an annual investment of over **\$120M** for projects to increase biking and walking.



Regarding its own internal operations, Caltrans is greening its own vehicle fleet to reduce dependency on volatile fuel sources and improve fuel availability. Likewise, it is using state of the art LEDs in street lighting and facilities to reduce energy dependency and has undertaken widespread retrofitting efforts to replace incandescent bulbs.

Caltrans/CHP Emergency Preparedness

Caltrans co-leads the Governor's Office Emergency Function for Transportation with California Highway Patrol and participates in emergency management-related exercises. Through this Function, Caltrans identifies emergency supply chains to ensure crucial supplies will not be cut off from impacted areas in emergencies, establishes redundant emergency communications systems to improve the resilience of emergency communications infrastructure, and provides transportation management centers to coordinate responses with local and federal partners. Caltrans further broadcasts public information through changeable message signs and highway advisory radio. Finally, 800 Caltrans engineers are on-call 24/7 to assess State and local infrastructure in emergencies.

High-Speed Rail Authority

The HSRA is responsible for the development and delivery of a high-speed rail system connecting the mega-regions of the state. Construction of the first segments is underway in the Central Valley, and initial operation is scheduled for 2022. High-speed rail is the backbone of electrified transportation

in California, and contributes to a resilient transportation network by shifting trips from fossil-fuel dependent modes, while reducing dependency on highways and airport for long-distance trips.

To address fuel reliability, the High-Speed Rail is committed to procuring 100% of electricity for operations from renewable sources and is working with utilities to complete studies and initiate upgrades transmission network to serve the rail.

High-Speed Rail has set net-zero energy performance criteria for station facilities and, as a means of exploring redundancy, is working with station communities on net energy positive opportunities, where feasible. High-Speed Rail also requires life-cycle analysis in design-build procurement documents, and is exploring logical ways to require bidders to address resilience as a component of design-life and safety considerations.

High-speed rail is the backbone of electrified rail transportation in California, and contributes to a resilient transportation network by shifting trips from fossil-fuel dependent modes, while reducing dependency on highways and airport for long-distance trips.

3. INCORPORATE CLIMATE IMPACTS IN TRANSPORTATION PLANS

Caltrans seeks to incorporate climate resilience into all long-range system planning activities, including the California Transportation Plan 2040



to be completed by end of 2015. This federally required 25-year Plan provides a policy framework to meet transportation needs and reduced greenhouse gas emissions. The CTP defines goals, performance-based policies, and strategies to achieve a collective vision for California's future statewide, integrated, multimodal transportation system. Caltrans Strategic Management Plan 2015 calls for completing 25 sustainable, multimodal corridor masterplans that include climate resiliency components by 2020.

In partnership with OPR and the Department of Finance, the Transportation Agency is helping re-frame the State's Five-Year Infrastructure Plan to include climate resilience considerations into all new transportation investments.

4. INFORM TRANSPORTATION PLANNING

The vulnerability assessments underway at Caltrans are crucial steps in making the state's transportation sector more resilient to climate change. This action is a central element of a broader effort underway at Caltrans to better understand and plan for climate impacts.

Caltrans is undertaking a statewide vulnerability assessment to be complete by 2017. Drawing from the findings of the assessments, Caltrans is considering how to include climate adaptation strategies into planning and design documents. Caltrans depends on other state and national agencies studies to adjust Caltrans' design and construction activities. For example, the Caltrans "Sea Level Rise Guidance" is based on sea level rise projections from CO-CAT and will be

updated with the estimates from the National Research Council's Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future. Similarly, Caltrans refers to the Federal Emergency Management Agency to adjust assumptions in federal flood plain maps.

Caltrans' new Strategic Management Plan 2015 calls for the development of a resiliency score taking into account climate change impacts. Work is underway to define the score and expected to be completed by end of 2017. Caltrans supports national Transportation Research Board research related to climate change and is utilizing simulation tools (such as ShakeCast) to integrate big data and predictive capabilities to prioritize recovery efforts.

5. INFORMATION SHARING AND EDUCATION

Both Caltrans and HSRA are implementing climate change information and education with partners.

In March 2015, CalTrans hosted a workshop with transportation stakeholders throughout the state on "Enhancing the Climate Change Resiliency of California's Transportation System"

With the Office of Emergency Services, Caltrans is developing a Guidance Plan for Emergency Management and Infrastructure Protection, including climate impacts, and supports the State Hazard Mitigation Plan.

The High-Speed Rail Authority requires contractor education to ensure climate adaptation and resilience knowledge.



Next Steps

While ongoing efforts to build resilience into California’s transportation sector through innovative climate adaptation initiatives are far-reaching, there is a need for more coordinated and comprehensive action, especially among state government entities. Safeguarding California recommended convening an interagency task force on reducing risks to California transportation, and next steps to continue the implementation of California’s adaptation strategy will be channeled through this new group as it is formed.

In early 2016, the California Transportation Agency (CalSTA) will convene a cross-departmental Transportation Sector Adaptation Team to address climate impacts. The proposed members of this group are:

- Caltrans
- High-Speed Rail Authority
- California Highway Patrol
- California Air Resources Board (ARB)
- California Department of Forestry and Fire Protection (CAL FIRE)
- California Energy Commission (CEC)
- California Natural Resources Agency (CNRA)
- California Public Utilities Commission (CPUC)
- Governor’s Office of Planning and Research (OPR)
- Ocean Protection Council (OPC)
- State Lands Commission (SLC)
- Strategic Growth Council (SGC)

The Transportation Sector Adaptation Team will tackle the key next steps through a work plan that prioritizes certain actions under each of the five recommendations presented in Safeguarding California. An outline of the proposed work plan is detailed here:

1. UNDERSTAND CLIMATE TRENDS THAT IMPACT TRANSPORTATION

- Identify increased role of clean transportation networks, including clean cars, transit, biking, and walking in reducing fuel dependency, connecting communities, and providing equitable evacuation routes. (2016)
- Identify how fish and wildlife connectivity across the transportation system may shift as climate changes and incorporate findings into California Essential Habitat Connectivity Project: A Strategy for Conserving a Connected California. Identify actions to preserve habitat connectivity and reduce fragmentation, including retrofitting existing transportation infrastructure that are current barriers to migration.



2. IMPROVE TRANSPORTATION SYSTEM RELIABILITY

- Enhance emergency preparedness during climate events for all transportation modes, particularly for disadvantaged communities who are less likely to own cars. (2016)
- Utilize information from vulnerability assessments and other data to inform new policies and practice of transportation:
 - o **Planning** – resiliency in multi-modal corridor planning
 - o **Funding** – long-term life-cycle cost-benefit analysis in project selection, including anticipated climate impacts and accounting for ecosystem service and habitat benefits provided by natural solutions
 - o **Project Design** – multi-modal access to destinations, natural system enhancements
 - o **Materials** – cost-effective and climate-adaptive materials
 - o **Contracting** – resiliency strategies in all design and construction contracts
 - o **Project Delivery** – efficient and clean construction
- Scale vulnerability criticality factors and scoring statewide and establish consistency for application at a project level to prioritize investment funding and integrate with asset management
- Ensure vulnerability assessments are followed by development of adaptation plans
- Integrate local and regional vulnerability assessments and adaptation plans with the State’s vulnerability assessments and adaptation plans, through partnering with organizations such as the Alliance of Regional Collaboratives for Climate Adaptation
- Integrate “big data” and shared geospatial information to better assess impacts of the State, regional and local transportation adaptation plans to automate and modernize information that can be assessed across sectors

3. INCORPORATE CLIMATE IMPACTS IN TRANSPORTATION PLANS

- Provide grant funding to regional governments as part of Regional Transportation Plans (2016)

4. INFORM TRANSPORTATION PLANNING

- Continue improving Cal-Adapt and support research to complete downscaling of climate projections (2016)
- Analyze the vulnerability of fuel and electricity networks
- Analyze the vulnerability of projects on the Primary Freight Network (ports, airports, highway, etc.)
- Develop a transportation “hot-spot” map to identify where the mixture of climate impacts, population increases, transportation demand



and demographics make communities most vulnerable to climate change impacts (2017)

- Complete economic assessment for projecting climate impacts on state’s transportation system, and integrate into benefit-cost project analysis (2017)
- Complete all Caltrans districts detailed vulnerability assessments (2017)

5. INFORMATION SHARING AND EDUCATION

- Establish statewide comprehensive GIS and data manager to ensure all state agencies are using the same data and reports/studies are consistent
- Convene climate adaptation educational forums with academia and partners

- Encourage collaboration between state, regional, and local adaptation efforts

- Create climate change transportation blog for agency interaction and skill sharing
 - o Include space for any agency to post new documents, videos, or comments

To achieve these ambitious goals, the first steps for the California State Transportation Agency (CalSTA) will be to carry out the following:

- o Formation of a steering committee
- o Steering committee elected
- o Meeting schedule agreement
- o Regular reporting

Monitoring and Evaluation

Tracking the efficacy of state efforts will be crucial to successfully continuing to adapt to intensifying climate impacts. The following metrics could help monitor the status of state efforts and how well they are contributing to a more resilient transportation system.

Metrics to evaluate the progress of state adaptation efforts include:

- Percentage complete by district of regionally downscaled Global Climate Models incorporating sea-level rise, precipitation, and heat projections.
- Number of Caltrans districts vulnerability assessments completed, and a rolled-up system-

wide resiliency assessment and criticality scoring.

- Transportation partners vulnerability assessments completed
- Number of Caltrans districts vulnerability adaptation plans completed
- Number of transportation partners adaptations plans integrate with Caltrans districts adaptation plans.



- Number of economic assessments for projecting climate impacts completed.
- Complete vulnerability study of Primary Freight Network
- Complete vulnerability study of fueling infrastructure
- Complete vulnerability study of electric utilities that support transportation
 - o Resiliency of electric vehicles and network
- Funds allocated to regions for Regional Transportation Plans climate resiliency planning
- Number of projects combining local/regional and State funding to identify or implement adaptation solutions

- Number of transportation-sector major infrastructure capital investments that consider climate change
- Number of transportation facilities impeding natural systems and habitat connectivity

Metrics to evaluate the overall resiliency of the transportation sector include:

- Transit, bicycle and pedestrian network level of connectivity and completion
- Number of miles of state highways that are vulnerable to flooding with 1.4 meters of SLR during a 100-year storm event
- Improved natural system and habitat connectivity

Water Sector Plan



AGRICULTURAL SECTOR PLAN



BIODIVERSITY AND HABITAT SECTOR PLAN



EMERGENCY MANAGEMENT SECTOR PLAN



ENERGY SECTOR PLAN



FORESTRY SECTOR PLAN



LAND USE AND COMMUNITY
DEVELOPMENT SECTOR PLAN



OCEANS AND COASTAL RESOURCES
AND ECOSYSTEMS SECTOR PLAN



PUBLIC HEALTH SECTOR PLAN



TRANSPORTATION SECTOR PLAN



WATER SECTOR PLAN



Water Sector Plan



Introduction

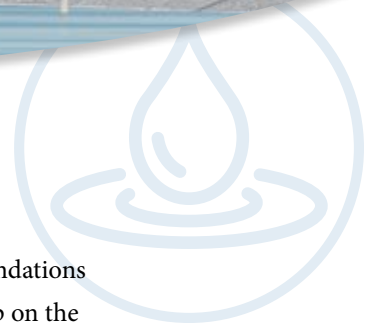
Climate change creates critical challenges for California water resources management. The vulnerability of the water sector to climate change stems from a modified hydrology that affects the frequency, magnitude, and duration of extreme events, which, in turn, affect water quantity, quality, and infrastructure. Warmer temperatures drive the snow line higher and reduce snowpack, resulting in less water for the environment, and urban and agricultural users. Warmer temperatures increase the risk of forest fire, which further affects water supply and temperature. Intense rainfall events will continue to affect the state, possibly leading to more frequent and/or more extensive flooding. The acceleration of sea-level rise will produce higher storm surges during coastal storms. Droughts are likely to become more frequent and persistent during this century. In addition, climate change may make preservation and restoration of habitat more difficult. For example, climate change is expected to warm rivers and streams. Already, summer temperatures often approach the upper tolerance limits for salmon and trout; higher air and water temperatures will exacerbate that problem.

Because California contains multiple climate zones, each region of the State will experience a combination of impacts from climate change unique to that area. Key climate change vulnerabilities for the various hydrologic regions of the State are shown in Figure #WS1. For more in-depth descriptions of regional vulnerabilities see *California Climate Science and Data for Water Management* (DWR, 2015). While significant uncertainties still remain for local precipitation and temperature changes, projections at the regional and statewide levels are already available.

Federal, State, and local water resource managers have multiple tools and institutional capabilities that can be used to adapt water management and limit vulnerability to changing conditions. Nonetheless, meeting the challenges of a rapidly

changing climate will require coordinated and integrated efforts that use a watershed-based approach to design, plan, and manage our water resources and water resource infrastructure to provide multiple benefits while considering natural, social, and built systems.

This plan will outline the specific vulnerabilities associated with ongoing and inevitable climate impacts, the current actions that California State government is undertaking to reduce those vulnerabilities, and a set of next steps that are needed to continue progress in adapting to threats from climate change. The State's climate adaptation strategy, which was updated in July 2014 by the Natural Resources Agency with the report *Safeguarding California: Reducing Climate*



Risk (Safeguarding California), guides ongoing and planned initiatives, and the plan concludes by outlining ways that progress has been made so far. While climate change presents serious challenges for water resource managers in California, this

plan to fully implement the recommendations in *Safeguarding California* is a key step on the road to protect California’s people, economy, and environment.

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Vulnerability Assessment

Major statewide climate change threats to California’s water sector summarized above are described in more detail in numerous State reports, plans, non-governmental reports, and peer-reviewed literature (e.g., California Department of Water Resources 2008, California Natural Resources Agency 2009, California Natural Resources Agency 2014). Climate change vulnerability assessments for the water sector provide the most useful information when they are focused on specific systems or regions of the State. Figure WS-2 shows how each region is expected to warm by the middle of the 21st century. It is clear that each region of the State is likely to experience climate change differently; some portions of the State may get wetter while other areas get drier; warming is expected to be much more severe in the Sierra Nevada than along the coast. Additionally, water resources are, for the most part, managed locally by thousands of different local water management agencies. Local agencies within similar foothill, inland valley, or coastal parts of the State may experience impacts unique to common topography and landscapes throughout large portions of the State. Additionally, each local water agency will have to contend with impacts to their local watershed, as well as the upstream and downstream watersheds that influence local water supply or water quality constraints. Local communities will also have to deal with impacts to any distant watersheds that may provide imported water supplies.

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Each local water agency will have to contend with impacts to their local watershed, as well as the upstream and downstream watersheds that influence local water supply or water quality constraints.

Specific types of impacts will pose much greater risk for some local resource managers than others (even within the same or adjacent watersheds). For example, sewage collection and wastewater

treatment infrastructure is vulnerable to multiple impacts of climate change. Sea level rise will challenge existing gravity-flow sewer systems and treatment facilities located along the coastline,



and increased storm surges will demand higher hydraulic capacity in treatment systems to sustain existing treatment levels, resulting in increased energy requirements and expensive capital improvements needed to adapt to these changes. The impact of increased drought conditions and the warming environment will lead to less in-stream flow dilution and inflow ambient conditions that require enhanced treatment to address higher levels of toxicity in warmer surface waters. Lastly, increased extreme precipitation events will increase the need to immediately upgrade and expand the capacity of existing sewage collection, wastewater treatment, storm water, flood management, and drinking water infrastructure for resiliency against flooding and spill-related vulnerabilities.

As State government continues implementation of Safeguarding California, the process to iteratively

update this comprehensive adaptation strategy can explore drawing from this combined statewide, regional, and local approach to address identified vulnerabilities. Implementation plans for other sectors of Safeguarding California explore threats at a sector-wide level, but the particularly disparate geographic climate impacts in the water sector set ideal circumstances for prioritizing and establishing case studies for utilizing regional vulnerability assessments. The following pages illustrate continued and new work from the California Department of Water Resources (DWR), and the State Water Resources Control Board (State Water Board) and the nine Regional Water Quality Control Boards (Regional Water Boards), working closely with other federal, State, regional, and local partners, to address the State response to climate vulnerabilities across California.



Figure #WS-1. California's Water Sector Climate Change Vulnerabilities

Climate Change Vulnerabilities

Because of the economic, geographic, and biological diversity of California, vulnerabilities to anticipated future climate changes are best assessed on a regional basis. A few of the key climate change vulnerabilities are indicated. For more in-depth descriptions please go to: http://www.water.ca.gov/climatechange/docs/CA_Climate_Science_and_Data_Final_Release_June_2015.pdf.



North Coast • Longer drought periods could reduce local fractured-rock groundwater supplies. • Sea level rise may make tidal marshland susceptible to more frequent, longer and deeper flooding.



San Francisco Bay • Sea level rise may increase the susceptibility of tidal wetlands to more frequent, longer and deeper flooding.



Sacramento-San Joaquin Delta • Sea level rise may increase stress on Delta levees and change water quality.



Central Coast • Coastal infrastructure and nearshore ecosystems are vulnerable to increasing sea level and storm surges, while coastal aquifers could be affected by increasing salinity intrusion.



South Coast • Extreme precipitation events may result in greater flood risk, debris flows, and degradation of habitat. • Higher temperatures and longer dry seasons would increase wildfire risk and impair water quality in local streams and lakes.



North Lahontan • Increased air and water temperatures would place additional stress on sensitive ecosystems and species. • Higher temperatures and longer dry seasons would increase wildfire risk.



Mountain Counties • Loss of snowpack storage may reduce reliability of surface water supplies. • Snowpack reduction may have significant impacts on the water-related tourism industry.



Sacramento River • Increased air and water temperatures would place additional stress on sensitive ecosystems and species. • Loss of snowpack storage may reduce reliability of surface water supplies and result in greater demand on groundwater resources.



San Joaquin River • Increasing temperatures and variable precipitation patterns would affect agricultural crops by reducing winter chill-hours, increasing extreme heat days and increasing evapotranspiration.



South Lahontan • Higher temperatures and longer dry seasons would increase wildfire risk and impair water quality in local streams and lakes. • Reduced snowpack would impact the winter-dependent economy which also supports disadvantaged communities.



Tulare Lake • Loss of snowpack storage may reduce reliability of surface imported water supplies and replenishment of local supplies, and result in greater demand on groundwater resources. • Increased air and water temperatures would place additional stress on sensitive ecosystems and species.



Colorado River • More frequent and longer droughts would reduce imported water supply reliability and decrease local water quality and habitat.



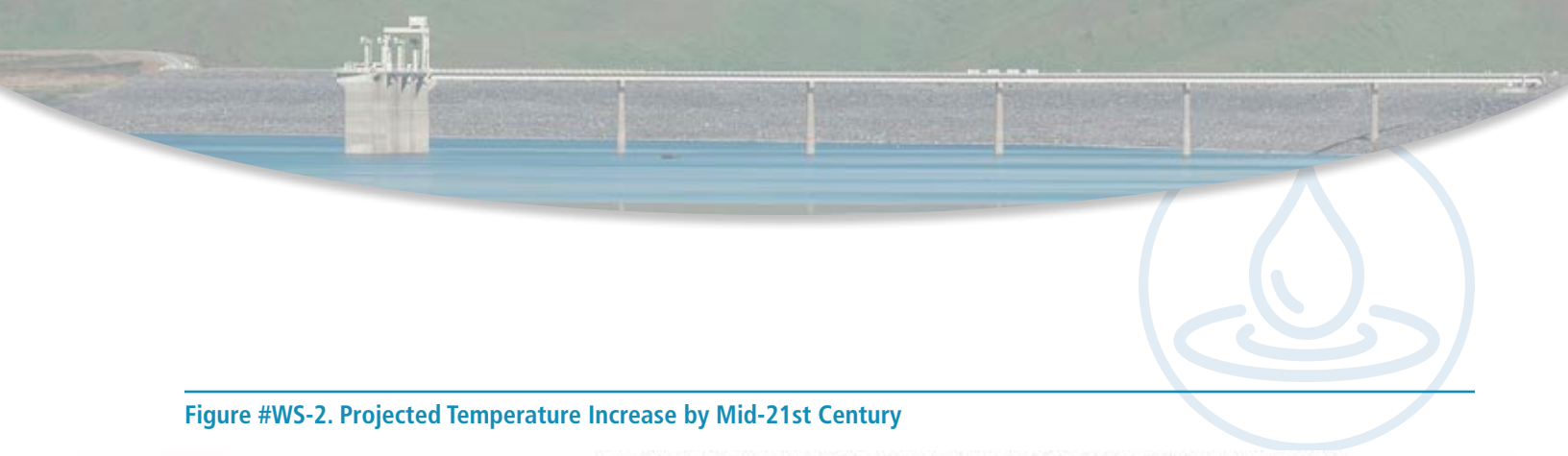


Figure #WS-2. Projected Temperature Increase by Mid-21st Century



For a detailed description of the Western Region Climate Center zones used for temperature projections, and how they differ from California's hydrologic zones, please see California Climate Science and Data for Water Resources Management, page 11, http://www.water.ca.gov/climatechange/docs/CA_Climate_Science_and_Data_Final_Release_June_2015.pdf, DWR, 2015).



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Current Actions to Prepare for Climate Impacts

The State of California has dozens of actions underway to prepare for climate change impacts on the water sector. These actions span the different areas of the water sector including: (1) surface water and groundwater, (2) drinking and environmental water supplies, (3) wastewater, (4) flood flows and storm water, and (5) recycled water. The actions focus on safeguarding State- and locally-managed infrastructure and resources by supporting current actions, and incentivizing local water managers to plan for future actions to address climate change impacts on local and regional water resources.

I. SAFEGUARDING CALIFORNIA: PRIORITY STRATEGIES FOR REDUCING CLIMATE RISK

A. Vigorously prepare California for flooding

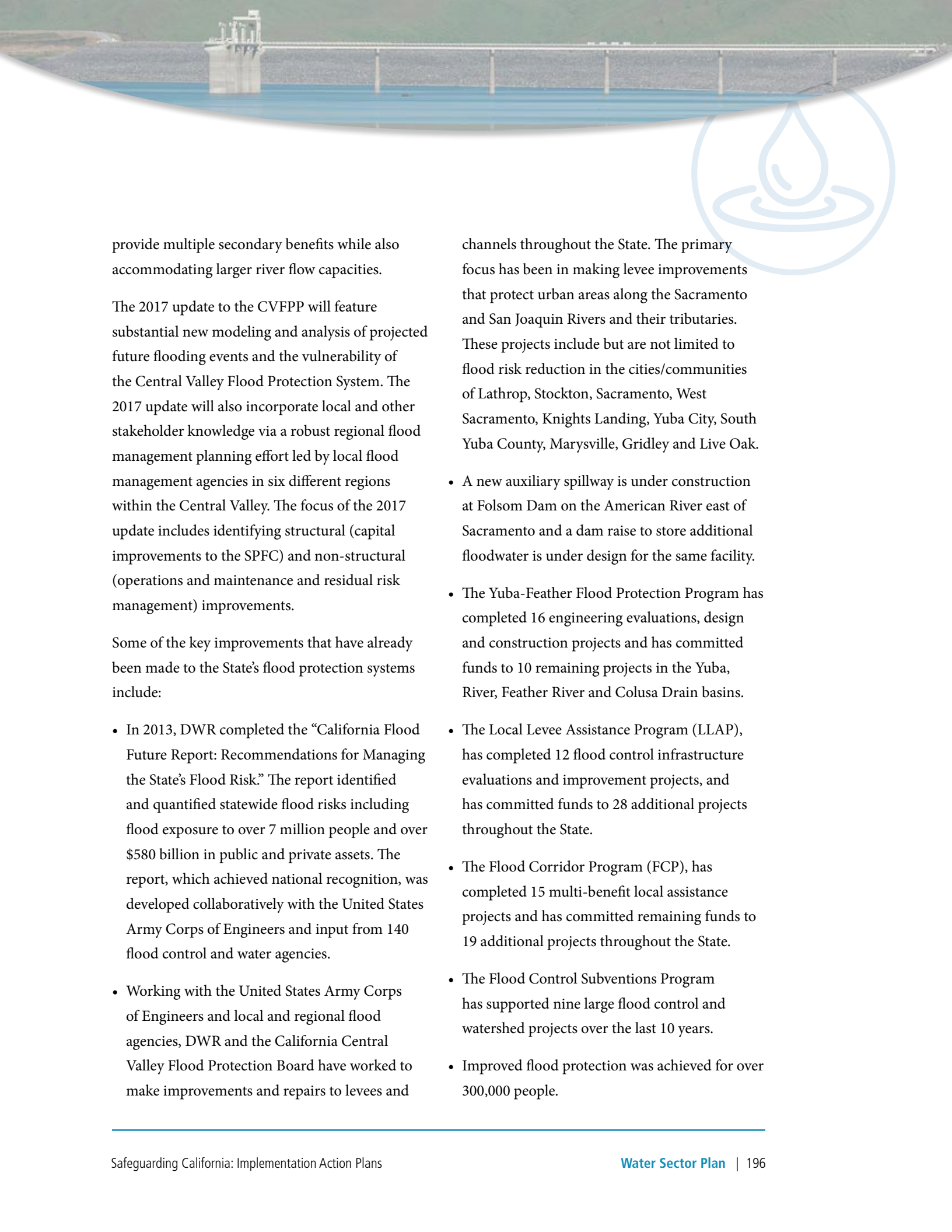
DWR continues to work with other State, federal, and local agencies to improve California’s resiliency and preparedness for the various types of extreme precipitation and high stream flow levels experienced in the past, with expectation of even more extreme events in the future.

The *2012 Central Valley Flood Protection Plan* (CVFPP) is guiding California’s participation (and influencing federal and local participation) in managing flood risk along the Sacramento River and San Joaquin River that feed into, and are part of the Sacramento-San Joaquin Bay-Delta. The CVFPP is updated every five years. The primary focus of the CVFPP is to address deficiencies in the State Plan of Flood Control (SPFC), which is the name of the State-owned and -maintained flood management system in the Central Valley. The CVFPP will help prioritize Central Valley flood risk reduction and ecosystem restoration investments, including preparing feasibility

level studies for the Sacramento River and San Joaquin River basins. The CVFPP will support State investments and regulatory actions that enhance flood system resiliency, address low-frequency riverine flooding, integrate programs and resources, and preserve management flexibility for future generations. Despite effective investments in flood management programs and infrastructure, flood risk remains high and is expected to increase over time due to projected population growth and development, California’s existing extreme hydrologic variability, and climate change. Actions such as the expansion of existing river and bypass channels through levee setbacks, creation of new flood bypass channels, and development of wildlife and fisheries habitats in the bypass system, all creating open space and integrating with recreation activities, could



Flood risk remains high and is expected to increase over time because of population growth and development, California’s existing extreme hydrologic variability, and climate change.



provide multiple secondary benefits while also accommodating larger river flow capacities.

The 2017 update to the CVFPP will feature substantial new modeling and analysis of projected future flooding events and the vulnerability of the Central Valley Flood Protection System. The 2017 update will also incorporate local and other stakeholder knowledge via a robust regional flood management planning effort led by local flood management agencies in six different regions within the Central Valley. The focus of the 2017 update includes identifying structural (capital improvements to the SPFC) and non-structural (operations and maintenance and residual risk management) improvements.

Some of the key improvements that have already been made to the State's flood protection systems include:

- In 2013, DWR completed the "California Flood Future Report: Recommendations for Managing the State's Flood Risk." The report identified and quantified statewide flood risks including flood exposure to over 7 million people and over \$580 billion in public and private assets. The report, which achieved national recognition, was developed collaboratively with the United States Army Corps of Engineers and input from 140 flood control and water agencies.
- Working with the United States Army Corps of Engineers and local and regional flood agencies, DWR and the California Central Valley Flood Protection Board have worked to make improvements and repairs to levees and

channels throughout the State. The primary focus has been in making levee improvements that protect urban areas along the Sacramento and San Joaquin Rivers and their tributaries. These projects include but are not limited to flood risk reduction in the cities/communities of Lathrop, Stockton, Sacramento, West Sacramento, Knights Landing, Yuba City, South Yuba County, Marysville, Gridley and Live Oak.

- A new auxiliary spillway is under construction at Folsom Dam on the American River east of Sacramento and a dam raise to store additional floodwater is under design for the same facility.
- The Yuba-Feather Flood Protection Program has completed 16 engineering evaluations, design and construction projects and has committed funds to 10 remaining projects in the Yuba, River, Feather River and Colusa Drain basins.
- The Local Levee Assistance Program (LLAP), has completed 12 flood control infrastructure evaluations and improvement projects, and has committed funds to 28 additional projects throughout the State.
- The Flood Corridor Program (FCP), has completed 15 multi-benefit local assistance projects and has committed remaining funds to 19 additional projects throughout the State.
- The Flood Control Subventions Program has supported nine large flood control and watershed projects over the last 10 years.
- Improved flood protection was achieved for over 300,000 people.



- Over 10,000 acres of agricultural land and 5,000 acres of wildlife habitat have been preserved.
- Over 225 miles of levees have been evaluated or improved.
- Approximately 5,000 acre-feet of floodplain transitory storage have been added.

Through research partnerships, DWR is also working with State, local, and federal partners to improve our scientific understanding of the climate system and use that knowledge to reduce flood risk. DWR is working with the National Oceanic and Atmospheric Administration and the research community to:

- Improve the State’s forecasting capability for seasonal precipitation and climate to provide reservoir managers with better information about future seasonal outlooks.
- Develop atmospheric river-based methods for water supply and flood management planning and operations to improve prediction of, and management of, storm waters that serve as the core of California’s water supply while concurrently posing the greatest risk of flooding.
- Improve forecast-based operations that will allow reservoir operators to manage reservoir storage levels according to actual detailed upstream watershed conditions and forecasted storms.
- Preserve existing reservoir storage for improved flood protection, proper management of surface drinking water supplies, and appropriate

reservoir releases to maintain minimum in-stream flows.

DWR is also supporting the development of regional flood management plans (RFMPs) developed to increase institutional relationships within the Central Valley that lead to

greater regional self-reliance and a broader focus on capital improvements that provide greater resiliency toward managing flood waters in a highly uncertain future. The RFMPs identified more than

580 actions that could be implemented to reduce existing and future flood risk, including calls to reform the National Flood Insurance Program to allow agricultural activities in floodplains, and the need for increased funding of annual flood system maintenance and operations activities at the local, State, and federal levels.

The State Water Board and the Regional Water Boards hold regulatory responsibility for controlling storm water pollutant discharges into surface and ground waters. The Water Boards implement federal and State regulatory requirements through permits for large communities, small communities, Caltrans, and industrial and construction activities. The Water Boards update these permits every five years to

DWR is working with State, local, and federal partners to improve our scientific understanding of the climate system and use that knowledge to reduce flood risk.



incorporate modified requirements which can address further impacts to the State's water quality and water supply from climate change. Water Board permits include provisions that allow for the necessary adaptation to impacts from extreme precipitation, extreme low and high stream flow conditions (due to both drought and flooding), and erosion and sediment control.

In 2016, the State Water Board adopted a Strategy to Optimize Resource Management of Storm Water (Storm Water Strategy; for more details see section I.H), a high-level planning effort that incorporates the recently-established storm water watershed planning and funding programs and future projects needed for the State to use storm water as a resource (no longer viewing storm water as a polluted nuisance). In addition to capturing and treating storm water, the Storm Water Strategy results in local 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.

All of California's continuing investments in flood control systems will reduce, but will never completely eliminate, the risk of floods. Public awareness, education, and involvement are important strategies for alerting the public to residual risks. Each year, DWR notifies more than 350,000 property owners whose properties receive protection from SPFC facilities. Each notice alerts the property owner to the source of potential

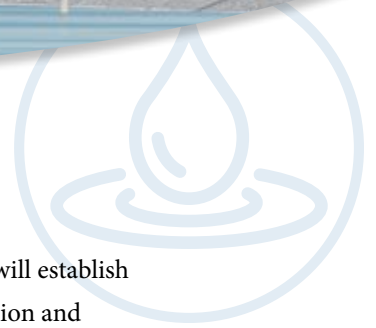
flooding and focuses on flood risk preparedness, prevention, and protection. A program website provides enhanced flood risk information, and an interactive viewer that allows property owners to enter a property address and view related levee flood protection zone maps.

Emergency preparedness, response, and recovery are also important components of managing residual flood risks. DWR, in cooperation with the Office of Emergency Services (OES) and other State, federal, and local agencies, continues to invest in, and prepare for, emergency responses to flooding, including:

- Development of flood safety plans at all levels of emergency response.
- Establishment of command and control structures at the local and county level for flood emergency response.
- Establishment of regional stockpiles of resources.
- Development of mutual aid agreements and response protocols specific to flooding, sewage spills, and drinking water system contamination and failures.
- Development of training and practice programs for emergency response agencies and personnel.

B. Support regional groundwater management for drought resiliency

The Governor signed the Sustainable Groundwater Management Act (SGMA) into law on September



16, 2014. This legislation defines sustainable groundwater management as the “management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results (Water Code Section 10721 [u]).”

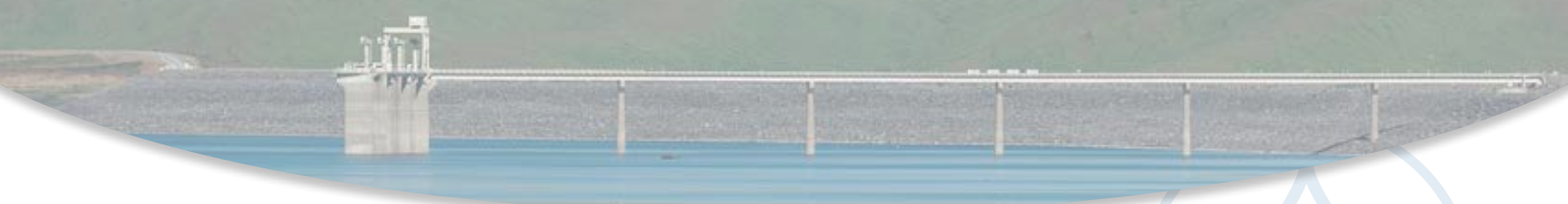
The legislation requires the formation of groundwater sustainability agencies (GSAs) in all high- and medium-priority groundwater basins under the California Statewide Groundwater Elevation Monitoring (CASGEM) program by June 30, 2017 (Water Code Section 10735.2 [a]). GSAs in basins subject to critical conditions of overdraft are required to be managed under a groundwater sustainability plan (GSP) by January 31, 2020 (Water Code Section 10720.7 [a] [1]), while all other high- and medium-priority groundwater basins are to be managed under a GSP by January 31, 2022 (Water Code Section 10720.7 [a] [2]). Each GSA is required to establish a sustainability goal and achieve that goal within 20 years of implementing its GSP. The sustainability goal requires achieving groundwater sustainability without causing significant and unreasonable “undesirable results.”

SGMA provides GSAs with incentives, tools, authority, and guidance to achieve local sustainable groundwater management. The development and implementation of SGMA plans will help achieve improved water supply reliability, resiliency, public health and safety, ecosystem services, and a stable California economy.

DWR’s responsibilities under SGMA will establish a new framework for the implementation and assessment of GSPs in California. A key outcome of this framework will be established standard methods and assumptions for baseline conditions concerning hydrology, water demand, and regulatory restrictions affecting surface water availability and surface water supplies. DWR will adopt a common set of methods, assumptions, and standardized approach for evaluating the effects of climate change on future water supply reliability and groundwater management practices. Providing GSAs with a standard approach for evaluating potential climate change impacts will help GSAs more accurately develop and implement the appropriate adaptive management options needed to maintain local groundwater sustainability.

SGMA authorizes the State Water Board, under a limited set of circumstances, to intervene in local groundwater management in order to protect groundwater resources in areas where local and regional agencies are unable or unwilling to sustainably manage the groundwater. State intervention requirements remain in place until local efforts are able to sustainably manage groundwater resources. In some circumstances, the State Water Board may, in consultation with

DWR will adopt a common set of methods, assumptions, and standardized approach for evaluating the effects of climate change on future water supply reliability and groundwater management practices.



DWR and through a public process, identify groundwater basins as probationary and develop interim sustainability plans for those basins. The interim plan remains in effect until the State Water Board finds that local efforts will likely achieve groundwater sustainability.

C. Diversify local supplies and increase water use efficiency

Increasing regional self-reliance and diversification of local water supplies, and maximizing water conservation and water use efficiency will enable Californians to better respond to changing economic and climatic conditions while ensuring a reliable water supply for the diversity of the State's water needs. These strategies must ultimately be implemented by local and regional water management agencies throughout the State, but DWR, the State and Regional Water Boards, and other State agencies are promoting local water supply development projects, and local conservation and efficiency projects, through State policies that allow, and multiple financial and technical assistance programs that incentivize, the following:

- Water appliance and fixture rebate programs.
- Agricultural water use efficiency grants.
- Desalination grants.
- Turf replacement grants.
- High-efficiency toilet retrofit program.
- Agricultural water management plan assistance.
- Water-Energy Technology (WET) Grant Program.

- Water-Energy Grant Program.
- Water Recycling Grant Program.
- Clean Water State Revolving Loan Fund Program.
- Drinking Water State Revolving Loan Fund Program.
- Update of State Model Water Efficient Landscape Ordinance.
- Local Assistance Program.
- Emergency Drinking Water Assistance Program.
- Storm Water Management Grant Funding Program.
- Conservation Rates Program.
- Groundwater Management Grant Funding Program.
- Integrated Regional Water Management (IRWM) climate change technical assistance.
- Statewide campaign to promote drought-tolerant landscapes.



Increasing regional self-reliance and diversification of local water supplies will enable Californians to better respond to changing economic and climatic conditions while ensuring a reliable water supply for the diversity of the state's water needs.

The State Water Board adopted the Recycled Water Policy in 2009 to encourage use of recycled water as a water supply, and streamline permitting of recycled water projects, which in most regions will diversify the local water supply options. A State mandate was established to increase 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. Regulations for groundwater replenishment using recycled water became effective in 2014, and are incorporated into Recycled Water-related regulations. The State Water Board, through its Division of Drinking Water, has been mandated by the Legislature to adopt regulations for augmenting surface water supplies with recycled water by December 31, 2016, and to submit a report to the Legislature by December 31, 2016 the feasibility of promulgating regulations for direct potable reuse of recycled water. An expert panel has been working since mid-2014 to determine if the proposed regulations for surface water augmentation of recycled water are sufficiently protective of public health and to give the State Water Board their assessment of the feasibility of adopting regulations allowing for the direct potable use of recycled water. This panel will complete its work by mid-2016. It is anticipated that recycled water surface water augmentation regulations will be adopted by the end of 2016, and a report on the feasibility of using recycled water for direct potable reuse will also be completed. Both of these milestones will make significant progress toward making recycled water a viable alternative potable water supply source.

The State Water Board's Storm Water Strategy (for more details see section I.H) to incentivize statewide use and redefine storm water as a resource will contribute to diversification of local supplies through, but not limited to, replenishment of depleted groundwater aquifers, increased storm

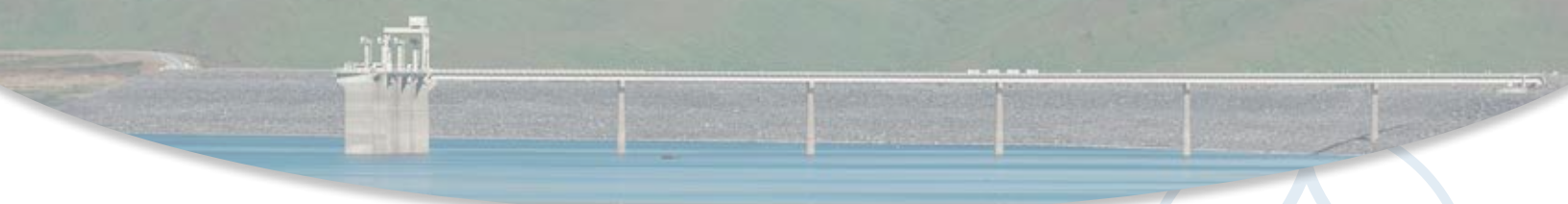
water use for local irrigation and non-potable water demands, increased flows in local streams and rivers, incentives for regionalization of local utilities, increased regional and local community partnering, and joint-involvement in regional and local water resource management.

The State Water Board has adopted Storm Water Grant Funding Guidelines to establish the process and criteria that the State Water Board will use to administer grants for multi-benefit storm water management projects funded by the Proposition

1 Storm Water Grant Program Funding. Proposition 1 is a water bond measure that, among other funds, authorized \$200 million in grants for multi-benefit storm water management projects to assist in adapting water infrastructure systems to climate change and

to provide incentives for water agencies throughout each watershed to collaborate in managing the region's water resources. The State Water Board has also adopted Storm Water Resource Plan Guidelines to provide guidance for development of storm water resource plans or functionally equivalent plan(s) required by the recent amendments to the California Water Code prior to receiving State grant funding for storm water projects.

The State Water Board provides grant and loan funding for the planning, design, and construction of water recycling projects that offset or augment State fresh water supplies.



The State Water Board provides grant and loan funding for the planning, design, and construction of water recycling projects that offset or augment State fresh water supplies. The purpose of the Water Recycling Funding Program is to promote the beneficial use of treated municipal wastewater by providing technical and financial assistance to agencies and other stakeholders in support of water recycling projects and research. Increase in treatment and cost of municipal wastewater discharges to surface waters impacted by climate provides additional recycling incentives for recycling of municipal wastewater. Higher levels of treatment for inland surface water dischargers to respond to lower flows and higher temperatures in receiving waters move those sanitation agencies closer to attaining the level of treatment required for recycled municipal wastewater per Title 22 reuse requirements.

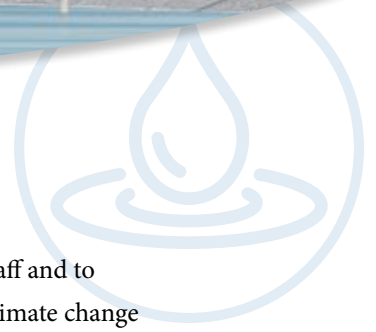
In addition to providing financial assistance for storm water and recycling water actions, the State Water Board has been promoting water conservation measures through implementation of statewide water conservation requirements and establishment of required local water agency conservation levels, which has both climate adaptation and mitigation benefits. Additionally, water conservation principles are incorporated in State and Regional Water Board resolutions, actions and permits, either directly through conservations measures and indirectly through permitting and incentives for increased use of recycled municipal wastewater, storm water, and grey water for agriculture and municipal irrigation.

Specifically addressing mandated water conservation, in May 2015, the State Water Board adopted an emergency regulation requiring an immediate 25 percent reduction in overall potable urban water use, in accordance with the Governor's Executive Order B-29-15. The regulation uses a sliding scale for setting conservation standards so that communities that have already reduced their consumption through past conservation have lower mandates than those that have not made such gains since the last major drought.

The State Water Board continues to work closely with water suppliers to implement the regulation and to support improved local efforts where conservation savings are falling short. In November 2015, the Governor issued an additional Executive Order directing the State Water Board to extend and revise the emergency water conservation regulations based on conditions through January 2016. The Board will consider the proposed emergency regulation extension in February 2016.

DWR is also continuing to implement its flagship local assistance program, the IRWM Program by awarding the remaining Proposition 84 grant funding and launching the Proposition 1 IRWM

The State Water Board has been promoting water conservation measures through implementation of statewide water conservation requirements and establishment of required local water agency conservation levels, which has both climate adaptation and mitigation benefits.



grant program. In total, California approved \$23.2 billion in water bonds between 2000 and 2013 (California Department of Water Resources 2013), a significant portion of that investment has gone to local agencies through financial and technical assistance programs.

In addition to providing funding through grant and assistance programs, DWR has undertaken a number of studies to determine how local water management agencies are addressing climate change in their planning processes.¹ These studies are designed to learn more about the challenges of conducting local level climate analysis and adaptation planning and to identify opportunities to simplify and streamline the process. DWR is also using the information gathered in the studies to develop new tools and resources to support climate change planning at the local and regional level. To date, DWR has completed studies looking at how urban water suppliers (urban water management plans), regional water management groups (integrated regional water management plans), and regional flood planning agencies (regional integrated flood plans) have addressed climate change in their planning processes. DWR also recently completed an evaluation of its 2011 *Climate Change Handbook for Regional Water Planning*, which is the key resource used by most regional water management groups.² Regional climate change specialists continue to be stationed by DWR in each of its four regional offices to work

directly with local and State agency staff and to provide direct technical support for climate change planning.

Water-use efficiency and conservation also provide adaptation for the energy sector by reducing the amount of energy needed to extract, convey, treat, deliver, and use water and wastewater. DWR, CPUC, and other State agencies are actively involved in efforts to better understand the water-energy nexus and to leverage resources for water efficiency improvements that provide energy benefits and energy efficiency improvements that provide water benefits. Additional water-energy-GHG work is also being done by the California Air Resources Board, DWR and others to promote GHG emissions reductions and climate change mitigation through the Climate Change Scoping Plan and AB32.



More than
25
million
Californians get their
drinking water from
the Delta.

D. Reduce Sacramento-San Joaquin River Delta climate change vulnerability

The Sacramento-San Joaquin River Delta (Delta) is the largest estuary on the West Coast, and is home to many threatened and endangered species, as well as a historic agricultural community. The Delta is also an important part of California's water supply system. Approximately 50 percent of all

¹ http://www.water.ca.gov/climatechange/docs/IRWM_CCReport_Final_June2012_EConrad_UCBerkeley.pdf
http://www.water.ca.gov/climatechange/docs/UWMPClimateChangeReport_Final_June2013.pdf
http://www.water.ca.gov/climatechange/docs/IRWM_RFMP_FinalReport_May2014.pdf

² <http://www.water.ca.gov/climatechange/CCHandbook.cfm>



runoff in the State flows through the Delta. More than 25 million Californians get their drinking water from the Delta; agriculture relies on water from the Delta to irrigate thousands of acres. But the Delta is severely threatened by climate change. Larger, more severe, storms will send larger flood flows through the Delta. At the same time, sea level rise will increase the amount of sea water intruding into coastal groundwater aquifers and the estuary from the Pacific Ocean. Both of those impacts will place additional stress on the groundwater drinking water and irrigation water supply, the Delta's already fragile levee system, and the deeply subsided Delta islands. As climate change reduces water supplies and increases water demands (as a result of higher temperatures), additional stresses are being placed on the Delta and other estuaries along the California coastline.

As discussed in the Forestry Sector, much can be done in the upper watersheds and source areas that feed the rivers that flow into the Delta to buffer the effects of climate change. In addition, DWR has several ongoing programs aimed at addressing climate impacts within the Delta itself.

- The largest investment aimed at reducing Delta vulnerability to climate change is the proposed California WaterFix project. This project will use water system upgrades to protect the State's water supplies from climate change. The upgrades will protect against water supply disruption from failure of aging levees resulting from sea-level rise, earthquakes, and flood events. The proposed new facilities will provide

greater operational flexibility so that statewide water supplies can be better managed during all hydrologic conditions. In July 2015, a partially recirculated draft environmental impact report/supplemental draft environmental impact statement

(EIR/EIS) was released for the Bay Delta Conservation Plan/California WaterFix. A final EIR/EIS is anticipated in spring 2016. More information about the California WaterFix is available at: <http://www.californiawaterfix.com/>

- Since the late 1990s, DWR's West Delta Program has been investigating subsidence on Delta peatlands. In 2008, large-scale pilot projects were implemented to investigate wetland crops (rice and tule) impacts on subsidence, water quality, and air quality. Monitoring air quality impacts since 2008 has shown that growing wetlands has a net greenhouse gas (GHG) benefit of 7 to 15 tons of CO₂ equivalent per acre per year. As a result, DWR is currently implementing a strategy to convert significant acreages of marginal farmland on Sherman and Twitchell islands into wetlands. To date, approximately 2,400 acres have been converted and another 1,100 acres will be converted to wetland crops by 2017.

As climate change reduces water supplies and increases water demands (as a result of higher temperatures), additional stresses are being placed on the Delta and other estuaries along the California coastline.

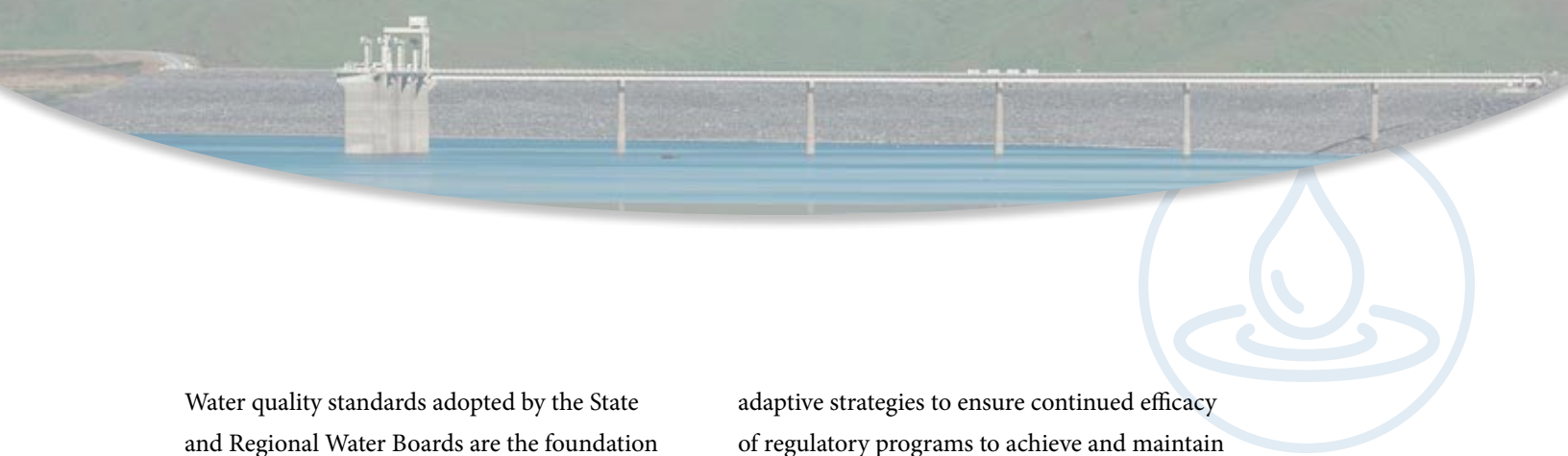


- Additionally, the West Delta Program is working with a few other agencies to develop a GHG protocol for wetlands in the Delta and coastal regions. The protocol was submitted to the American Carbon Registry in June 2015, and will ultimately be submitted to the California Air Resources Board for its review and approval in early 2016. Expanding upon this effort, DWR and local reclamation districts recently received a \$10.5 million grant from the California Department of Fish and Wildlife’s GHG Grant Program to construct additional wetland projects on Sherman Island, and to investigate GHG sequestration Delta-wide. Partnering with University of California, Berkeley, DWR will quantify GHG emissions from common agricultural practices, as well as continue to quantify GHG sequestration rates from wetland treatments, ultimately yielding mathematical models that will predict the net GHG flux based on easily acquired field information.
- In 2010, the State Water Board prepared a report that included the volume, timing, and quality of flow for fishery protection under existing conditions. In order for any flow objective to be established, the State Water Board must consider and balance all competing uses of water in its decision-making. Recognizing that changes in existing conditions may alter the need for flow, and as our understanding of the Delta improves, the State Water Board intends to develop and establish the framework for adaptive management to review and modify flow criteria in the Delta that is responsive to scientific

advances, changing environmental conditions including climate change, and changes in conveyance and water operations.

E. Prepare California for hotter and drier conditions and improve water storage capacity

In November 2014, California voters passed Proposition 1: the Water Quality, Supply, and Infrastructure Improvement Act of 2014. The Act allocated \$2.7 billion to the California Water Commission (CWC) to fund the public benefits associated with water storage projects, which include ecosystem improvements, water quality improvements, flood control, emergency response, and recreation. The CWC is implementing the requirements of the Act through the Water Storage Investment Program (WSIP). The projects funded through the WSIP must improve operations of the State water system, be cost effective, provide a net improvement in ecosystem and water quality conditions, and provide measurable benefits to the Delta ecosystem or its tributaries. WSIP will be developed and implemented in accordance with Executive Order B-30-15 and special consideration will be given to actions that build climate preparedness and reduce GHG emissions, take flexible and adaptive approaches for uncertain climate impacts, protect the State’s most vulnerable populations, and consider natural infrastructure solutions. Box WS-1 provides an example of a storage project that could be partially funded through WSIP and how the project’s benefits change as the climate changes.



Water quality standards adopted by the State and Regional Water Boards are the foundation of municipal and industrial permits that protect and restore the chemical, physical, and biological integrity of the State’s surface and ground waters. Hotter and drier conditions with climate change are expected to affect water quality in many ways, and the Water Boards will continue implementing

adaptive strategies to ensure continued efficacy of regulatory programs to achieve and maintain compliance with water quality objectives for continued protection of beneficial uses. For example, critically low stream flows are noted more often in the State’s inland surface waters due to drought conditions; in the past, the Water Board regulatory permits may have allowed for dilution

Box #WS-1 North of Delta Offstream Storage Project

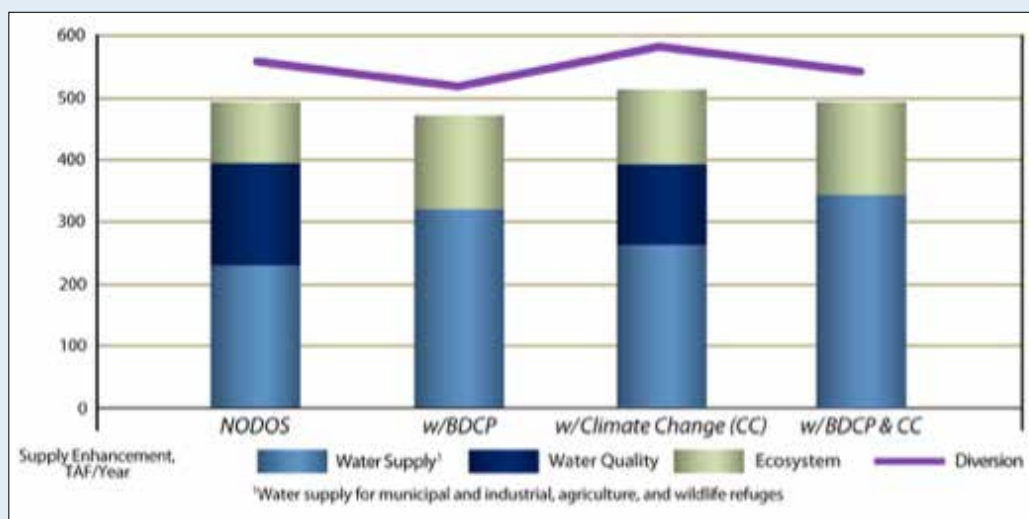
The North of Delta Offstream Storage (NODOS) investigation evaluated the performance of a surface storage reservoir located in Sites, California, about 10 miles west of the Sacramento River. Water would be pumped into the reservoir from various sources when excess flows are available and would be released from storage when additional water is needed. The project was evaluated with potential alternative futures, including four climate change scenarios and three Bay Delta Conservation Plan (BDCP) conveyance and operations scenarios. In 2015, the BDCP was transitioned and reconfigured and is now known as the California WaterFix. While the operations of NODOS were modified to

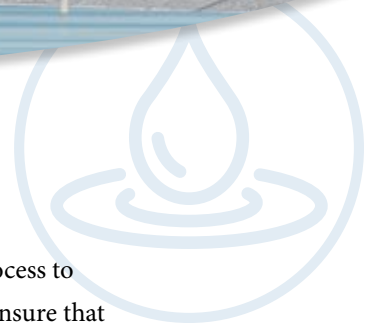
accommodate alternative futures, sensitivity studies indicate that NODOS performance would be resilient.

Figure #WC-3 shows a comparison of NODOS performance with alternative futures. For example, water diversion to fill NODOS would be reduced by 7 percent with BDCP, increased

by 4 percent with climate change and sea level rise, and decreased by 3 percent with both climate change and BDCP. NODOS water quality actions would not be needed with the BDCP scenarios because BDCP would provide significant water quality improvements with its north Delta diversion location. With BDCP, NODOS water would be shifted for uses supporting restoration and increasing water supply reliability. Both water supply reliability and restoration benefits would be increased with each alternative future as compared to the No Action future. Total benefits would be decreased by 4 percent with BDCP, increased by 4 percent with climate change, and unchanged with both.

Figure #WS-3. NODOS Climate Change Resilience Analysis





credits, reducing the level of treatment needed by municipalities discharging community wastewater. To maintain existing water quality objectives in the same streams experiencing lower stream flows, the dilution credits may no longer be granted to inland wastewater effluent-dominated water bodies. Similarly, the water temperatures of our inland streams and rivers is increasing; warmer ambient water temperatures, with accompanying changes in pH, creates a more toxic condition for aquatic life with the same level of ammonia in the municipal wastewater discharge. Maintaining water quality objectives incentivizes communities to proceed with other compliance options to meet water quality requirements in these circumstances, such as recycling the treated wastewater, thus augmenting local water supplies.

Additionally, in 2013, the State Water Board adopted a statewide Aquifer Storage and Recovery permit. This permit allows water purveyors to store water of drinking water quality in a local aquifer (as allowed by a water rights permit). Examples of communities that have proceeded with aquifer storage and recovery projects to add another layer of resilience to local water supply include the cities of Roseville, Woodland, and Davis.

F. Address water-related impacts of climate change on vulnerable and disadvantaged populations and cultural resources

Vulnerable and disadvantaged populations and cultural resources face significant water-related impacts of climate change, as the 2012-2015 drought has shown (e.g., poor water quality, increased costs). DWR has taken a lead role

through the California Water Plan process to identify the key actions necessary to ensure that disadvantaged communities receive an equitable distribution of benefits from State processes and programs. Objective 13 of *California Water Plan Update 2013* includes multiple key actions necessary to ensure these communities receive equitable distribution of State resources.

In 2014, DWR published *Californians without Safe Drinking Water and Sanitation*, which looks more deeply into where Californians lacked safe drinking water and sanitation, the challenges those communities face, and the progress that has been made in the 10 years since the previous investigation of these conditions was conducted.

In 2015, the State awarded \$28 million, funded by the Greenhouse Gas Revolving Fund (proceeds from cap and trade allowance auctions), for water-energy-GHG grants.

More than \$22 million (80 percent) was given to disadvantaged communities.

The California Conservation Corps (CCC), which enrolls young men and women to complete public service conservation projects throughout the State, is a partner in providing “boots on the ground” to

DWR has taken a lead role through the the California Water Plan process to identify the key actions necessary to ensure that disadvantaged communities receive an equitable distribution of benefits from State processes and programs.



address water-related impacts of climate change on vulnerable and disadvantaged populations. CCC crews have engaged in climate-related projects including turf removal, irrigation retrofits, plumbing retrofits, erosion control on riverbanks, flood preparedness, and flood fighting.

The California Department of Public Health, Drinking Water Program was transferred to the State Water Board in July 2014, resulting in immediate benefits as the drought emergency has unfolded, especially for disadvantaged communities. For example, the transfer has enabled the State Water Board, through the coordinated efforts of its Division of Water Rights and Division of Drinking Water, to get more accurate assessments of actual disadvantaged community water supply conditions. This enabled its Division of Financial Assistance to more effectively fund new wells, interties, and emergency drinking water supplies for dozens of communities with failing water systems during the drought. Within the State Water Board, the new Division of Drinking Water has instituted many programs that are designed to improve the drinking water systems that serve disadvantaged communities. Its small water system plan has targeted 183 small public water systems, many of which are disadvantaged, that are in violation of one or more drinking water maximum contaminant levels for aggressive enforcement action to bring them into compliance. These efforts also include directing these systems to the State Water Board's funding programs to get the funding they need to correct the system deficiencies that prevent them from providing

water to their customers that meets current water quality standards. Proposition 1, as well as the State Revolving Fund Program, provides both low interest loan and grant agreements for planning and infrastructure improvement projects for these water systems. Legislation was signed by the Governor in 2015 to enable the State Water Board's Division of Drinking Water to encourage, as well as to legally mandate, consolidation of failing drinking water systems with larger public water systems with the capacity to absorb them. Funding is also provided from the State Water Board to enable these consolidations to be completed.

In 2015, the Division of Drinking Water issued a report to the Legislature titled *Safe Drinking Water Plan for California*, which addressed small and disadvantaged communities with a focus on water quality issues in drinking water supplies. Many of these drinking water quality issues may be resolved by development of new supplies or consolidation with larger water agencies.

Many of the management and funding efforts being made in the Division of Drinking Water are also being made for wastewater, water recycling, and storm water programs serving disadvantaged communities. In order to better serve the drinking water and wastewater needs of disadvantaged communities, the Office of Sustainable Water Solutions was established within the State Water Board's Division of Financial Assistance in March 2015 by Assembly Bill 92. Some of the key functions are to promote permanent and sustainable solutions to ensure effective and efficient provision of safe, clean, affordable, and



reliable drinking water and wastewater treatment services, focusing on addressing financial and technical assistance needs, fostering partnerships, and capacity-building in disadvantaged communities.

Through their primary mission, numerous Water Boards’ programs will help address water-related adaptation to climate change. For example, the general mission of the Water Boards’ Storm Water Program is to ensure that pollutants present in storm water are minimized through the use of effective best management practices at municipal, industrial, and construction sites. Also, many storm water best management practices result in enhanced percolation of storm water into groundwater aquifers that can serve as water supply sources. A permitting process under the National Pollutant Discharge Elimination System is used to regulate these activities and promote clean storm water discharges. Ensuring that the quality of storm water discharges meets appropriate water quality objectives, including those for the protection of human health, results in the protection of beneficial uses of the water supply including for municipal and domestic supply. Higher water quality in surface and groundwater supplies means reduced cost to treat water supplies prior to human use. Good implementation of the Storm Water Program will help address water-related impacts of climate change on vulnerable and disadvantaged communities.

G. Continue to mainstream climate considerations into water management

In addition to the actions described in this Safeguarding California plan that are already being implemented by DWR

to mainstream climate considerations into water management, DWR completed a three-year collaboration with the Climate Change Technical Advisory Group (CCTAG) as part of its Climate Action Plan: Phase II. The DWR Climate Action Plan: Phase II will provide DWR and the broader water sector with consistent, scalable, high quality technical climate change analysis

tools and resources based on the best available science. DWR empaneled the CCTAG, an external advisory group comprised of 14 experts in hydrology, climatology, engineering, local water resource management, groundwater, and law to discuss scientific tools and analytical methods for water resource assessments, and the practical constraints of climate change analysis faced by a State agency. This collaborative effort resulted in a report that provides CCTAG’s perspectives and guidance for several elements of climate change

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analysis including: model selection, downscaling, and extreme event and stress test evaluations. This guidance will provide a detailed decision framework and analysis tools for use by DWR program and project managers as well as inform the State's Fourth Climate Change Assessment. These tools will streamline and improve the quality and consistency of climate change analysis across State-level water resource analyses. DWR will also work with the science community, and local and regional water managers, to develop similar guidance and tools that can be applied across the wide range of needs for local and regional water management and planning.

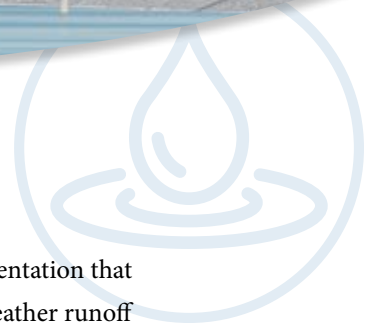
Several other State agencies have plans to use the information developed by DWR and CCTAG to improve, streamline, and standardize climate change analysis for their own purposes. The State Water Board, for example, is increasing climate change staff within the water quality and financial assistance divisions, and is working with Regional Water Boards to develop and implement a regional/State plan to address climate change. Streamlined permitting, and considerations for encouraging and supporting water conservation, groundwater replenishment (including storage and recovery), storm water capture, regionalization of water and wastewater treatment, and water recycling are included in State Water Board actions, increasing the water sector resilience and continued preparedness for adaptation to climate change.

The State Water Board is investing millions of dollars annually towards statewide water quality

data and information (via the Surface Water Ambient Monitoring Program – SWAMP – and the Groundwater Ambient Monitoring and Assessment – GAMA). Much of these data serve as the foundation and framework that is anticipated to be critical for adaptive management planning and implementation needed to adapt and respond to climate change stressors. Critical water management decisions are being informed by data collected through these programs, along with data from other, real-time sources now. One example is the use of integrated information on the www.baydeltalive.com website to inform water management decisions affecting millions of Californians. The investment in and use of systems like this is preparing us better for future water management decisions driven more and more by climate change-related stresses.

H. Utilize low-impact development and other methods in State and regional stormwater permits to restore the natural hydrograph

Low Impact Development (LID) is a sustainable practice that benefits water supply and contributes to water quality protection. Unlike traditional storm water management, which collects and conveys storm water runoff through storm drains, pipes, or other conveyances to a centralized storm water facility, LID takes a different approach by using site design and storm water management to maintain the site's pre-development runoff rates and volumes. The goal of LID is to mimic a site's predevelopment hydrology by using design techniques that infiltrate, filter, store, evaporate, and detain runoff close to the source of rainfall.



The State and Regional Water Boards recognize LID and green infrastructure as critical tools for climate adaptation at varying scales, from low-impact development in urban streetscapes to natural and living buffers against flooding and sea level rise. The State and Regional Water Boards incorporate requirements for LID and green infrastructure in their statewide and regional storm water permits, and dischargers have begun planning and implementing storm water projects that provide multiple benefits to the landscape and surrounding community.

In January 2016, the State Water Board adopted a Strategy to Optimize Resource Management of Storm Water (Storm Water Strategy) that identifies high priority statewide projects to promote storm water as a water resource, and address barriers such as lack of local funding and technical support. Through the newly-adopted Storm Water Strategy, the State and Regional Water Boards are continuing with a comprehensive funding and regulatory approach for storm water management that directly incorporates the ongoing adaptation needed to jointly address storm water management, water supply management, and flood management. The Storm Water Strategy works hand-in-hand with State and Regional Water Board-issued storm water permits implementing water quality requirements on local municipalities and industries.

All but one of the Water Boards' municipal separate storm sewer systems (MS4s) permits include requirements for LID and/or green infrastructure. More recently adopted permits

also include watershed-based implementation that contributes to storm water and dry weather runoff capture and infiltration within developed and undeveloped portions of the watershed. Regional Water Boards are incorporating a watershed storm water management approach and green infrastructure master planning that provides strong incentives for storm water and dry weather runoff capture across the jurisdictional watersheds.

The watershed-based regulatory approaches to storm water management is a comprehensive approach to municipal, commercial, and industrial storm water that incorporates requirements for LID and green infrastructure, and protects/restores the natural hydrograph, through local planning efforts. Examples

of local planning efforts include: (1) Green Infrastructure Plans in the San Francisco Bay region, (2) Watershed (and Enhanced Watershed) Management Plans in the Los Angeles region, (3) Water Quality Improvement Plans in the San Diego region, and (4) Total Maximum Daily Load (TMDL) Implementation Plans in the North Coast and Lahontan (Lake Tahoe) regions.

Municipalities statewide are leading the charge in addressing storm water quality issues using green

Municipalities statewide are leading the charge in addressing storm water quality issues using green infrastructure approaches that capture, treat, and infiltrate storm water runoff into local aquifers, and/or use storm water as a non-potable water supply.



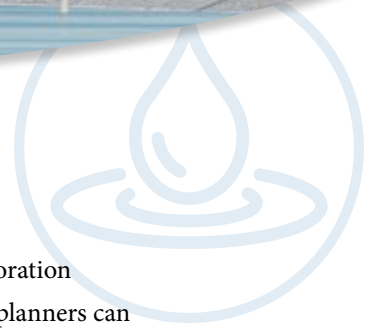
infrastructure approaches that capture, treat, and infiltrate storm water runoff into local aquifers, and/or use storm water as a non-potable water supply. Regional and local watershed planning efforts are incorporating drinking water, storm water, wastewater, and flood management seek to replicate natural hydrology and watershed processes by managing storm water and dry weather runoff onsite or within the watershed where rainfall occurs. In addition to flood control, these watershed-based approaches are a critical tool for climate adaptation, providing multiple tangible and intangible benefits to the water quality, landscape, and surrounding community, including:

- Supply of fresh water to local creeks and streams, enhancing stream flows to sustain aquatic life and wildlife habitat, and establishing a healthy hydrological-connection to local groundwater aquifers;
- Reduced pollutant loads discharged to surface waters;
- Attenuated flood waters and overall flood management;
- Recharge of groundwater aquifers through pervious urban or agricultural areas to support sustainable groundwater levels and increase local drinking and irrigation water supplies;
- Supply of fresh water to increase parks and recreational landscapes including walking, hiking, bird-watching, hunting, swimming, fishing, and boating;

- Harvesting and local landscape irrigation use of rainwater;
- Minimization of erosion, landslides, and/or destabilized land; and
- Reduction of unnatural alteration of natural drainage features of streams, rivers, wetlands, and lakes (also known as hydromodification).

The State Water Board has developed Proposition 1 Storm Water Grant Funding guidelines (See section I.C) with the goal of initiating grant awards for storm water projects in 2016 that best advance the goals of improving water quality and realizing multi-benefit storm water management projects, which may include green infrastructure, rainwater and storm water capture projects, and storm water treatment facilities. The State Water Board also established guidance for municipalities on how to fulfill the Water Code requirements, and accompanying State Water Board recommendations, for incorporating quantifiable metrics to properly evaluate and implement projects resulting in multiple benefits.

Lastly, through its issuance of a statewide storm water permit for the California Department of Transportation (Caltrans), the State Water Board allows Caltrans to comply with its water quality requirements through cooperative agreements with municipalities located adjacent to its right of way, and a Caltrans grants program that provides funds for the State Water Board to administer to municipalities for storm water management. The Caltrans has developed and is implementing



its Storm Water Program, which includes implementation of 10 years of planned projects that prioritize treatment and management of storm water entering the most pollutant-impaired surface water bodies

I. 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

State law requires demonstration of “adequate water supplies” for development, and there are extensive requirements for land use and water resource planning. Existing law also requires local government to work at a collaborative regional scale for reducing GHG emissions, and that such planning will benefit water management. Nonetheless, individual land use decisions may or may not result in sustainable development resilient to climate change. In keeping with their longstanding primary responsibility for land use planning and regulations, land use decisions at the city and county levels provide additional opportunities to reduce water consumption and GHG emissions through implementation of more sustainable land use policies, siting, and design techniques.

Cities and counties, with their existing land use authority, have primary responsibility for land use planning and regulation in California. Land use planners consider water throughout the local land use planning process, and water is a critical element in adopting sustainable land

use planning policies. Stronger collaboration between land use planners and water planners can promote more sustainable land use patterns and greater integration of water and wastewater management into local land use plans. When planned and implemented correctly, integrated regional and local water management aligns flood and storm water management, drinking and irrigation water supply, water quality protection, and groundwater management, and contributes to successful adaptation that robustly supports local government land use and growth policies, while focusing to minimize increased greenhouse gas emissions due to increased pumping and treatment facilities.

State agencies are working to align land use and water planning through multiple programs. For example:

- Objective 15 of California Water Plan Update 2013 is to “Strengthen Alignment of Land Use Planning and Integrated Water Management.” Objective 15 identifies multiple actions to be taken by the State Legislature, State agencies, local governments, and regional planning agencies that will improve integration between: water managers and planners and land use planners and decision makers.

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- DWR and Sonoma State University’s Center for Sustainable Communities have developed an integrated water and land management tool capable of specifying different residential land cover and infrastructure choices, and comparing development outcomes. The tool examines the costs and benefits associated with land use projects using compact, integrated water management, and low-impact development technologies. For climate change analyses, the tool can be used to calculate the GHG intensity of water supplies and to help identify land use strategies that reduce water use.
- The State and Regional Water Boards continue to integrate statewide and regional policies, plans, and permits to incentivize: (1) the unification of planning efforts for drinking water, storm water, and wastewater with local land-use and climate change planning efforts, and (2) regionalization of local utilities to address regional water and land-use objectives and goals.
- The Governor’s Office of Planning and Research (OPR) is currently updating and overhauling the General Plan Guidelines. A General Plan is the local government’s long-term blueprint for the community’s vision of future growth. OPR is responsible for updating the General Plan Guidelines – the “how to” resource for drafting a general plan. OPR also monitors general plan implementation with annual progress reports from cities and counties, and grants general plan extensions for qualified cities and counties. The new General Plan Guidelines will include

resources, data, tools, and model policies to help cities and counties update their general plans, and has been informed by extensive outreach and collaboration. Information on integrating water resource planning and land use planning will be one of the major additions to this update of the General Plan Guidelines.



J. Protect and restore water resources for important ecosystems

Following Governor Brown’s announcement on April 30, 2015, regarding modifying the permit strategy for the Bay-Delta Conservation Plan, and creating two new programs known as the California WaterFix and California EcoRestore, the DWR EcoRestore Program was established. California EcoRestore is a California Natural Resources Agency initiative to help coordinate and advance at least 30,000 acres of critical habitat restoration in the Delta during the next four years. Driven by world-class science and guided by adaptive management, California EcoRestore, working through new and existing programs, will pursue habitat restoration projects to address aquatic and terrestrial ecosystem needs in order to improve the overall health of the Delta.

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California EcoRestore aims to address legacy impacts, such as invasive species in the Delta and the effects from the ongoing operation of the State and federal water projects, and strengthen and protect ecosystems in the face of climate change. More than 10 percent of the 30,000-acre goal will be focused on creating managed wetlands for subsidence reversal, and on carbon management to address impacts of climate change. Many of the individual projects implemented under California EcoRestore will include aspects to improve the Delta's resilience to changing climate impacts. For example, tidal habitat restoration makes up nearly one-third of the habitat restoration goal. That includes creating a wide upland transition area to provide refuge for wetland animals during high tides, which are predicted to increase with climate change, and opportunities for wetland migration upslope in response to sea level rise. The enhancement of floodplains and improved floodplain connections to rivers will restore the ability of floodplains to absorb flood flows and provide a reservoir of water to help aquatic species withstand droughts. The DWR EcoRestore program, which will be the department's primary connection to California EcoRestore, was established to provide the department with a centralized location for coordination, communication, and integration of all habitat restoration planning and implementation efforts. Many of the department's programs have landscape overlap, especially those within the Delta, which offers the opportunity for increased alignment in order to maximize the value of the monetary investment and the environmental

benefit. This new program is focused on improving efficiency and streamlining the process for utilizing resources, approving land acquisition, resolving issues and developing policy, coordinating unified communication and outreach efforts, and tracking the progress of habitat restoration projects.

The State Water Board is in the process of developing and implementing updates to the Bay-Delta Plan and flow objectives for priority tributaries to the Delta to protect beneficial uses in the Bay-Delta watershed through the following phases:

- Phase 1 involves updating San Joaquin River flow and southern Delta water quality requirements included in the Bay-Delta Plan. The State Water Board hearing to consider adoption of changes to the Bay-Delta Plan and certification of Final Substitute Environmental Document is anticipated for summer 2016.
- Phase 2 involves other comprehensive changes to the Bay-Delta Plan to protect beneficial uses not addressed in Phase 1 (Delta outflows, Sacramento River inflows, Suisun Marsh salinity, Delta Cross Channel Gate closure, export limits, reverse flows). This phase is scheduled to be completed by early 2018.
- Phase 3 involves changes to water rights and other measures to implement changes to the Bay-Delta Plan from Phases 1 and 2.
- Phase 4 involves developing and implementing flow objectives for priority Delta tributaries outside of the Bay-Delta Plan updates. This phase will be ongoing.



K. Better understand climate risks to California water and develop tools to support efforts to prepare for climate risks

California is a national and international leader in improving scientific understanding of the causes, impacts, and risks of climate change on water resources. The State also leads in developing tools and resources for managers and planners to prepare for climate risks and their impacts. California State agencies and commissions have independently, and in partnership with the research community, local agencies, and federal agencies, developed a wide range of tools and resources that support climate preparedness and reduce GHG emissions from new supply, treatment, and conveyance system infrastructure.

At the highest level, *California Water Plan Update 2013* provides an in-depth analysis of the climate change risks in the Central Valley (Sacramento, San Joaquin, and Tulare Lake basins³). More than 200 scenarios of land use, population, and climate change were evaluated to explore the range of uncertainty in future conditions. For each scenario, a range of system performance metrics (e.g., urban supply reliability, agricultural supply reliability, unmet environmental demand) was calculated. Those performance metrics provide a range of potential impacts to different water uses resulting from expected changes in land use, population, and climate. Implementation of a range of resource management strategy packages was also evaluated to identify which strategies would be most robust for addressing impacts across the range of future

scenarios—providing a high-level starting point for more detailed investigations of adaptation strategies.

California also continues to invest in tools that support efforts by planners, professionals, and the public to prepare for climate risks in the water sector. Cal-Adapt.org is undergoing updates that integrate new modeling and science to show more accurate projections for precipitation and snowpack. Innovative new tools such as DataBasin are being integrated into resource planning processes for information sharing and decision-making allowing increased transparency and public participation in areas such as watershed policy.

The California Public Utilities Commission is developing a tool to identify the cost effectiveness of water energy projects. In 2015, the CPUC adopted the Water-Energy Calculator and the Avoided Water Capacity Cost Model that will allow better quantifying of the benefits from reduced water use.

California is a national and international leader in improving scientific understanding of the causes, impacts, and risks of climate change on water resources.

The following studies, carried out since the publication of *Safeguarding California*, show the continued broad-based effort to better understand climate impacts:

California Climate Science and Data for Water Resources Management Brochure (2015). This brochure, developed by DWR, is a concise

³ <http://www.waterplan.water.ca.gov/cwpu2013/index.cfm>



and comprehensive overview of observed and projected impacts of climate change on the State’s water sector, regionally-specific impacts and strategies, and water-energy information.

Paleohydrology Study: Klamath/San Joaquin/Sacramento Hydroclimatic Reconstructions from Tree Rings (2014). DWR commissioned the University of Arizona to provide hydroclimate reconstructions, using updated tree-ring chronologies from the Klamath, San Joaquin and Sacramento River basins. The report allows assessment of hydrologic variability over centuries to millennia, gives historical context for assessing recent droughts, and can be used in climate change research, analysis, and planning.

Through the actions of DWR, the State Water Board, and others, the State of California has made significant progress toward safeguarding the

water sector; however, substantial additional steps remain. Indeed, because California’s water sector is exposed to some of the most difficult challenges of climate change, improvements and innovations to implement state of the art technologies with reduced GHG emissions will need to be continuously made. Many actions are already being planned and developed.

The State makes every effort to publicly post all new research and studies so that local agencies may benefit from the information they contain. For example, DWR maintains webpages that highlight climate change publications⁴ and resources specific to local and regional resources.⁵ Cal-Adapt.org also has a page that features a number of resources and publications on climate change impacts and adaptation.⁶

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Next Steps and Future Actions

The California Water Action Plan (CWAP) is a roadmap for water management during the Brown administration, and the Safeguarding Water Implementation Plan will guide the State in its climate adaptation management actions, as identified in the CWAP.

Improving Statewide Flood Management:

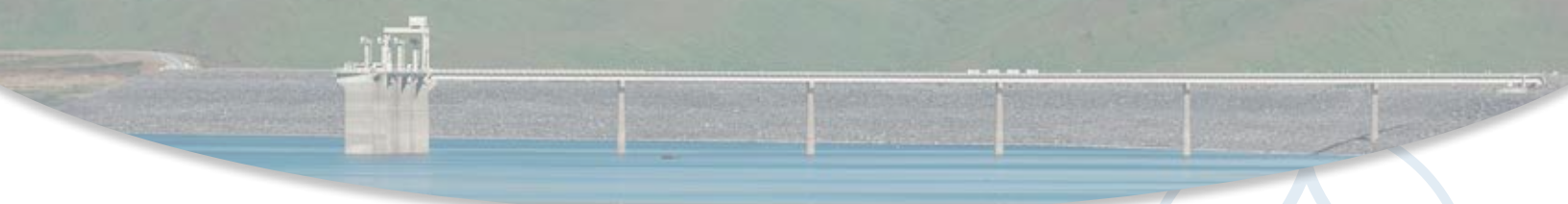
DWR’s Statewide Flood Management Planning Program is developing a flood investment strategy. The investment strategy will address flood risk management in the context of integrated water

management. It will include an inventory of planned projects statewide, and recommendations for State investments using an outcome based framework for effectiveness. The recommendations consider existing and changed conditions including identifying:

⁴ http://www.water.ca.gov/climatechange/pub_video.cfm

⁵ <http://www.water.ca.gov/climatechange/resources.cfm>.

⁶ <http://cal-adapt.org/resources/>



- Local, State, and federal agency proposed flood management project needs.
- Potential management actions to address flood risk and climate change to balance risk and reward on floodplains.
- How climate change and sea-level rise affect flood risk, and how flood risk is understood by the public.

Incentivizing Integrated Regional and Multiple-Benefit Projects: The State Water Board highly encourages projects that provide regionalized utilities and provide multiple benefit – tangible quantifiable water treatment/supply and flood management benefits, economy-of-scale benefits, and intangible, at-times unmeasurable community benefits – that utilize storm water as a resource. (See section I.H for further information on the State Water Board’s Storm Water Strategy). The Storm Water Strategy is intended to guide the Storm Water Program for at least the next ten years, and climate change adaptation is one of the key principles throughout the Strategy.

Improvements to Economic Analysis to Consider a Broader Accounting of Costs and Benefits: The DWR Economic Analysis Section is planning to update its Economic Analysis Guidebook. Updates will include recent developments in theory and practice, State and federal regulations and directives, new methods of economic modeling and analyses, valuation of ecosystem services, and sustainability indicators and metrics. These changes are intended to improve economic analysis within DWR in light of recent developments in methodologies and State

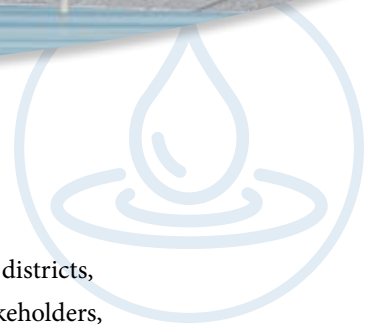
directives, including the Governor’s recent Executive Order B-30-15 that mandates State agencies take climate change into account and employ the Full Life Cycle Cost Accounting method in planning and investment decisions. As a result, the updates will incorporate a full life cycle accounting of costs in economic analysis in consideration of climate change impacts.

Improved Reporting of Current Hydroclimate Conditions and Trends: Starting in 2016 and annually thereafter, the State Climatologist’s Office will publish a hydroclimate bulletin that presents a broad range of climate-related metrics, focusing on indicators important to the water sector. The indicators will be

presented and discussed in relation to the historical record. The bulletin will discuss and analyze the recent water year in detail, calling out significant events and characteristics of the year in relation to the historical record. The bulletin will also discuss climate signal detection, data sources and gaps, and potential for future sampling networks to improve knowledge of the climate.

DWR Climate Action Plan–Phase III Vulnerability Assessment and Adaptation Plan: DWR is currently working on a detailed climate change vulnerability assessment and adaptation

Starting in 2016 and annually thereafter, the State Climatologist’s Office will publish a hydroclimate bulletin that presents a broad range of climate-related metrics, focusing on indicators important to the water sector.



plan for state owned and operated assets. Using several new quantitative tools that draw on the latest research and science, DWR will identify the activities and assets it controls that face the greatest climate change threats and the adaptation strategies that can be employed to minimize or mitigate those threats. As part of the vulnerability assessment and adaptation plan, DWR worked with researchers at the University of Massachusetts to employ a new approach to climate change analysis called “decision scaling” that allows DWR to explore a very wide range of future conditions and the specific risks posed by California’s uncertain future. DWR will publish the results of this cutting edge climate change analysis in 2016. <http://www.water.ca.gov/climatechange/CAP.cfm>

Decision Scaling Analysis of Climate Change

Impacts on California: DWR Vulnerability Assessment and Adaptation Plan. In 2014, DWR began working with researchers at the University of Massachusetts who were pioneering a new approach to climate change analysis. The approach focuses on system evaluation to identify key thresholds of vulnerability and then uses information from global climate models to evaluate the likelihood of future conditions that would exceed those vulnerability thresholds. DWR will publish the results of this cutting edge climate change analysis procedure as part of its vulnerability assessment in 2016.

Improve Operation of Integrated Water Supply and Flood Protection Systems to Provide

Increased Benefits: DWR is conducting a system reoperation study (SRS) in cooperation with other

State and federal agencies, local water districts, groundwater managers, and other stakeholders, to identify potential strategies for reoperation of the statewide flood protection and water supply systems. DWR is developing the SRS to identify viable reoperation strategies and understand how integrated management can:

- Improve the reliability of municipal and irrigation water supply.
- Reduce flood hazards.
- Restore and protect ecosystem function and habitat conditions.
- Buffer the hydrologic variations expected from climate change.
- Improve water quality.

In 2014, DWR began working with researchers at the University of Massachusetts who were pioneering a new approach to climate change analysis.

California’s water supply and flood management infrastructure, including Federal, State, and locally owned systems, is physically interconnected to the extent that it is technically feasible to move water around the system from Trinity County in the north to Imperial County in the south. But, the management of the water system may not be as well integrated as it could be. The underlying logic of the SRS is that California can do more with its existing water infrastructure by taking advantage of the physical interconnections (and enhancing them) while also operating the system in a coordinated manner to optimize the benefits.



The SRS will evaluate how potential reoperation strategies perform across potential future climate scenarios ranging from warmer and wetter, to much hotter and dryer. The information from this climate change sensitivity analysis will be used to provide an analytical indicator of the potential resiliency of system reoperation strategies to the effects of climate change.

Improve Quantitative Vulnerability Assessments of State Owned/Operated Infrastructure: For water related infrastructure such as the State Water Project, climate change impact analysis can provide local water agencies with important information that they can use to help plan for their water supplies. A number of improved methodologies and tools exist for improved impact and vulnerability analysis. The State will move forward with advanced vulnerability assessments for priority water related infrastructure.

Urban Water System Resilience Model. The California Public Utilities Commission (CPUC) will encourage the development of a new urban water resiliency modeling tool that assess water system capabilities resiliency metrics such as the ability to respond to, adapt to, or recover from a disturbance. Leveraging work done in the electric and gas sector, the CPUC will work with partners such as the National Association of Regulatory Utilities Commissioners, the U.S. Department of Energy’s Office of Electricity Delivery and Energy Reliability, and academic institutions to expand, transform, and integrate existing climate, energy, and water models. A new water resilience modeling platform will allow utilities

and stakeholders to evaluate the performance of proposed system changes to a variety of climate scenarios.

Some of the key features in a resiliency modeling platform include:

- Incorporation of water system vulnerabilities to climate risks.
- Incorporation of probability distributions of climate events.
- Real time infrastructure status updates—approaching full-system awareness
- Evaluation of the interaction of event uncertainties.
- Capability to assess the conditional impact of events.
- Capability to assess the conditional cost of events.
- Comparison of proposed adaptation portfolios.

State Water Resources Control Board Staff. The State Water Board has been provided California Air Resources Board (CARB) funding for two staff positions to work on greenhouse gas emissions reductions; to date one staff has been hired and works at the State Water Board. The second staff position was loaned to CPUC to develop a tool for evaluating the cost effectiveness of water energy projects. The staff position has been filled and the staff will be moved to a permanent position at the CPUC. With the additional staff position, the State Water Board will focus on incorporating



climate considerations into State and Regional Water Board policies, plans and permits while concurrently addressing water supply and water quality protection needs. The Water Boards will also continue its re will be increased capacity to work with academics, other State agencies, and other stakeholders to expand Water-Energy technologies, and incorporate climate change considerations (including reduction of GHG emissions) into water management regulatory and funding actions. Ultimately, the CARB-funded position for greenhouse gas emissions reductions will be moved to the State Water Board, Division of Financial Assistance to ensure State funding investments contribute to California's need to address climate change.

The State and Regional Water Boards will continue to focus on water conservation, water use efficiency, recycled water, storm water capture and use, water recycling, and gray water use, all of which are climate resiliency tools to adapt to California's uncertain hydrologic future.

Strategy to incorporate climate change

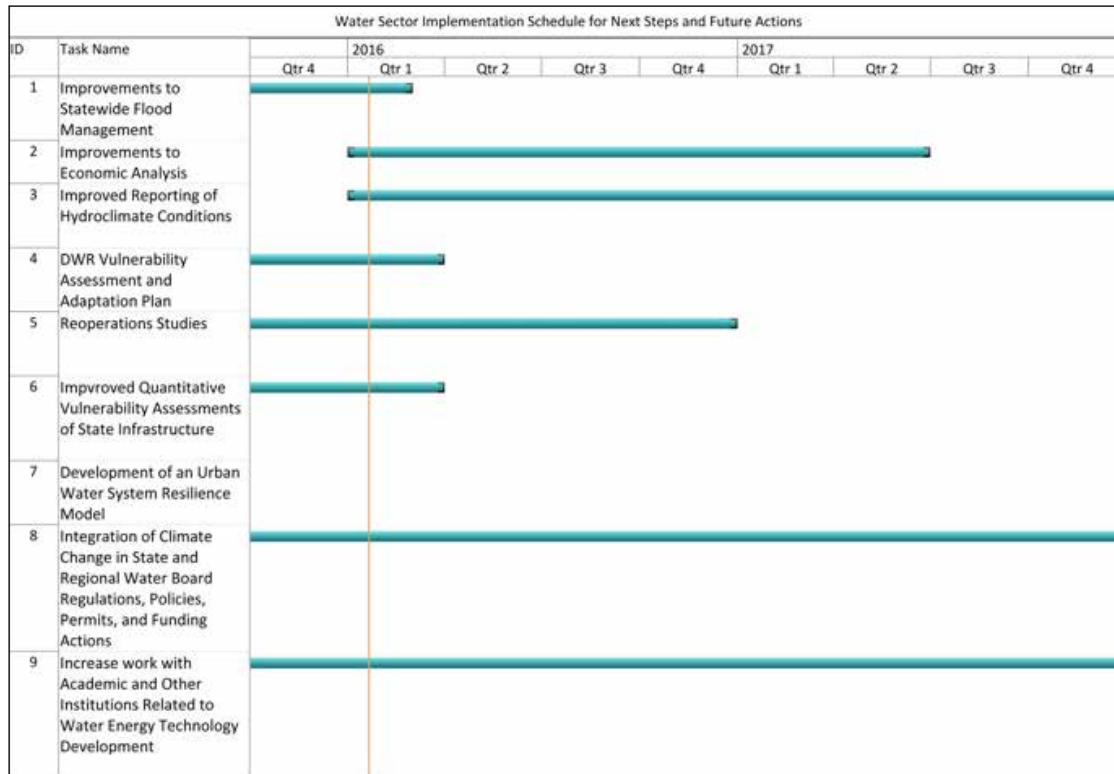
considerations: An effort is underway for the State Water Board to incorporate climate change considerations consistently throughout the organization, each division, office, and the nine Regional Boards. In 2016, the State Water Board will consider the adoption of a resolution outlining its actions and priorities to address climate change over the next few years.

Bay-Delta Water Quality Control Plan. The State Water Board will complete its update of the Water Quality Control Plan for the Delta and its upstream watersheds. New resources were allocated to this effort in the FY 2015-16 budget. The Board will complete planning activities in the San Joaquin Basin and the southern Delta in 2016. Delta outflow and other flow-related Delta standards will be updated by spring 2018. The Water Board's action will balance competing uses of water including municipal and agricultural supply, hydropower, fishery protection, recreation, and other uses



A. TIMELINE FOR IMPLEMENTATION OF EXPANDED AND NEW INITIATIVES

Figure #WC-4 Water Sector Implementation Schedule for Next Steps and Future Actions





Monitoring and Evaluation

A

METRICS FOR EVALUATION

Measuring climate resilience in the water sector, like in other sectors, is complex. Resilience will take on different characteristics for different aspects of the water sector (e.g., wastewater, urban water supply, environmental streamflows) and in different areas of the State impacts and therefore resilience characteristics will differ.

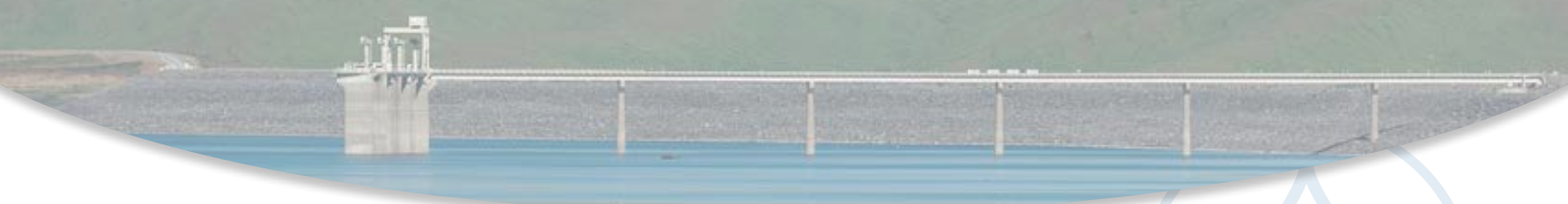
Work has begun on developing sustainability indicators for water resources (California Water Sustainability Indicators Framework, 2011). These sustainability indicators could be used as a starting point for development of monitoring and evaluation metrics for climate change resilience. Work on these sustainability indicators highlighted that there was no shortage of potential indicators of sustainability. More than 100 indicators were suggested and explored as part of the California Water Plan Water Sustainability Indicators Project (<http://indicators.ucdavis.edu/water/indicators>). Indicators included such metrics as:

- **Water Scarcity Index:** Water scarcity is a function of water availability and water use.
- **Abundance of Key Non-Native Species:** Relative abundance of key non-native species, for example Brazilian waterweed (*Egeria densa*) and water hyacinth (*Eichhornia crassipes*), and harmful invasive species such as *Microcystis aeruginosa* and other harmful algal blooms.
- **Managed Geomorphic Flows:** Magnitude and timing of managed system flows suitable

for native riparian habitats and geomorphic processes.

- **Water Footprint:** the sum of the water used directly or indirectly to produce goods and services consumed by humanity. Agricultural production accounts for most of global water use, but drinking, manufacturing, cooking, recreation, washing, cleaning, landscaping, cooling, and processing all contribute to water use.
- **Levee Stability:** Frequency of levee breaks in the region.

The abundance of indicators notwithstanding, data upon which to measure historical and/or current conditions is often lacking, of low quality, or inconsistent. Thus, developing evaluation metrics for the water sector may involve a significant new monitoring and baselining effort before progress can begin to be measured. To this end the Water Board SWAMP program (http://www.waterboards.ca.gov/water_issues/programs/swamp/) is working with the Office of Environmental Health Hazard Assessment (OEHHA) to not only build up baseline and trend datasets but to optimize the indicators needed to inform decisions



anticipated on the five, ten and twenty year planning horizon: <http://oehha.ca.gov/multimedia/epic/2013EnvIndicatorReport.html>

B. IDENTIFY OTHER NEEDED TECHNICAL ADVICE

DWR, CPUC, the State and Regional Water Boards, and other State agencies have done a tremendous amount of work to investigate, analyze, and describe potential impacts of climate change on the water sector. But, much work remains to be done to prepare California for the future impacts of a changing climate. The State has limited authority and finite resources for analyzing, planning, and implementing adaptation and resiliency strategies for the water sector—most water resources are managed by local governments and agencies. Many local water managers have yet

to begin analyzing and planning for impacts of climate change on their specific watersheds and water systems. Additional tools, resources, and incentives for local agencies are needed to increase the level of planning, facility design and facility operation for climate change and greenhouse gas impacts by local resource managers. While many resources already exist such as those described in Section I-K, as well as in other sections of this implementation plan, there remains a tremendous need at the local and regional level for technical assistance to conduct analysis and adaptation planning that considers the specific impacts, constraints, and opportunities of the local region and the specific resource management agency

Appendices



AGRICULTURAL SECTOR PLAN



BIODIVERSITY AND HABITAT SECTOR PLAN



EMERGENCY MANAGEMENT SECTOR PLAN



ENERGY SECTOR PLAN



FORESTRY SECTOR PLAN



LAND USE AND COMMUNITY
DEVELOPMENT SECTOR PLAN



OCEANS AND COASTAL RESOURCES
AND ECOSYSTEMS SECTOR PLAN



PUBLIC HEALTH SECTOR PLAN



TRANSPORTATION SECTOR PLAN



WATER SECTOR PLAN



Appendices

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Executive Order B-30-15 by Office of Edmund G. Brown Jr.

WHEREAS climate change poses an ever-growing threat to the well-being, public health, natural resources, economy, and the environment of California, including loss of snowpack, drought, sea level rise, more frequent and intense wildfires, heat waves, more severe smog, and harm to natural and working lands, and these effects are already being felt in the state; and

WHEREAS the Intergovernmental Panel on Climate Change concluded in its Fifth Assessment Report, issued in 2014, that “warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia” and that “continued emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems;” and

WHEREAS projections of climate change show that, even under the best-case scenario for global emission reductions, additional climate change impacts are inevitable, and these impacts pose tremendous risks to the state’s people, agriculture, economy, infrastructure and the environment; and

WHEREAS climate change will disproportionately affect the state’s most vulnerable citizens; and

WHEREAS building on decades of successful actions to reduce pollution and increase energy efficiency the California Global Warming Solutions Act of 2006 placed California at the forefront of

global and national efforts to reduce the threat of climate change; and

WHEREAS the Intergovernmental Panel on Climate Change has identified limiting global warming to 2 degrees Celsius or less by 2050 as necessary to avoid potentially catastrophic climate change impacts, and remaining below this threshold requires accelerated reductions of greenhouse gas emissions; and

WHEREAS California has established greenhouse gas emission reduction targets to reduce greenhouse gas emissions to 1990 levels by 2020 and further reduce such emissions to 80 percent below 1990 levels by 2050; and

WHEREAS setting an interim target of emission reductions for 2030 is necessary to guide regulatory policy and investments in California in the midterm, and put California on the most cost-effective path for long term emission reductions; and

WHEREAS all agencies with jurisdiction over sources of greenhouse gas emissions will need to continue to develop and implement emissions reduction programs to reach the state’s 2050 target and attain a level of emissions necessary to avoid dangerous climate change; and

WHEREAS taking climate change into account in planning and decision making will help the state make more informed decisions and avoid high costs in the future.



NOW, THEREFORE, I, EDMUND G. BROWN JR., Governor of the State of California, in accordance with the authority vested in me by the Constitution and statutes of the State of California, in particular Government Code sections 8567 and 8571 of the California Government Code, do hereby issue this Executive Order, effective immediately

IT IS HEREBY ORDERED THAT:

1. A new interim statewide greenhouse gas emission reduction target to reduce greenhouse gas emissions to 40 percent below 1990 levels by 2030 is established in order to ensure California meets its target of reducing greenhouse gas emissions to 80 percent below 1990 levels by 2050.
2. All state agencies with jurisdiction over sources of greenhouse gas emissions shall implement measures, pursuant to statutory authority, to achieve reductions of greenhouse gas emissions to meet the 2030 and 2050 greenhouse gas emissions reductions targets.
3. The California Air Resources Board shall update the Climate Change Scoping Plan to express the 2030 target in terms of million metric tons of carbon dioxide equivalent.
4. The California Natural Resources Agency shall update every three years the state's climate adaptation strategy, Safeguarding California, and ensure that its provisions are fully implemented. The Safeguarding California plan will:
 - Identify vulnerabilities to climate change by sector and regions, including, at a minimum, the following sectors: water, energy, transportation, public health, agriculture, emergency services, forestry, biodiversity and habitat, and ocean and coastal resources;
 - Outline primary risks to residents, property, communities and natural systems from these vulnerabilities, and identify priority actions needed to reduce these risks; and
 - Identify a lead agency or group of agencies to lead adaptation efforts in each sector.
5. Each sector lead will be responsible to:
 - Prepare an implementation plan by September 2015 to outline the actions that will be taken as identified in Safeguarding California, and
 - Report back to the California Natural Resources Agency by June 2016 on actions taken.
6. State agencies shall take climate change into account in their planning and investment decisions, and employ full life-cycle cost accounting to evaluate and compare infrastructure investments and alternatives.
7. State agencies' planning and investment shall be guided by the following principles
 - Priority should be given to actions that both build climate preparedness and reduce greenhouse gas emissions;



- Where possible, flexible and adaptive approaches should be taken to prepare for uncertain climate impacts;
 - Actions should protect the state’s most vulnerable populations; and
 - Natural infrastructure solutions should be prioritized.
8. The state’s Five-Year Infrastructure Plan will take current and future climate change impacts into account in all infrastructure projects
9. The Governor’s Office of Planning and Research will establish a technical, advisory group to help state agencies incorporate climate change impacts into planning and investment decisions.
10. The state will continue its rigorous climate change research program focused on

understanding the impacts of climate change and how best to prepare and adapt to such impacts.

This Executive Order is not intended to create, and does not, create any rights or benefits, whether substantive or procedural, enforceable at law or in equity, against the State of California, its agencies, departments, entities, officers, employees, or any other person.

I FURTHER DIRECT that as soon as hereafter possible, this Order be filed in the Office of the Secretary of State and that widespread publicity and notice be given to this Order.

IN WITNESS WHEREOF I have hereunto set my hand and caused the Great Seal of the State of California to be affixed this 29th day of April 2015.



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Land Use and Community Development

APPENDIX A: CURRENT ACTIONS

Coordinate Planning, Policy, Requirements and Regulations

AGENCY	ACTIONS
OPR	<ul style="list-style-type: none"> Continue preparation of the Environmental Goals and Policy Report. The EGPR will provide an overview of the state’s environmental goals, keys steps to achieving these goals, and develop a framework of metrics and indicators to help inform decision making, at all levels, to help track progress toward reaching these goals <p>Timing: 2015-2016 Priority: High</p>
OPR	<ul style="list-style-type: none"> Continue preparation of the General Plan Guidelines. The Governor’s Office of Planning and Research has been engaged in a thorough update of the General Plan Guidelines (GPG). The new GPG will include resources, data, tools, and model policies to help cities and counties update their general plans, and has been informed by extensive outreach and collaboration. <p>Timing: 2015-2016 Priority: High</p>
HCD	<ul style="list-style-type: none"> Continue preparation of the State Housing Plan. The plan will include a housing needs assessment and policy framework with activities such as climate change, housing conditions, efficiency and growth priorities <p>Timing: 2015-2016 Priority: Medium</p>
HCD	<ul style="list-style-type: none"> Continue the review of housing elements of the general plan and preparation of the regional housing needs assessments. The housing element generally contains a Housing needs assessment, including projected needs (RHNA), inventory of resources and constraints and a detailed action plan. <p>Timing: Ongoing Priority: Medium</p>
HCD	<ul style="list-style-type: none"> Continue implementation of State Housing Law: Cal Green and Building Standards. The State Housing Law (SHL) Program was established to assure the availability of affordable housing and uniform statewide code enforcement; to protect the health, safety, and general welfare of the public and occupants of housing and buildings accessory thereto. To fulfill this obligation the SHL Program may propose building standards, to implement legislation as regulations. The program has limited oversight authority of the day- to- day application of state laws, regulations, and code enforcement by a city, county, city and county building, housing, health, and fire department or fire district. <p>Timing: Tri-annually and Intervening Years Priority: High</p>



Improve Alignment of Existing Programs and Investments

AGENCY	ACTIONS
OPR and HCD	<ul style="list-style-type: none"> Implement awards from the National Disaster Resiliency Competition. Grants to be awarded to Tuolumne County and other partners to implement a resiliency and sustainability pilot program for forested watershed areas at risk of catastrophic wildfire. <p>Timing: 2015-2016 Priority: High</p>
HCD and SGC	<ul style="list-style-type: none"> Continue utilization of existing funding to promote environmental related goals such as infill, sustainability and climate change. Programs include the Affordable Housing and Sustainable Communities, Community Development Block Grant, Dry Well Relocation, Drought Related Rental Assistance, Housing Related Parks, Multifamily Housing Program and Infill Infrastructure Grant Program <p>Timing: Annually Priority: Medium</p>

Enhance Outreach, Capacity, Implementation and Outcomes

AGENCY	ACTIONS
OPR, CalFire, DWR and HCD	<ul style="list-style-type: none"> Track general plan updates associated with housing element updates. Various mandates to update general plan are tied to the housing element law schedule. For example, the land use element must be updated for disadvantaged communities. Other topics include flood and fire. The 5th cycle updates of the housing element are approaching completion which means so should the other general plan amendments. <p>Timing: 2015-2016 Priority: High</p>
HCD	<ul style="list-style-type: none"> Expand role in implementation of the housing element. HCD will be starting up efforts on the implementation of housing elements, including improved reporting and data, rezoning of higher density sites and expanded outreach and assistance to local governments/ <p>Timing: 2015-2019 Priority: Medium</p>
OPR, HCD	<ul style="list-style-type: none"> Explore various models and strategies to expand local planning and implementation capacity including CIVIC Spark <p>Timing: 2016 Priority: High</p>
OPR, SGC, HCD	<ul style="list-style-type: none"> Improve Regional Collaboration through approaches such as ARCCA. Through the development of the NDRC application, HCD, OPR, CalEPA, CalFIRE and Tuolumne County are engaging the regional resiliency and climate action collaboratives <p>Timing: 2015-2018 Priority: High</p>



**APPENDIX B:
NEXT STEPS**

Coordinate Planning, Policy, Requirements and Regulations

AGENCY	ACTIONS
OPR, HCD DWR	<ul style="list-style-type: none"> Continue on-going state level planning and guideline activities such as the EGPR, General Plan Guidelines, State Housing Plan, California Water Plan and State Transportation Plan Timing: Ongoing Priority: High
OPR, CalOES, Other Agencies	To implement SB 379, OPR and the Office for Emergency Services (CalOES) will coordinate with other state agencies to help support local government integration of climate change vulnerability, adaptation, and hazard mitigation discussions. Communication and coordination with local governments will lead to dissemination of relevant resources. Timing: By 2017 Priority: High
HCD	<ul style="list-style-type: none"> Seek modifications to housing element law. Housing element law involves many connections to climate adaptation. However, statute could provide more clarity. Specific areas to enhance include the housing needs assessment, sites inventory and RHNA methodology. Steps include: <ul style="list-style-type: none"> o Discuss potential changes in housing element working group Timing: 2016-2017 Priority: Medium
HCD	<ul style="list-style-type: none"> Evaluate and revise building standards to better address climate adaptation, including: <ul style="list-style-type: none"> o Conduct working group on existing and potential standards relative to climate change o Prepare modification for stakeholder input o Carry out building standard process Timing: 2016-2018 Priority: Medium



Improve Alignment of Existing Programs and Investments

AGENCY	ACTIONS
HCD	<ul style="list-style-type: none"> • Carry out evaluation of programs to align with climate change objectives, including: <ul style="list-style-type: none"> o Develop evaluation criteria for climate adaptation, including cross-sectoral benefits, vulnerable population, application streamlining and opportunities to foster flexibility and innovation o Coordination with other state agencies and departments o Carry out evaluation and modifications to programs <p>Timing: Bi-annually Priority: Medium</p>
HCD	<ul style="list-style-type: none"> • Protect HCD and other state invested properties from climate change, including special needs populations, mobile home and manufactured homes, by taking actions that reduce climate risk, including: <ul style="list-style-type: none"> o CollectING GIS Layers o ConductING Spatial Analysis and Prepare Summary Report o DevelopING Resiliency Action Plan <p>Timing: 2015-2016 Priority: High</p>

Enhance Outreach, Capacity, Implementation and Outcomes

AGENCY	ACTIONS
OPR, HCD, CalFire, Other Agencies	<ul style="list-style-type: none"> • Continue National Disaster Resiliency Competition or other related efforts. <ul style="list-style-type: none"> o Coordinate through an interagency Advisory Committee <p>Timing: Ongoing Priority: High</p>
OPR	<ul style="list-style-type: none"> • Initiate implementation of SB 246 (Chapter 606, statutes of 2015) through efforts such as: <ul style="list-style-type: none"> o Preparing to establish the Integrated Climate Adaptation Resiliency Program (e.g., tools and guidance, coordinating state agency support to local and regional efforts, informing state programs) o Establishing an advisory council to support OPR in coordinating state, regional and local agencies o Developing a clearinghouse of climate adaption information <p>Timing: 2015-2017 Priority: High</p>
OPR, HCD	<ul style="list-style-type: none"> • OPR will track progress in amendments to local general plans and consult with HCD to explore options for improvement prior to the next housing element revision.



Enhance Outreach, Capacity, Implementation and Outcomes - continued

OPR, HCD	<ul style="list-style-type: none"> • Continue efforts to assist in the preparation of general plan amendments related to climate change and disadvantaged communities, including: <ul style="list-style-type: none"> o Conduct survey of local governments and collect updates o Disseminate updates and planning resources o Re-survey to track progress o Prepare strategy to assist with implementation <p>Timing: 2015-2017 Priority: High</p>
HCD	<ul style="list-style-type: none"> • Expand implementation, outreach and performance tracking. HCD, as part of its expanding implementation efforts, could seek partnerships with other agencies to complement outreach efforts and strengthen housing and community development outcomes related to climate adaptation. Part of this function would include improving performance tracking such as units built by affordability and geography (e.g., transit priority areas, fire and flood hazard areas). Specific steps include: <ul style="list-style-type: none"> o Initial HCD outreach program development and carry through o Agency outreach and input (post GP Guidelines) o Expanded program <p>Timing: 2016 Priority: Medium</p>
HCD, CNRA	<ul style="list-style-type: none"> • HCD and CNRA will collaboratively explore rural issues related to climate change with partner agencies. <p>Timing: Initiate in 2016 and on-going</p>
OPR	<ul style="list-style-type: none"> • Explore and carry out local capacity building, such as Civic Spark, including a focus on disadvantaged communities <p>Timing: 2016 and Ongoing</p>
HCD	<ul style="list-style-type: none"> • Enhance regional collaboration. Regional governments undertake many complex planning functions and could benefit from a state role such as coordination, assistance and other collaboration. Potential topic areas include SCS implementation and resiliency and equity planning. <p>Timing: 2015 and Ongoing</p>

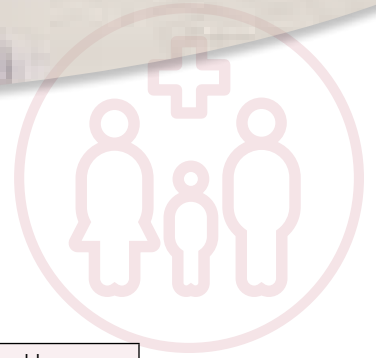


Public Health

APPENDIX A:

HEALTH VULNERABILITY RESOURCES

Cal-Adapt.org Energy	Cal-Adapt provides a view of how climate change exposures might affect California at the local level with maps and access to data. The data and information in this site is produced by the State’s scientific and research community, and is in the process of being updated. Cal-Adapt is the result of a key recommendation in the <i>2009 California Climate Adaptation Strategy</i> .
CalBRACE CDPH	CalBRACE utilizes the Centers for Disease Control and Prevention’s Building Resilience Against Climate Effects (BRACE) Framework for public health jurisdictions. Step One in the framework includes a vulnerability assessment that is being conducted initially for ten counties in California with 24 indicators in environmental exposures, social vulnerability and adaptive capacity domains. BRACE Step One entails identifying the scope of the most likely climate impacts, the potential health outcomes associated with those climatic changes, and the populations and locations vulnerable to these health impacts within a jurisdiction.
Indicators of Climate Change in California OEHHA	CalEPA’s Office of Environmental Health Hazard Assessment (OEHHA) works on metrics for tracking climate change and its impacts on California’s water resources, oceans, fish and wildlife, forests, agriculture, and the health and well- being of the state’s residents. OEHHA released a 2013 update to its <i>Indicators of Climate Change in California</i> report, originally published in 2009. OEHHA convened a workshop on June 16-17, 2015 to solicit ideas and information for the next update of its Indicators report, scheduled for release in 2017.
CalEnviro Screen CalEPA	The California Communities Environmental Health Screening Tool: CalEnviroScreen Version 2.0 (CalEnviroScreen 2.0) is a screening methodology that can be used to help identify California communities that are disproportionately burdened by multiple sources of pollution. The tool provides added value for adaption planning to develop vulnerability assessments that overlay pollution sources with sea level rise, wildfires, air pollution, extreme heat or floods. The tool was updated in October 2014 to include additional data along the US-Mexico border.
Environmental Justice Screening Method (EJSM)	The Environmental Justice Screening Method (EJSM) was developed by the University of California at Berkeley, University of Southern California, and Occidental College. The EJSM provides a climate vulnerability layer in its mapping for the entire state of California, incorporating population sensitivities such as elderly living alone, car access, SES, and other metrics, with place-based characteristics that affect heat island risks such as green space and impervious surfaces. The tool identifies consistent racial disparities in vulnerability to climate risk.



HEALTH VULNERABILITY RESOURCES – C O N T I N U E D

Health Disadvantage Index (HDI)	HDI is a model cumulative index of community health disadvantage. It was developed by statewide public health department data experts by adapting international best practices and integrating 27 economic, social, environmental, and health data indicators. Sample HDI indicators include economic security, educational and employment opportunity, civic engagement, neighborhood quality, and premature mortality. Indicators are weighted based on their impact on human health, development and well-being.
Urban Heat Island Index	CalEPA released the <i>Urban Heat Island Index</i> in September 2015 to provide an UHI effect index for California that would allow cities to set quantifiable goals for heat reduction, including means to measure heat and GHG reduction benefits of various cool or sustainable materials strategies. http://www.calepa.ca.gov/UrbanHeat/
Publications in peer-reviewed journals OEHHA	OEHHA has published many articles in peer-reviewed journals identifying vulnerable populations for mortality and morbidity from heat exposure during the warmest months of May through September, ozone, or particulate matter in California over several years.



APPENDIX B: CURRENT ACTIONS

This table groups current actions according to the categories developed in Safeguarding California.

Improve Capacity of Communities to Prepare, Respond, and Recover from Climate-Related Health Risks

	INITIATIVES	SUMMARY
Planning for diverse climate change and water-related public health risks	Cleanup of contaminated sites prone to sea-level rise	Promote cleanup of areas surrounding Brownfields development in anticipation of SLR and potential for contamination from un-remediated adjacent sites during flooding.
	SLR Interagency Mapping Partners	Coastal Commission interagency work group focused on mapping sea level rise in California.
	California Health in All Policies Task Force – Implementation Plans	Incorporates urban greening recommendations from Preparing California for Extreme Heat Guidance into action plans of the Health in All Policies Task Force (enhance state agency coordination). Year: 2013 Agency: CDPH
	Collaboration to prepare for effects of sea level rise combined with floods due to El Niño-related storms	During the fall of 2015, the Ocean Protection Council and CalEPA along with the Governor’s Office led multi-sectoral discussions of the environmental and human risks due to the confluence of sea level rise, king tides and heavy winter storms influenced by the El Niño Southern Oscillation. These discussions included cross-border effects, with representatives of Mexico’s emergency preparedness agencies. See website www.storms.ca.gov
	Urban Heat Island(UHI) Index Development	Addresses urban heat island effect, based on Recommendation I.2 of “Preparing California for Extreme Heat”. This is an inter-agency group that came up with definition of UHI index. Production of maps of the Index at the census tract level in California cities. Completed September 2015 Year: 2015 Agencies: CalEPA, DIR, CalOES, CDPH, NOAA/NWS
Evaluate health care infrastructure resilience	Health Care Facility Preparedness	There is extensive work happening in California to prepare health care facilities for the impacts of climate change such as sea level rise, increased storms, extreme heat, drought, etc. CalOES in collaboration with private, public and non-profit medical facilities, CDPH Hospital Preparedness and Emergency Preparedness Office all play a role in preparing for surges or disaster events.



Improve Capacity of Communities to Prepare, Respond, and Recover from Climate-Related Health Risks – CONTINUED

	INITIATIVES	SUMMARY
OEHHA and CDPH Support implementation of recommendations in Extreme Heat Guidance Document	Updated Guidelines for General Plans	Internal CDPH work group convened by Health in All Policies staff to provide input into the update for the general plan guidance for county planning departments adding more emphasis on adaptation and social determinants of health to reduce vulnerability to climate change impacts to public health. Year: 2015 Agency: OPR – CDPH
	Conduct Epidemiologic Studies on Heat	Most epidemiologic studies on temperature during the warm season and heat waves focusing on California have been conducted within the past decade. Exposure has been defined primarily as apparent temperature, a combination of temperature and humidity. Outcomes that have been studied include mortality, morbidity, such as hospitalizations, emergency room visits, and in one study, preterm delivery. Air pollutants have often been examined as potential confounders or effect modifiers. The results have generally shown a positive association between temperature and various health outcomes, and have identified increased risk specifically for pregnant women, infants, young children, the elderly, and has varied by race/ethnicity. In addition to the typical heat-related illnesses, greater risk for both mortality and morbidity has been shown for specific cardiovascular diseases related to elevated cholesterol levels during heat exposure, such as ischemic heart disease and ischemic stroke among others. Identifying vulnerable subgroups by local regions will be essential for preventing heat-related mortality and morbidity.
Support development of public health planning tools for local communities	Preparing Public Health Officials for Climate Change: A decision support tool	This project will develop a decision support tool for public health officials using probabilistic short-and medium-term weather/climate forecasts designed to assist the public health sector with adapting to climate variability and change. Tool development will involve close collaboration with the California Department of Public Health , Office of Environmental Health Hazard Assessment (OEHHA), and local public health agencies, whose needs and preferences will be incorporated into design of this decision support tool. Proposed research. Agencies: CNRA, CDPH, OEHHA Source: California Fourth Assessment
	Healthy Planning Leadership Webinar Series	Nine webinars geared towards better understanding planning with a health lens. Two will focus on climate change and how to integrate healthy planning and mitigation and adaptation measures. Agency: OPR 2015-16



Improve Capacity of Communities to Prepare, Respond, and Recover from Climate-Related Health Risks – CONTINUED

	INITIATIVES	SUMMARY
Support development of public health planning tools for local communities	General Plan Guidelines	Contain a section on Climate Change, Social Equity, Community Engagement, and Healthy Communities also has an online mapping tool which will look at social indicators that increase vulnerability. Of note, additional recommendations outside of elements required by statute are not mandatory. Agency: OPR 2015
	Indicators of Climate Change in California	Update of <i>Indicators of Climate Change in California</i> , scheduled for publication in 2017, by CalEPA Office of Environmental Health Hazard Assessment Agency: CalEPA-OEHHA 2015
	Integrated Transportation and Health Impacts Model (ITHIM)	The Integrated Transport and Health Impacts Model (ITHIM) is a tool to estimate the health co-benefits and potential harms from active transport and low carbon driving in urban populations. It showed that increasing median daily walking and bicycling from 4 to 22 minutes in the San Francisco Bay Area reduced the burden of cardiovascular disease and diabetes by 14% (32,466 DALYs), increased the traffic injury burden by 39% (5907 DALYS), and decreased greenhouse gas emissions by 14%. Low-carbon driving reduced GHGE by 33.5% and cardiorespiratory disease burden by less than 1%. Virtually all (99%) of the health benefits were a result of increasing physical activity rather than from reductions in air pollution (shifting to low-carbon driving).
Healthy energy efficient buildings	Green Building Action Plan	Executive Order B-18-12 directs agencies and departments to green the state’s buildings, reduce GHG emission and improve energy efficiency. All new and renovated state buildings larger than 10,000SF to achieve LEED Silver certification or higher, and to incorporate clean on-site power generation and clean back-up power supplies.
	CALGreen (Green Building Code)	California’s Green Building Code (CALGreen, current code in effect is 2013 version). Provides requirements/options for constructing green buildings, including options to incorporate urban greening strategies, hardscape standards (e.g. lighter colored to absorb less heat), and cool roofs. Agency: Dept. of General Services / Building Standards Commission
	Green Building Research	The California Air Resources Board’s (ARB) green building research agenda is focused on reducing GHG emissions while also avoiding any increases to other criteria pollutants that may affect public health. Research projects include looking at co-benefits of green buildings, residential energy use and GHG emissions impacts of compact land use types, and benefits of widespread deployment of cool roofs. Agency: California Air Resources Board



Improve Capacity of Communities to Prepare, Respond, and Recover from Climate-Related Health Risks – CONTINUED

	INITIATIVES	SUMMARY
Healthy energy efficient buildings	Building Energy Efficiency Standards	Building Energy Efficiency Standards apply to new homes and commercial buildings, and offer builders better insulation, lighting, ventilation systems, and windows that will help to reduce energy use in homes and businesses. Agency: California Energy Commission
	Residential Energy Efficiency and Energy Assistance Programs	The Weatherization Assistance Program (WAP) is designed to help low-income individuals and families increase the energy efficiency of their homes for both rental or owned properties. The Low-Income Home Energy Assistance Program (LiHEAP) provides assistance to eligible low-income households to manage and meet immediate residential heating and/or cooling needs. Agency: Department of Community Services and Development The Energy Savings Assistance Program provides weatherization services at no cost to low-income households who meet California Alternate Rates for Energy (CARE) income guidelines. Agency: California Public Utilities Commission (CPUC)
Low allergen or non-allergenic urban greening	HiAP 2011-2015 Action Report: Support Urban and Community Greening and Access to Green Spaces	Report supports establishment of a baseline tree canopy inventory; develop / disseminate information (including role of vegetation in reducing exposures to near-road pollutants, and cooling public and private spaces) to non-traditional partners about the health, environmental, and economic co-benefits of parks, urban forestry, and urban and community greening (including role of vegetation in reducing exposures to near-road pollutants, as well as cooling public and private spaces). Current Agencies: SGC / HiAP, CAL FIRE, ARB, OPR
	Urban Forestry Program	Urban forestry and greening in cities and communities reduces heat island effects and carbon emissions. Promotes tools and research on allergens and co-benefits of urban greening, bio-roofs, landscaping impacts on health and community cohesion, mental health, and crime reduction. \$16 million Cap & Trade funding in 2015. Agency: CAL FIRE



Better Understanding of Climate Impacts on Public Health

	INITIATIVES	SUMMARY
Local vulnerability assessment efforts to design and implement strategies to address local risks	CalEnviro Screen 2.0	CalEnviroScreen is a screening methodology that can be used to help identify California communities that are disproportionately burdened by multiple sources of pollution. Useful to determine where risks of toxic exposure could occur during flooding and sea level rise.
	CalBRACE	In collaboration with CDC and California local health departments, provides resources, technical assistance for State and local public health departments including downscaled vulnerability reports, technical assistance, funding and capacity building for the State and local public health departments. Years: 2012 – 2016 Agency: CDPH
	Cal-Adapt Web Portal	Website providing interactive maps and charts on various projected climate effects, including heat, precipitation, snowpack, sea level rise, and wildfire. Year: Current Agency: CEC
	California Statewide Plan to Promote Health and Mental Health Equity	Portrait of Promise: The California Statewide Plan to Promote Health and Mental Health Equity is a report to the legislature and the people of California by the Office of Health Equity. The plan includes actions to incorporate health equity into CDPH’s and the state’s climate action approach and collaboration across sectors. Year: 2015 Agency: CDPH
	CASPER (Community Assessment for Public Health Emergency Response) on health impacts of drought	In fall 2015 CDPH conducted one CASPER (Community Assessment for Public Health Emergency Response) in Mariposa and two in Tulare County, both hard-hit by the several-year drought. The results of this statistically valid survey of residents will identify health impacts of drought, and can inform action at the state and local levels to reduce and prevent health harms from drought.
Increase capacity to monitor climate-related deaths and illnesses	California Environmental Health Tracking Program	Provides data and information on diseases and environmental threats to inform environmental and public health programs, research, and policies. Includes climate change vulnerability maps. Year: 2002 (ongoing) Agency: CDPH
	Health Impacts from Wildfire Smoke Exposure Research	Research public health impact of wildfires: characterize increases in emergency room visits, hospitalizations, physician visits; identify spectrum of affected conditions; assess impact in vulnerable populations. Years: 2014 – 2016 Agency: CDPH
	California Mosquito-Borne Virus Surveillance and Response Plan	Plan provides guidelines and information on the surveillance and control of mosquito-borne viruses in California, prompts surveillance and control activities associated with virus transmission risk level, and provides local and state agencies with a decision support system. Year: 2015 Agency: CDPH



Better Understanding of Climate Impacts on Public Health – CONTINUED

	INITIATIVES	SUMMARY
Increase capacity to monitor climate-related deaths and illnesses	Binational Border Infectious Disease Epidemiology Program	The Office of Binational Border Health is engaged in 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. Year: Current 2015 Agency: CDPH
Social vulnerability mapping for climate change	CalBRACE VA Mapping for California Counties & state	County level and state reports that highlights the susceptibility of various vulnerable populations to the impacts of climate change. Year: 2015 Agency: CEC, CNRA
Regional Studies of Aeroallergens		No action identified on this recommendation.



Information Sharing and Education

	INITIATIVES	SUMMARY
Raise awareness and foster action to address climate risks to public health	Climate Action Team - Public Health Working Group	Climate Action Team - Public Health Working Group meets quarterly for sharing information on climate and health-related topics; webcast and archived presentations, and also works across sectors on deliverables to address climate impacts on human health. Year: 2009 (ongoing) Agency: CDPH, ARB
	CalBRACE Local Public Health Partnership	Provides opportunities for county health departments to collaborate and share resources. Held 2-day workshop in September 2015. Local Public Health Partnership community of practice, an online collaboration tool. Year: 2012 – 2016 Agency: CDPH, CDC
	Update of Guidelines for General Plans	A Public Health Workgroup convened by Health in Policies staff provided input into the update for the general plan guidance adding more emphasis on adaptation and social determinants of health to reduce vulnerability to climate change impacts to public health. Year: 2015 Agency: OPR – CDPH
	Public Health Emergency Preparedness Training Workshop	Partially funded through CDC Public Health Preparedness Program; Workshop provides opportunities to share best practices for building emergency preparedness and response capacity. 2015 Workshop featured panel on impacts of the drought and climate change on public health. Year: 2015 (Annual) Agency: CDPH
	California Department of Health Website	CDPH web site: Office of Health Equity - Climate and Health and California Environmental Health Tracking Portal provide an entry point to resources on climate change and public health in California. Summarizes mitigation and adaptation tools, educational materials, and climate and health communications resources. Tracking Program provides background on exposures and research. Year: Current 2015 Agency: CDPH
Public education on how to reduce and prepare for climate health risks	Outsideln SLO Pilot Project Communication - San Luis Obispo	A 2014-2015 Public Health –climate change awareness and prevention campaign piloted in San Luis Obispo County by CDPH and San Luis Obispo County Public Health Department, and partners. Year: Current 2015 Agency: CDPH



Information Sharing and Education – CONTINUED

	INITIATIVES	SUMMARY
Public education on how to reduce and prepare for climate health risks	Public Health and Emergency Preparedness Training Series for Latino Community- serving Organizations	Quarterly trainings on Emergency Preparedness with community leaders and organizations that serve the San Diego County Latino population. Content includes all hazards preparedness, emergency preparedness tools and resources, best practices on reaching vulnerable populations, and more. Year: Current 2015 Agency: CDPH
	Cool your School	Cool Your School is a series of 6th-grade, classroom-based, science activities rooted in Berkeley Lab’s cool-surface and cool materials research and aligned with California science content standards. Run by Berkeley Labs, Supported by OPR



APPENDIX C: METRICS FOR CLIMATE CHANGE AND RESILIENCE MONITORING

The chart below compares metrics from a sample of the screening methods used to assess vulnerability and resilience to environmental exposures including climate change.

Over the long-term, success at increasing community resilience to climate change health impacts depends on changing the structural, social and economic drivers discussed in the beginning of the Public Health chapter that impact living conditions and ultimately health inequities that include heightened vulnerability to climate impacts. The Healthy Communities Data and Indicator Project (HCI) at the CDPH Office of Health Equity provides data at the county, town or census tract level that help measure to what degree a community provides the characteristics of a healthy community.(48) The National Association for the Advancement of Colored People's publication, *Equity in Building Resilience in Adaptation Planning* offers an extensive list of metrics, some of which are included here, for preexisting vulnerabilities, assets that shape a healthy community, and indicators of actions taken to increase resilience.(49)

Other indicators in this list track exposure to toxins, which are often released in conjunction with greenhouse gases or harm health, thus

impacting vulnerability. Still other indicators track health conditions that can increase vulnerability, environmental conditions that can harm health or are affected by climate change, and demographic characteristics that may affect resilience.

This table is presented to facilitate collaboration among creators of different tools, as well as users of the tools, and to bring the interests of environmental justice advocates together with those of health equity advocates, in their mutual pursuit of health equity and environmental justice. These indicators can also serve to measure progress towards (a) reducing exposure to toxins among vulnerable populations, (b) reducing underlying vulnerabilities in populations, and (c) actions taken to mitigate climate change and build community resilience.

The chart developed by Rachel Morello Frosch for an Environmental Justice Screening Method Webinar, Wednesday, May 13, 2015 was the prototype that was adapted and expanded for this chart: https://dornsife.usc.edu/assets/sites/242/docs/Screening_Methods_Comparison_v2.pdf.

Due to space limitations, not all indicators from each source are included in this chart.



Key to abbreviations:

EJSM = Environmental Justice Screening Method(50)

OEHHA = Office of Environmental Health Hazard Assessment Indicators of Climate Change in CA(51)

CEVA = Cumulative Environmental Vulnerabilities Assessment(52)

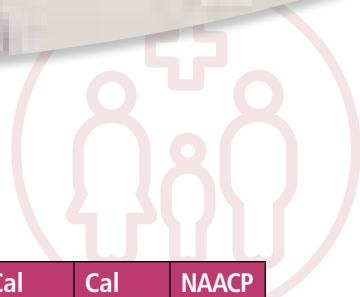
HCI = Healthy Community Indicators(53)

CalBRACE = CalBRACE Vulnerability Indicators(54)

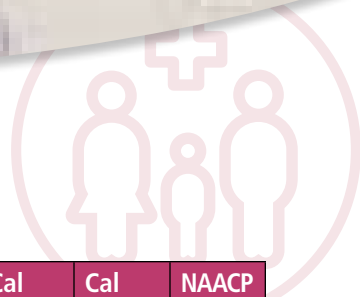
CES 2.0 = CalEnviroScreen 2.0(55)

NAACP = National Association for the Advancement of Colored Peoples Resilience Indicators(49)

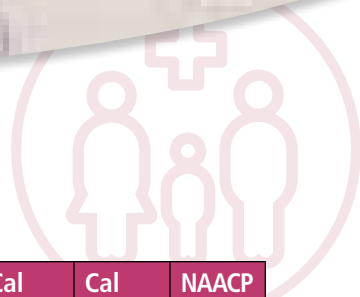
INDICATORS	EJSM	OEHHA	CEVA	HCI	Cal BRACE	Cal ES 2.0	NAACP
Hazard Proximity Metrics - Sensitive Land Uses/Areas							
Childcare facilities	X						
Healthcare facilities	X		X				
Schools	X						X
Urban Parks Playgrounds / Beach, Coast or Open space,% live within ½	X			X			
Senior Residential	X						
Rural areas					X		
Nursing facilities, prisons, college dorms					X		
Hazard Proximity Metrics - Polluting Facilities/Land Uses							
CARB Facilities of Interest (FOI) (air toxics and GHG emissions facilities)	X						
Industry-wide facilities (auto paint/body, gas stations)	X						
Hazardous/solid waste facilities, cleanup sites	X		X			X	X
Railroads	X					X	
Ports	X					X	
Refineries	X		X				
Intermodal distribution facilities	X						
Traffic exposure	X					X	
Chrome plating facilities (FOI)	X		X				
Cleanup sites (EnviroStor)			X			X	
Solid waste (FOI)	X		X			X	
Groundwater threats from leaking underground storage sites and cleanups (GeoTracker)			X			X	
Impaired water bodies			X			X	
Adequate /effective sewage/waste management systems							X



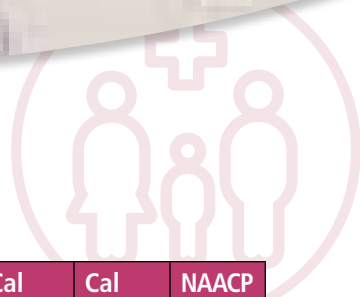
INDICATORS	EJSM	OEHHA	CEVA	HCI	Cal BRACE	Cal ES 2.0	NAACP RES
Health Risk and Exposure Metrics							
Risk Screening Environmental Indicators	X					X	
National Air Toxics Assessment – cancer risk	X						
National Air Toxics Assessment – respiratory hazard	X		X				
Toxic releases from facilities						X	
PM2.5 (interpolated from CARB monitors)	X			X	X	X	X
Ozone (interpolated from CARB monitors)	X		X	X	X	X	X
Diesel PM emissions- <i>DPM emissions data are folded into the NATA cancer risk data.</i>	X					X	
Black carbon concentration		X					
Pesticide exposure	X		X			X	
Water quality – contaminants	X		X	X		X	
Water quality – source vulnerability	X						
Impaired water bodies			X			X	
Mosquito-borne diseases		X					
Heat-related mortality and morbidity		X					
Heat-related emergency room visits					X		
Urban heat islands		X					
Social and Health Vulnerability Metrics							
Race/ethnicity	X		X		X		X
Poverty level	X		X	X	X	X	X
Educational attainment	X		X	X	X	X	X
Age (<5 and >64)	X		X		X	X	X
Gender / Sexual orientation							X
Linguistic isolation or ESL	X		X		X	X	X
Unemployment			X	X		X	X
Homeless persons							X
Undocumented persons							
Renters/home ownership	X		X				X
Median house value	X						
Housing Cost Burden- Households paying > 30% (or 50%) income on housing				X	X		
Household overcrowding				X			
Voter participation	X				X		X



INDICATORS	EJSM	OEHHA	CEVA	HCI	Cal BRACE	Cal ES 2.0	NAACP RES
Social and Health Vulnerability Metrics (continued)							
Public Transit Access, % Live within ½ mile				X	X		X
Low birth weight and/or SGA	X		X			X	
Asthma hospitalization (0-19 years)			X				
Asthma diagnosis ever/ Asthma emergency room visits					X	X	
Elderly living alone	X						
Auto ownership	X				X		X
Air conditioning ownership					X		
Living Wage % families				X			X
Health insurance coverage					X		X
Mental disability					X		X
Physical disability					X		X
Adults with multiple chronic conditions					X		
Annual ED visits related to heat							
Adult obesity					X		
Persons with pre-existing health conditions							X
Work outdoors					X		
Food Affordability				X			
Food insecurity					X	X	
Access to Healthy Foods				X			X
Age-adjusted death rate by race and ethnicity					X		
Violent crime					X		X
Years of potential life lost before age 65			X				
Climate Vulnerability Metrics							
Tree canopy	X				X		
Impervious surfaces	X				X		
Projected temperature, observed temperature or temperature changes	X	X			X		
Projected increase in warm nights	X						
Extreme heat events		X			X		
Precipitation		X					
Sierra Nevada snowmelt runoff		X					
Snow-water content		X					



INDICATORS	EJSM	OEHHA	CEVA	HCI	Cal BRACE	Cal ES 2.0	NAACP RES
Climate Vulnerability Metrics (continued)							
Wildfire		X			X		
Ocean acidification		X					
Winter chill		X					
Sea level rise and flood risk		X			X		
Adaptive Capacity Process/Outcome Metrics							
Adaptation specific planning/decision making							X
Public health sector adaptation specific planning/decision making							
Health and human services sector adaptation specific planning/decision making							
Equity based resource allocation							X
Inclusive stakeholder engagement in adaptation/ resilience planning							X
Flood control measures							X
Coastal/shoreline restoration projects (mapping/ distribution)							X
Solar and Wind installations (mapping/distribution)							X
Storm water management projects							X
Cooling Centers							X
Early Warning Systems							X
Gender responsive emergency management plans							X
Property value increased or decreased							X
Schools temporarily/ permanently closed							X
Homes damaged/flooded/destroyed							X
Residents returning /rebuilding							X
Renters/ homeowners displaced (temporarily and permanently)							X
Crops lost/farms lost due to drought/flooding/other climate hazards							X
Emergency Child Care Centers							X
Sheltering provisions for LGBTQ persons							X
Laws/ordinances to prevent gentrification/displacement							X
Community/health impact reports for redevelopment projects							X



INDICATORS	EJSM	OEHHA	CEVA	HCI	Cal BRACE	Cal ES 2.0	NAACP RES
Adaptive Capacity Process/Outcome Metrics (continued)							
Culture shift as result of disaster/displacement/ agriculture yields, etc.							X
Community benefits /workers agreements for new developments							X
Local community farms/gardens							X
Jobs lost temporarily (temporarily and permanently)							X
New Jobs created (temporarily and permanently)							X
Business owners/businesses returning /rebuilding on same site							X
Local hires for infrastructure projects (storm water, solar, waste water, etc)							X
Health care/mental health care services and facilities							X
Sufficient interpretation/language access to matches populace							X

REFERENCES

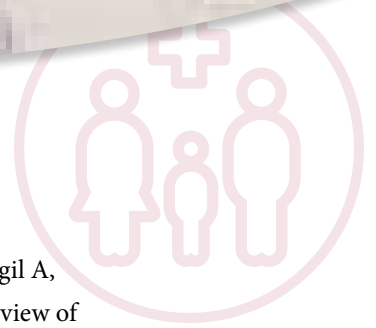
1. What is Public Health?: American Public Health Association website <http://www.apha.org/what-is-public-health>. Accessed December 31, 2015.
2. Costello A, Mustafa Abbas, Adriana Allen, Sarah Bell, Richard Bellamy, Sharon Friel, et al. Managing the health effects of climate change. The Lancet Commissions 2009;373(9676):1693-1733.
3. 2009 California Climate Adaptation Strategy: California Natural Resources Agency; 2009.
4. Safeguarding California: Reducing Climate Risk: California Natural Resources Agency; 2014.
5. 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: California Department of Public Health; 2015.
6. IPCC. 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. Cambridge, UK, and New York, NY, USA: Cambridge University Press; 2012.
7. Pathways to resilience: Transforming cities in a changing climate: Movement Strategy Center, Movement Generation, The Praxis Project, and Reimagine! RP&E; 2015.



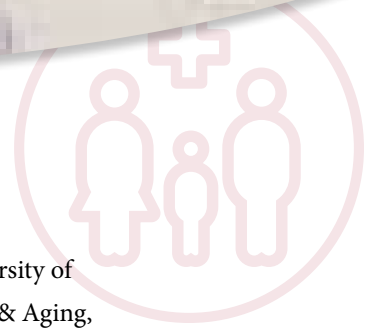
8. Impacts, adaptation and vulnerability. Contribution of working group II to the third assessment report of the Intergovernmental Panel on Climate Change. In: McCarthy J CO, Leary N, Dokken D, White, K., editor. Climate Change 2001. Cambridge, United Kingdom and New York, NY, USA: Intergovernmental Panel on Climate Change; 2001.
9. Morello-Frosch R PM, Sadd J, Shonkoff S. . The Climate Gap: Inequalities in How Climate Change Hurts Americans & How to Close the Gap; 2009.
10. English P, Fitzsimmons K, Hoshiko S, Kim T, Margolis H, McKone T, et al. Public Health Impacts of Climate Change in California: Community Vulnerability Assessments and Adaptation Strategies. Report No. 1: Heat-Related Illness and Mortality. Information for the Public Health Network in California.: Climate Change Public Health Impacts Assessment and Response Collaborative. California Department of Public Health and the Public Health Institute.; 2007.
11. Beckett K, Freer-Smith P, Taylor G. Urban woodlands: Their role in reducing the effects of particulate pollution. Environmental Pollution 1998;99(3):347-360.
12. Ebi K, McGregor G. Climate change, tropospheric ozone and particulate matter, and health impacts. Environmental Health Perspectives 2008;116(11):1449-1455.
13. 2014 U.S. Climate Action Report to the UN Framework Convention on Climate Change: US Department of State; 2014.
14. Cal-Adapt: Exploring California's climate change research. California Energy Commission website <http://cal-adapt.org/>. Accessed January 9, 2015.
15. Luber G, McGeehin M. Climate change and extreme heat events. American Journal of Preventive Medicine 2008;35(5):429-435.
16. P-1: State and County Population Projections, Major Age Groups: 2010-2050. California Department of Finance website <http://www.dof.ca.gov/research/demographic/projections/>. Accessed January 9, 2015.
17. Sheridan SC, Allen MJ, Lee CC, Kalkstein LS. Future heat vulnerability in California Part II: Projecting future heat-related mortality. Climatic Change 2012;115(2):311-326.
18. Gould S, MPH, Dervin K, MPH. Climate Action for Health: Integrating Public Health into Climate Action Planning. California Department of Public Health; 2012.
19. Brosemer K, Ganion J. Recognizing Tribal Climate Action. The White House webpage <https://www.whitehouse.gov/blog/2015/04/22/recognizing-tribal-climate-action>. Updated April 22, 2015. Accessed January 14, 2016.
20. Maizlish N, Woodcock J, Co S, Ostro B, Fanal A, Fairley D. Health Cobenefits and Transportation-Related Reductions



- in Greenhouse Gas Emissions in the San Francisco Bay Area. *American Journal of Public Health* 2013.
21. Ban-Weiss G, Jordan W, Levinson R. Using remote sensing to quantify albedo of roofs in seven California cities. Berkeley, CA: Lawrence Berkeley National Laboratory; 2014.
 22. Nowak D, Hirabayashi S, Bodine A, Greenfield E. Tree and forest effects on air quality and human health in the United States. *Environmental Pollution* 2014;193:119-129.
 23. Kuo FE, Sullivan WC. Environment and crime in the inner city: Does vegetation reduce crime? *Environment and Behavior* 2001;33(3):343-367.
 24. Cai W, Borlace S, Lengaigne M, van Rensch P, Collins M, Vecchi G, et al. Increasing frequency of extreme El Niño events due to greenhouse warming. *Nature Climate Change* 2014;4:111–116.
 25. Rudolph L, Sisson A, Caplan J, Dillon L, Ben-Moshe K, Mohammadi M, et al. Health in All Policies Report to the Strategic Growth Council: California Department of Public Health and University of California, San Francisco; 2010.
 26. Neumann J. Adaptation to Climate Change: Revisiting Infrastructure Norms. Washington, D.C.: Resources for the Future; 2009.
 27. Sublett J, Seltzer J, Burkhead R, Williams P, Wedner H, Phipatanakul W, et al. Air filters and air cleaners: Rostrum by the American Academy of Allergy, Asthma & Immunology Indoor Allergen Committee. *J Allergy Clin Immunol* 2010;125:32-38.
 28. Saving energy, improving health: Potential impacts of energy efficiency program design on noise and air pollution exposure: Program on Health, Equity, and Sustainability, SFDPH. May 30, 2013. Available at http://www.pewtrusts.org/en/~media/assets/external-sites/health-impact-project/savingenergyimprovinghealth_finalhia.pdf. Accessed January 18, 2016.
 29. Preparing California for Extreme Heat: Guidance and Recommendations: California Department of Public Health and California Environmental Protection Agency; 2013.
 30. Living Building Challenge. Available at <http://living-future.org/lbc/about> Accessed January 18, 2016.
 31. National Research Council. Sea-level rise for the coasts of California, Oregon, and Washington: Past, present, and future. Washington, DC: The National Academies Press; 2012.
 32. Heberger M, Cooley H, Herrera P, Gleick PH, Moore E. The impacts of sea-level rise on the California coast: The Pacific Institute; 2009.
 33. Ebi KL, Semenza JC. Community-based adaptation to the health impacts of climate change. *American journal of preventive medicine* 2008;35(5):501-507.



34. Beaudoin CE. News, social capital and health in the context of Katrina. *J Health Care Poor Underserved* 2007;18(2):418-430.
35. Community Based Participatory Research for Health. San Francisco, CA: Jossey-Bass; 2008.
36. Kalkstein JL, Sailor D, Shickman K, Sheridan S. 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.
37. Galea S, Nandi A, Vlahov D. The epidemiology of post-traumatic stress disorder after disasters. *Epidemiol Rev* 2005;27:78-91.
38. Norris FH. Range, magnitude, and duration of the effects of disasters on mental health: Review update 2005. *Research Education Disaster Mental Health, Dartmouth Medical School and National Center for PTSD website* http://www.redmh.org/research/general/REDMH_effects.pdf. Accessed December 31, 2015. In; 2005.
39. Hanigan I, Butler C, Kokic P, Hutchinson M. Suicide and drought in New South Wales, Australia, 1970-2007. *PNAS* 2012 109 (35):13950-13955.
40. Doherty TJ, Clayton S. The psychological impacts of global climate change. *Am Psychol* 2011;66(4):265-276.
41. Russell R, Guerry AD, Balvanera P, Gould RK, Basurto X, Chan KMA, et al. Humans and Nature: How Knowing and Experiencing Nature Affect Well-Being. In: Gadgil A, Liverman DM, editors. *Annual Review of Environment and Resources*, Vol 38. Palo Alto: Annual Reviews; 2013. p. 473-502.
42. 2013 Building Energy Efficiency Standards: California Energy Commission 2013.
43. Reid C, Gamble J. Aeroallergens, allergic disease, and climate change: Impacts and adaptation. *EcoHealth* 2009;6(3): 458-470.
44. Near roadway air pollution and health: United States Environmental Protection Agency website <http://www3.epa.gov/otaq/nearroadway.htm>. Accessed December 31, 2015.
45. Pollack S, Bluestone B, Billingham C. Maintaining diversity in America's transit-rich neighborhoods: tools for equitable neighborhood change. *Federal Reserve Bank of Boston* 2010(1).
46. A practitioner's guide for advancing health equity: Community strategies for preventing chronic disease. Atlanta, GA: US Department of Health and Human Services- Centers for Disease Control and Prevention - Division of Community Health; 2013.
47. Healthy Places: Health effects of gentrification. Centers for Disease Control and Prevention website <http://www.cdc.gov/healthyplaces/healthtopics/gentrification.htm>. Accessed December 31, 2015.



48. Maizlish N, Tran D, Bustamante-Zamora D. Healthy communities data and indicators project: How-to manual and illustrative guide. Richmond and San Francisco, CA: California Department of Public Health Office of Health Equity and University of California, San Francisco, Institute for Health & Aging; 2014.
49. Equity in building resilience in adaptation planning: National Association for the Advancement of Colored People (NAACP); 2015.
50. Environmental Justice Screening Method (EJSM). USC Dornsife Center for Environmental and Regional Equity website. Available at <http://dornsife.usc.edu/per/cumulative-impacts/>. Accessed January 18, 2016.
51. Indicators of climate change in California: California Environmental Protection Agency Office of Environmental Health Hazard Assessment; 2013.
52. Huang G, Londond J. Cumulative Environmental Vulnerability and Environmental Justice in California's San Joaquin Valley. *Int J Environ Res Public Health* 2012;9(5): 1593–1608.
53. Maizlish N, Tran, D, Bustamante-Zamora, DM. Healthy communities data and indicators project: How-to manual and illustrative guide. In: California Department of Public Health Office of Health Equity and University of California SF, Institute for Health & Aging, editor. Richmond and San Francisco, CA; 2014.
54. Chan J, English D, English P, Maizlish N, Weinstein E, Lipton R. Public health planning for climate adaptation in California: Vulnerability assessment introduction and guide. Sacramento, CA: Office of Health Equity, California Department of Public Health (Pending)
55. CalEnviroScreen version 2.0. California Office of Environmental Health Hazard Assessment. Available at <http://oehha.ca.gov/ej/ces2.html>. Accessed January 18, 2016.
56. Public Health and Housing near High Volume Roadways in California: Local Public Health Department Engagement Examples. Sacramento, CA: California Department of Public Health; 2016 (Pending).
57. Rudolph L, Gould S, Berko J. Climate Change, Health, and Equity: Opportunities for Action. Oakland, CA: Public Health Institute; 2015. Available at <http://www.phi.org/uploads/application/files/h7fjouo1i38v3tu427p9s9kcmhs3oxsi7tsg1fov h3yesd5hXu.pdf>. Accessed January 18, 2016.



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Ocean and Coastal Ecosystems and Resources

APPENDIX A. ACRONYMS

AB	Assembly Bill
BCDC	San Francisco Bay Conservation and Development Commission
CCC	California Coastal Commission
CNRA	California Natural Resources Agency
CAT	Climate Action Team
DFW	Department of Fish and Wildlife
DPR	Department of Parks and Recreation
LCP	Local Coastal Program
NOAA	National Oceanic and Atmospheric Administration
OEHHA	Office of Environmental Health Hazard Assessment
OPC	Ocean Protection Council
OST	Ocean Science Trust
PCC	Pacific Coast Collaborative
SCC	State Coastal Conservancy
SLC	State Lands Commission



APPENDIX C.

STATE COASTAL AGENCIES' CURRENT ACTIONS TO PREPARE FOR CLIMATE CHANGE IMPACTS, ORGANIZED BY THE RECOMMENDATION CATEGORIES IN SAFEGUARDING CALIFORNIA

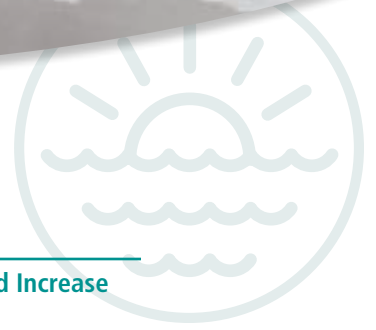
1. Improve Management Practices for Coastal and Ocean Ecosystems and Resources, and Increase Capacity to Withstand and Recover from Climate Impacts

AGENCY	ACTIONS
BCDC	<ul style="list-style-type: none"> • Adapting to Rising Tides Program: Assesses the vulnerability of multiple asset categories, and evaluates the risks and consequences to society, equity, governance, environment, and economy posed by the vulnerabilities. The working group includes cities, counties, and regional, state, and federal agencies and organizations. Adaptation measures will be recommended to address vulnerabilities • Head of the Tide Project: Includes development of a guidance document to assist San Francisco Bay Area regional planners, flood managers, and local governments to understand the vulnerabilities that flood control channels and Bay tributaries face due to sea-level rise and potential measures to improve resilience • Policies for a Rising Bay Project: Supports assessment of the Bay fill policies in relation to rising sea levels. • Bay Plan Climate Policies: Adopted to inform review of BCDC permit applications in light of sea-level rise. • Regional Sediment Management activities: Assess changing Bay sediment dynamics and potential management measures.
CCC	<ul style="list-style-type: none"> • LCP Local Assistance Grant Program: Provides funding to support LCP updates that specifically address issues related to climate change such as sea-level rise and facilitate local adaptation. • LCP updates: Implement adaptation planning and build resilient communities, including addressing sea-level rise and associated coastal hazards. • Coastal Development Permits: Address sea-level rise where applicable to ensure resilience for the life of the development. • Sea Level Rise Policy Guidance: Provides an overview of the best available science on sea-level rise for California and recommends a methodology for addressing it in CCC planning and regulatory actions. The final document was adopted unanimously by the CCC on August 12, 2015. • Beach Valuation Study: Explores new methods to assess the true costs of shoreline armoring to the public in order to support mitigation of the adverse impacts of hard armoring to recreation, public access, and beach ecology. NOAA-funded Project of Special Merit.



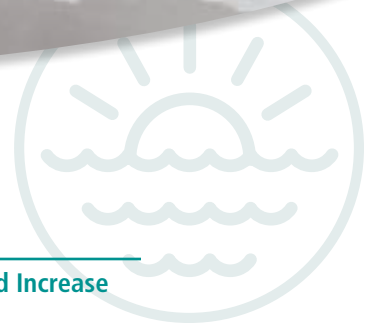
1. Improve Management Practices for Coastal and Ocean Ecosystems and Resources, and Increase Capacity to Withstand and Recover from Climate Impacts – C O N T I N U E D

AGENCY	ACTIONS
DPR	<ul style="list-style-type: none"> • Coastal erosion policy: Discourages development (including permanent new structures, facilities, and structural protection) in sites that are subject to impacts such as wave erosion and seacliff retreat. New projects must also consider the projected impacts of sea-level rise. Additionally, parks managers follow coastal development permit guidelines for hazard avoidance, when applicable. • Coastal restoration projects: Many focus on enhancing natural dune structure and movement. Also, projects such as invasive species removal or the removal/modification of structural barriers are consistent with an integrated ecosystem approach to reducing climate impacts.
OPC	<ul style="list-style-type: none"> • LCP Sea-level Rise Grant Program: Provides funding to support incorporation of sea-level rise considerations into LCP updates through modeling, vulnerability assessments, adaptation planning, or policy development. • AB 2516: Create the Sea-level Rise Planning Database to help assess the implementation of key state policies, provide information on sea-level rise planning activities to facilitate coordination and collaboration, and understand the factors contributing to successful adaptation. As part of this effort, the OPC is also developing a catalogue of funding opportunities to support adaptation to sea-level rise and other coastal climate change hazards.
SCC	<p>The SCC is currently implementing dozens of projects that support improved management practices and capacity building. Specifically, SCC’s projects seek to encourage innovative design of new structures/infrastructure in areas vulnerable to sea-level rise, support pilot projects for innovative shoreline management, study and invest in cost-effective green infrastructure, support and continue progress toward a more integrated ecosystem approach, and continue development of the State Sediment Master Plan and sediment management.</p> <ul style="list-style-type: none"> • South Bay Salt Pond Restoration Project: Develop and implement a comprehensive plan to build multi-benefit flood protection for the Silicon Valley in conjunction with a 15,000-acre green infrastructure wetland restoration project. (Over 3,000 acres to date.) • Dozens of estuarine wetland restoration projects and habitat restoration projects: Increase coastal resilience and promote reuse of sediment. • Living Shorelines projects in the City of Arcata, San Francisco Bay and Upper Newport Bay • Managed retreat projects in the City of Ventura and San Francisco • CoSMoS: Support development of this sophisticated climate change planning tool with improved technical capacity for California.
SLC	<ul style="list-style-type: none"> • Incorporating sea-level rise into the SLC’s decision-making: Consider how to reduce the potential for adverse sea-level rise impacts to the resources and values protected by the Public Trust Doctrine, including impacts to public access, and the potential for hazard creation via damaged structures and/or inundation of facilities. Decisions incorporate management practices such as acquisition of rolling easements and boundary determinations to protect the landward migration of the public-private property boundary. • Marine oil terminals: The SLC requires that marine oil terminals consider sea-level rise projections over the remaining lives of the terminals



1. Improve Management Practices for Coastal and Ocean Ecosystems and Resources, and Increase Capacity to Withstand and Recover from Climate Impacts – C O N T I N U E D

AGENCY	ACTIONS
Cross-agency	<ul style="list-style-type: none"> • State Coastal Leadership Group on Sea-level Rise: <ul style="list-style-type: none"> o Select Committee Hearing on Sea-level Rise – Raised awareness of capacity issues and the need for continued and improved funding. Recommended climate change adaptation be addressed through support for agency actions, rather than additional/new legislative mandates, as tools exist within current agency authorities. o Public Trust Doctrine – Initiated discussion to describe a vision for maintaining public trust and access as sea levels rise. • California Collaborative on Coastal Resilience: A multi-agency initiative (CCC, SCC, SLC, and OPC) to develop an approach to support coastal communities effectively and efficiently to strengthen sea-level rise resilience. A pilot project in Humboldt Bay has included an analysis of local resilience planning needs and a stakeholder workshop, and support for the community is currently being organized. In addition, the effort is enhancing interagency collaboration, and the pilot is informing development of a transferable model for statewide application. • Coastal Sediment Management Workgroup: Hold regular meetings of the CCC, BCDC, SCC, DFW, DPR, CNRA, SLC, State Water Resources Control Board, U.S. Army Corps of Engineers, U.S. Geological Survey, U.S. Environmental Protection Agency, National Park Service, California Marine Affairs and Navigation Conference, and California Coastal Coalition to discuss upcoming sediment projects and provide support for and technical review of regional sediment management plans. • Coastal and Ocean Resources Working Group for the CAT: Member agencies are discussing means to address future climate change risks even as they respond to the immediate challenges posed by El Niño and needed emergency response. • CCC and SLC collaboration to address the protection of Public Trust resources: Assess the impacts of sea-level rise, shoreline armoring, and other hazard mitigation measures on sovereign lands as well as adjacent uplands that may become inundated due to sea-level rise. The agencies are seeking NOAA funding to support these efforts. • OPC and CCC coordination of their respective grant programs funding local planning efforts: Developed a joint grant application and announcement for the second rounds of grant funding, and together reviewed the applications and developed recommendations. Through an interagency agreement, CCC staff administer the OPC LCP Sea-level Rise Grant Program. This coordination helps to streamline the grant execution process, simplify reporting and invoicing requirements for local governments, save the state money, and increase the success of the projects through early and on-going communication between the local governments and CCC staff on development of projects supporting applications for LCPs or LCP updates under the Coastal Act.



1. Improve Management Practices for Coastal and Ocean Ecosystems and Resources, and Increase Capacity to Withstand and Recover from Climate Impacts – CONTINUED

AGENCY	ACTIONS
Cross-agency (continued)	<ul style="list-style-type: none"> Sea-Level Rise and Floodplain Management Focus Group: Body of floodplain managers and coastal decision-makers that was convened to guide and shape the outputs of the NOAA sea-level rise and floodplain management project. Members of the Focus Group will help to link project efforts to their broader communities, promoting partnerships, strengthening the network of institutions focused on addressing coastal vulnerability and climate adaptation, and helping to distribute and share the project's products. Members include the CCC, SCC, California Office of Emergency Services, Department of Water Resources, Governor's Office of Planning and Research (OPR), OST, Federal Emergency Management Agency, NOAA, as well as representatives from the counties of Los Angeles, Marin, and Santa Cruz and the cities of Chula Vista and San Francisco.

2. Better Understand Evolving Trends that May Impact Ocean and Coastal Ecosystems and Resources

AGENCY	ACTIONS
OPC	Comment letter on President Obama's Executive Order on Federal Emergency Management Agency flood standards.
SCC	Federal Emergency Management Agency Flood Risk Reduction – Local Project Identification: Identify priority needs and actions related to flood risk reduction in coastal counties from San Francisco to San Diego.
SLC	Offshore renewable energy: Research and facilitate the advancement of offshore renewable energy, including through participation in the Marine Renewable Energy Working Group.

3. Better Understand Climate Impacts on Ocean and Coastal Ecosystems and Resources

AGENCY	ACTIONS
BCDC	<ul style="list-style-type: none"> Adapting to Rising Tides. Head of Tides Project. Innovative Wetlands Adaptation Techniques Project: Assessed wetlands value for flood control and vulnerability to rising sea levels.
CCC	<ul style="list-style-type: none"> LCP Grant Program: Supports projects that include sea-level rise vulnerability assessments and subsequent adaptation planning through LCPs.
DPR	<ul style="list-style-type: none"> Division of Boating and Waterways: Undertakes long-term data gathering, monitoring, and modeling, as well as applied research. Coastal site surveys: Collaborates with the Society for California Archaeology to address climate change and sea-level rise.
OPC	<ul style="list-style-type: none"> LCP Sea-level Rise Grant Program.

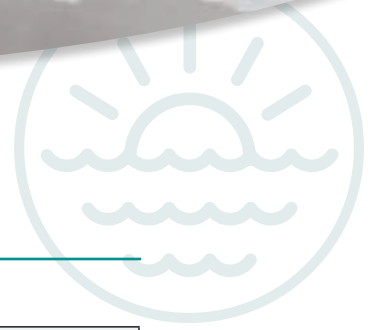


3. Better Understand Climate Impacts on Ocean and Coastal Ecosystems and Resources – CONTINUED

SCC	<ul style="list-style-type: none"> • Vulnerability assessments: Provides support in many coastal communities through the Climate Ready program, including Humboldt Bay, Marin County, San Mateo County, City of Benicia, Monterey, Santa Barbara, Ventura, Los Angeles, and San Diego. • Economic impact analyses: Provides support in Monterey. • CoSMoS: Support and work toward best modeling.
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4. Share Information and Educate

AGENCY	ACTIONS
BCDC	<ul style="list-style-type: none"> • Policies for a Rising Bay Project. • Adapting to Rising Tides: Advise local governments on adaptation planning, including through a Help Desk. • Head of Tides Project.
CCC	<ul style="list-style-type: none"> • Outreach and education related to the Sea Level Rise Policy Guidance: 30-plus outreach meetings/presentations and six webinars for local government and other stakeholders on the draft Sea-level Rise Guidance. Outreach and training materials are currently being developed for the recently adopted document, with activities to begin before the end of 2016. • Overhaul of Climate Change website: In-progress with initial focus on sea-level rise. Additional material will provide information on extreme weather events and ocean acidification issues as well as greenhouse gas emissions.
DPR	<ul style="list-style-type: none"> • Developed a guidance document for evaluating new and current projects in consideration of projected sea-level rise, describing several tools and resources for undertaking this evaluation.
OPC	<ul style="list-style-type: none"> • <i>Making Waves: Communicating Ocean-Climate Impacts and Solutions</i>: Funded by OPC. Describes challenges and potential solutions for these challenges to better communicate the impacts of climate change on oceans. • “Successful Adaptation to Coastal Climate Change” Workshop: Held in February 2015, the workshop brought together representatives of state coastal agencies, CNRA, and the California Environmental Protection Agency to identify the cornerstones of a vision for coastal adaptation in 2050.
SCC	<ul style="list-style-type: none"> • Surviving the Storm Report: Helped develop a comprehensive report on the economic impacts of storms and sea-level rise in the San Francisco Bay Area, in partnership with the Bay Area Council. • CoSMoS: Support community outreach related to the CoSMoS model to build local capacity. • Baylands Ecosystem Habitat Goals Science Update: To be released in October 2016.
SLC	<ul style="list-style-type: none"> • Facilitating AB 691 (Chapter 592, Statutes of 2013) compliance: Requires local legislative grantees (e.g. ports and local jurisdictions that manage state-owned public trust lands) to address the impacts of sea-level rise on granted public trust lands. • Sea-level rise vulnerability tools webpage.



4. Share Information and Educate – CONTINUED

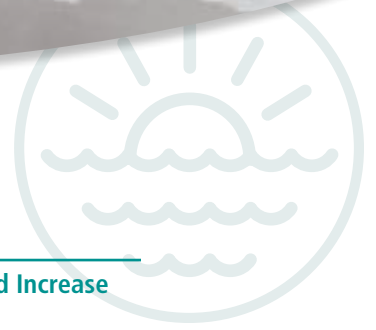
Cross-agency	<ul style="list-style-type: none"> • California Collaborative on Coastal Resilience: Public workshop in Humboldt Bay included approximately 100 participants from a number of sectors; reports based on workshop results are currently being drafted. • State Coastal Leadership Group on Sea-level Rise • Coastal Sediment Management Workgroup
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APPENDIX D.

STATE COASTAL AGENCIES' NEXT STEPS, ORGANIZED BY THE RECOMMENDATION CATEGORIES IN SAFEGUARDING CALIFORNIA

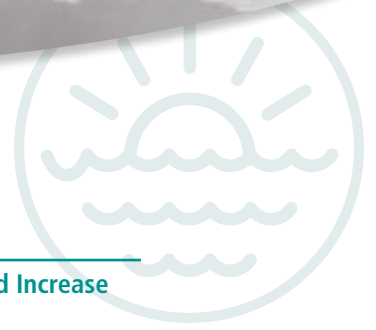
1. Improve Management Practices for Coastal and Ocean Ecosystems and Resources, and Increase Capacity to Withstand and Recover from Climate Impacts

AGENCY	ACTIONS
BCDC	<ul style="list-style-type: none"> • Update BCDC's policies and regulations: As needed, to reflect new information and understanding regarding adaptation and to increase effectiveness of BCDC's programs. • Adapting to Rising Tides: Expand the program to the nine Bay Area counties. • Provide support through regulatory and planning work.
CCC	<ul style="list-style-type: none"> • CCC 2013-2018 Strategic Plan: Continue to develop policy guidance for addressing impacts of climate change, assess coastal resource vulnerabilities to guide development of priority coastal adaptation planning strategies, and reduce greenhouse gas emissions through support of smart growth, other mitigation measures, and public education. • LCP Local Assistance Grant program: Make an additional \$3 million in funds (in addition to the \$2 million already awarded) available to local governments to support LCP updates and sea-level rise vulnerability assessments. • <i>Sea Level Rise Policy Guidance</i>: Conduct ongoing outreach and coordination with partners to provide information and guidance through workshops, presentations to local governments, and educational materials. • NOAA-funded Project of Special Merit: CCC staff to develop policy guidance and model ordinance language for resilient shoreline residential developments in hazardous areas affected by sea-level rise. • Technical support for local adaptation: CCC staff to continue to work with local partners on vulnerability assessments as well as policy and ordinance development for adaptation. • Provide support through ongoing regulatory and planning work.



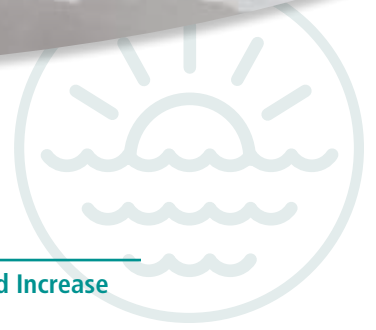
1. Improve Management Practices for Coastal and Ocean Ecosystems and Resources, and Increase Capacity to Withstand and Recover from Climate Impacts – C O N T I N U E D

AGENCY	ACTIONS
DPR	<ul style="list-style-type: none"> • Implement and improve upon policy and guidance: For evaluating potential impacts from sea-level rise related flooding or inundation on proposed projects. • Training: Consider and better anticipate increased emergency services related to climate-induced stressors in future training. • Restoration projects: Expand implementation of restoration projects in coastal park units. Collaborate on innovative shoreline management opportunities. • Sediment-related projects: Continue to undertake planning for and support projects that restore natural sources of sediment. Engage on additional coastal sediment management issues through Division of Boating and Waterways.
OPC	<ul style="list-style-type: none"> • <i>AB 2516: Track development actions.</i> • Shared vision of ocean and coastal health: With the OST, continue to bring together managers, scientists, tribal representatives and other groups to build a shared vision for ocean and coastal health and successful adaptation by addressing questions such as: <i>How will we know if our management actions are resulting in healthy ocean and coastal areas? What are concrete actions that agencies and researchers can take to reduce the impacts of OAH? How can we increase the climate resilience of our fisheries? How can we determine if we are successfully adapting to sea-level rise? How can we use marine protected areas as living laboratories to understand changing ocean conditions and to offer refuges from stressors?</i> • Further strengthen institutional partnerships: Enhance partnerships to cross boundaries and leverage resources through initiatives such as the State Coastal Leadership on Sea-level Rise, West Coast OAH Panel, Marine Protected Area Collaboratives and Partnership Plan, West Coast Governor’s Alliance on Ocean Health, and the emerging West Coast Ocean Partnership. • Convene groups to discuss priority issues: Identify lead agencies on cross-cutting issues, based on agency mandates, scientific information needed to support decision-making, and ways in which the state’s MPAs can be used to promote ocean and coastal health in the face of climate change.
SCC	<ul style="list-style-type: none"> • Continue to implement dozens of projects that support better management practices and capacity building. Areas of focus will continue to include promoting innovative design of new structure/infrastructure in areas vulnerable to sea-level rise, supporting pilot projects for innovative shoreline management, studying and investing in cost-effective green infrastructure, furthering progress toward a more integrated ecosystem approach, and continuing to develop the State Sediment Master Plan and sediment management. With Proposition 1 funding, the SCC expects to do more work on saltwater intrusion into groundwater.



1. Improve Management Practices for Coastal and Ocean Ecosystems and Resources, and Increase Capacity to Withstand and Recover from Climate Impacts – CONTINUED

AGENCY	ACTIONS
SLC	<ul style="list-style-type: none"> • Improve SLC capacity to address sea-level rise: Expand the policy development, agency coordination, and outreach activities of the SLC Sea-level Rise Program. Explore new initiatives to address implementation gaps related to activities necessary to protect and enhance the public’s rights under the Public Trust Doctrine and associated Public Trust resources, avoid hazards, and anticipate/reduce climate-related emergencies on SLC land. New staff is needed in the legal, boundary, and science classifications in order to accomplish SLC resiliency goals and would help SLC address the legal implications involved in boundary changes between sovereign land and private upland, boundary dispute resolution, and updated leasing policies that incorporate climate change and sea-level rise adaptation. • Concrete implementation steps: Include addressing the increased incidences of coastal armoring to protect private property and participating in innovative solutions that consider both private and public property interests, as well as ecosystem protection (including the use of living shorelines and other green infrastructure); continuing to incorporate sea-level rise into staff’s analysis and recommendations (e.g., alternatives to reduce impacts) for new development projects; working with lessees to adapt existing and future facilities/structures to account for sea-level rise and increased storm events; and developing lease terms to protect the state from hazard liability associated with sea-level rise and increased storm events.
Cross-agency	<ul style="list-style-type: none"> • Strengthen existing coastal and ocean policy and legislation to promote adaptation and resilience: <ul style="list-style-type: none"> o Starting with prior efforts to do so, review existing legislation and policy pertinent to coastal and ocean areas to identify the components that support adaptation actions such as managed retreat and rolling easements, and the components that hinder it. In addition to considering coastal and ocean-specific legislation and policy, examine potential conflicts with legislation such as the federal Clean Water and Endangered Species Acts. o Upon completion of the review, convene a legal and policy clinic involving federal and state agencies, local governments, engineers, lawyers, and ecologists who can: <ul style="list-style-type: none"> • Contribute to a conversation about how to reinterpret/modify the existing legislative and policy framework to promote resilience; • Identify concrete policy and legislative opportunities to support improved capacity to address adaptation issues, integrate climate into relevant decision-making, and discourage maladaptation; and • Recommend options to create new funding mechanisms. o Evaluate the recommendations provided by the expert group, and look for opportunities to implement them, where appropriate, to strengthen adaptation and resilience. • Develop and distribute a California Environmental Quality Act checklist that facilitates application of state policy and technical guidance on sea-level rise.



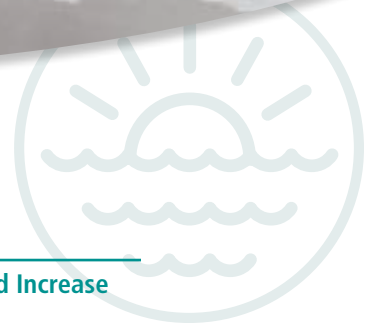
1. Improve Management Practices for Coastal and Ocean Ecosystems and Resources, and Increase Capacity to Withstand and Recover from Climate Impacts – CONTINUED

AGENCY	ACTIONS
Cross-agency (continued)	<ul style="list-style-type: none"> • Prioritize non-armoring solutions to erosion, storm events, and sea-level rise, including natural protective infrastructure, where feasible and appropriate, in existing and new development: <ul style="list-style-type: none"> o <i>Limit armoring</i> <ul style="list-style-type: none"> • Resolve conflicts in Coastal Act sections 30235 and 30253 to limit the availability of armoring. • Strengthen the SLC’s and CCC’s enforcement authorities and capacities to address unlawful armoring structures. • Clearly define a legitimate “sudden unexpected emergency,” limit the availability of emergency seawall permits to these instances, and improve mechanisms to force removal of emergency armoring structures in the absence of longer-term authorization. o <i>Prioritize non-armoring solutions</i> <ul style="list-style-type: none"> • Prepare a technical analysis (e.g., environmental and cost analysis), specifications, and guidance, for non-armoring approaches and their applicability to different shoreline types for use by project proponents in planning and designing projects. Convene regulators and identify options for streamlining permits for designs that meet regulatory criteria while promoting broader state coastal and ocean adaptation goals. • Provide funding to implementing agencies such as the SCC to incentivize construction of on-the-ground non-armoring solutions. • Ensure that public funding and government decision-making prioritize non-armoring solutions and do not increase the vulnerability of infrastructure or property. • Draft a clear, consistent statement on the State’s approach to protect and enhance the public’s rights under the Public Trust Doctrine as it relates to impacts from sea-level rise: The CCC and SLC, in collaboration with the other member agencies of the State Coastal Leadership Group on Sea-level Rise, to develop language clearly articulating the State’s approach to protect and enhance the public’s rights under the Public Trust Doctrine as it relates sea-level rise impacts. Share the language with other regulatory trustees, legislative trustee entities (e.g. ports), and state agencies so that they can insert it into their projects, programs, and grant documents, as appropriate. • Continue to allocate grant funding for disadvantaged coastal communities: Continue to provide funding to disadvantaged coastal communities through programs such as the Climate Ready and LCP grants. Use criteria from the U.S. Census Bureau’s American Community Survey or from the California Environmental Protection Agency’s Communities Environmental Health Screening Tool to determine qualifying disadvantaged communities. • Include adaptation co-benefits as a consideration for projects funded by cap-and-trade money: Work with the California Air Resources Board to define adaptation co-benefits, and develop criteria to promote consideration of defined adaptation co-benefits into projects supported by cap-and-trade funding.



1. Improve Management Practices for Coastal and Ocean Ecosystems and Resources, and Increase Capacity to Withstand and Recover from Climate Impacts – CONTINUED

AGENCY	ACTIONS
Cross-agency (continued)	<ul style="list-style-type: none"> • Integrate scientific advances into state planning and decision-making: The OPC, with the OST, to develop and implement a broader process for incorporating advances in climate change science into updates of the State’s sea-level rise guidance, based on an assessment of state agencies’ and local governments’ use of the existing guidance. Work with the Technical Advisory Group established by the OPR to identify opportunities to inform the development of guidance for other climate change variables and support implementation of Executive Order B-30-15. • Promote the integration of natural resource and community issues: Apply the technical analysis, specifications, and guidance developed for non-armoring approaches to plan and design pilot projects that support integration of the natural and built environments in adaptation planning (e.g., restoring wetlands’ functions also to strengthen their capacity to buffer against climate change). Use the results of the pilot projects (e.g., integrating the update to the Baylands Ecosystem Habitat Goals with regional and local land use planning efforts) and case studies to illustrate where, when, and how to integrate natural resource and community issues. • Complete and update the State’s regional sediment management plans: Draft coordinated regional sediment plans to provide for sediment to increase resilience of coastal habitats, such as reconnecting sediments from watersheds to feed downstream wetlands and littoral systems, and facilitating the effective use of dredged material from navigation projects in tidelands restoration. • Develop state agency adaptation plans to support a shared vision of coastal and ocean health: Based on vulnerability assessments, create agency-specific adaptation plans to identify actions that can be taken to address aspects of agencies’ programs that are vulnerable to climate change stressors and to build adaptive capacity. Include description of actions to incorporate climate policies such as Executive Order B-30-15 into all relevant agency decision-making. • Obtain funding to support critical work planning for the impacts of sea-level rise and climate change: Identify agency priorities, needed actions to build agency capacity, including allocating staff time to coordinate on adaptation and resilience issues, and required funding. Make the case to the legislature for funding, and apply for federal grants for related projects. • Integrate adaptation considerations into agencies’ funding guidelines, project selection criteria, and review processes: Develop a shared understanding across state coastal agencies of metrics and prioritized adaptation measures that support broader goals for coastal and ocean health. Identify key state agency funding decisions (e.g., Water Board, Department of Water Resources’ Integrated Regional Water Management program, Department of Transportation) in which sea-level rise considerations are not fully integrated, and work with the relevant agencies to incorporate state policy and technical guidance on sea-level rise and other climate impacts.



1. Improve Management Practices for Coastal and Ocean Ecosystems and Resources, and Increase Capacity to Withstand and Recover from Climate Impacts – C O N T I N U E D

AGENCY	ACTIONS
Cross-agency (continued)	<ul style="list-style-type: none"> • Strengthen local planning mechanisms to require science-based planning for sea-level rise and implementation of established plans in ways that protect public access and natural resources: <ul style="list-style-type: none"> o Ensure that local governments, including port districts, have access to planning and implementation funds. o Reinforce the CCC’s adopted Sea Level Rise Policy Guidance. o Support the adoption of standardized erosion rate and setback distance calculations to address changes anticipated to result from sea-level rise. o Prepare regional adaptation strategies, where appropriate, to integrate adaptation planning across jurisdictions, using a collaborative approach involving local, regional, and state entities. o Identify critical areas of habitat at risk along the coast and areas needed to allow them to migrate as seas rise. Prioritize funding to acquire and preserve them. • Reduce coastal flooding: Provide funding to implement “no regrets” projects that will reduce the impacts of flooding associated with future sea-level rise. • Develop steady funding to pay for sea-level rise adaptation by the state. • Pursue non-armoring responses to sea-level rise and related hazards for public-owned lands: Include options such as relocating public development (e.g., buildings, parking areas, roadways, utilities), rather than spending taxpayer money to temporarily protect structures in hazardous areas. • Apply an equity lens to coastal and ocean climate change adaptation activities: Develop guidelines to help state agencies and localities evaluate the impacts of adaptation to ensure that disadvantaged communities do not disproportionately bear the costs of adaptation. • Build adaptation knowledge base: Develop criteria for tracking projects (in different types of locales and ecosystems, under different timeframes, for different types of actions) and summarize lessons learned to start to develop a collective body of knowledge. This will allow for a targeted use of limited resources to capture lessons learned.

2. Better Understand Evolving Trends that May Impact Ocean and Coastal Ecosystems and Resources

AGENCY	ACTIONS
SCC	<ul style="list-style-type: none"> • Work with the Federal Emergency Management Agency and local partners to collect beach profile data and high-water mark data in the winter storm season.
SLC	<ul style="list-style-type: none"> • Expand the Marine Renewable Energy Working Group by supporting the addition of federal staff (Bureau of Ocean Energy Management) via a formal Task Force request, which would help fulfill the recommendation related to the <i>Impacts and Opportunities of Renewable Energy Development in Safeguarding California</i>.



3. Better Understand Climate Impacts on Ocean and Coastal Ecosystems and Resources

AGENCY	ACTIONS
BCDC	<ul style="list-style-type: none"> • Adapting to Rising Tides: Nine County Assessment. • 50th Anniversary Celebration.
DPR	<ul style="list-style-type: none"> • Study on the vulnerability of DPR’s coastal resources: Initiate an examination of DPR’s natural and cultural resources’ projected exposure to sea-level rise-related flooding and inundation. This study will be a crucial step towards developing a departmental strategy for addressing sea-level rise impacts.
OPC	<ul style="list-style-type: none"> • Create an approach for integrating scientific advances into state planning and decision-making: <ul style="list-style-type: none"> o Develop process and criteria for updating sea-level rise guidance and for integrating scientific advances on sea-level rise into planning and decision-making. o Develop and implement outreach, communications, and capacity-building strategy, based on the results of a needs assessment, to facilitate use of the revised guidance by state agencies and their partners and to communicate the updating process. Produce and disseminate materials. o Convene a working group for the OPC Science Advisory Team and relevant state agencies to discuss state priorities for future sea-level rise research. The working group will meet annually to set priorities.
SCC	<ul style="list-style-type: none"> • Southern California Wetlands Recovery Project Regional Strategy: Lead update of the Regional Strategy to consider climate change. • Coastal wetlands: Identify vulnerability of coastal wetlands and priority upland transition sites. • California Coastal and Estuarine Land Conservation Program Plan: Update to address climate impacts. Continue to support vulnerability assessments and economic analyses in coastal communities around the state and San Francisco Bay Area.
SLC	<ul style="list-style-type: none"> • Identification and mapping of coastal infrastructure and vulnerable sites: Identify and map existing infrastructure and impediments to coastal access. Identify historically contaminated sites or current industrial sites that could be vulnerable to inundation and develop response plans. • Additional staff: Needed to assist local trustees of granted lands in assessing the impacts of sea-level rise on their granted public trust lands, as required by AB 691. • Capacity to analyze potential sea-level rise impacts: Improve capacity to use integrated spatial tools for planning, risk management analysis, and internal and external communication/education. • Interactive sea-level rise mapping and analysis platform: Participate in developing a platform that can be shared across agencies, applicants, grantees, and others, and which would contribute to all four of the broad <i>Safeguarding California</i> Ocean and Coastal Ecosystems and Resources recommendations.



3. Better Understand Climate Impacts on Ocean and Coastal Ecosystems and Resources – CONTINUED

AGENCY	ACTIONS
Cross-agency	<ul style="list-style-type: none"> • Conduct “quick and dirty” assessments to evaluate vulnerability of agencies’ coastal assets: Using available tools and resources, conduct preliminary assessments of the vulnerability of agencies’ coastal infrastructure assets to storms and sea-level rise. The results of the preliminary assessments can be used to determine where additional detailed vulnerability and risk assessments are needed to inform further action. Where detailed assessments are deemed unnecessary due to limited exposure and/or sensitivity to climate risks, develop monitoring plans for the assets. For high-risk assets, detailed assessments are to be used to identify appropriate adaptation actions. Where relevant, link to disaster risk-reduction efforts. • Assess vulnerability of future coastal public access to rising sea levels: Conduct a vulnerability assessment of coastal public access to increasing sea levels in 2025, 2050, and 2100. The goal is to have a shared understanding of what may be compromised or lost due to sea-level rise and to identify actions that need to be taken to maintain and/or improve public access. Ensure that all projects that include public access provide for its resilience to increasing sea levels. Prepare regional strategies that assess and plan for resilience of public access to rising sea levels.

4. Share Information and Educate

AGENCY	ACTIONS
BCDC	<ul style="list-style-type: none"> • Adapting to Rising Tides: Nine County Assessment and Help Desk. • 50th Anniversary Celebration.
CCC	<ul style="list-style-type: none"> • Develop culturally and linguistically relevant educational materials for diverse populations (e.g., vulnerable communities, school-age children, business, and labor): Use best practices in climate change education to promote an understanding of the risks associated with climate change.
SCC	<ul style="list-style-type: none"> • Southern California Wetlands Recovery Project Regional Strategy: Update to consider climate change. • Baylands Ecosystem Habitat Goals Update: Communicate findings and recommendations to stakeholders and decision makers • Vulnerability assessments and economic analyses: Continue to support sharing of results with stakeholders around the state. • Beach profile information: Support data collection at selected locations.



4. Share Information and Educate – C O N T I N U E D

AGENCY	ACTIONS
Cross-agency	<ul style="list-style-type: none"> • Support existing staff and technical expertise, and provide additional staff resources within the coastal zone management program to build durable capacity: Provide funding to maintain highly trained and experienced staff at the state coastal agencies to continue to provide on-the-ground support, and serve as regional specialists on advisory committees. Provide additional staff to state coastal agencies, as needed, to work with project/permit applicants, grant recipients, and local governments to increase their capacity for adaptation planning, such as through the Help Desk that BCDC’s ART program provides for local governments. • Create a framework for thinking through trade-offs involved in adaptation decisions: Develop and disseminate an actionable, flexible framework to help state agencies consider trade-offs involved in adaptation decisions to inform selection and prioritization of adaptations. • Compile and collaboratively identify and implement management actions to respond to climate change in coastal and marine areas, including parks, reserves, and protected areas: Bring together state coastal agencies (e.g., OPC, SCC, and DPR) to identify pilot projects and implement green solutions at State Parks and other protected areas. Based on results of pilot projects and other implementation efforts, identify criteria to help planners and managers evaluate and prioritize adaptation measures. • Fund the development of guidelines to inform regional and local use of sea-level rise data and information – Support preparation of guidelines to help regional and local planners and decision-makers navigate the differences between available sea-level rise guidance and downscaling products, understand the general impacts predicted by these products, and appropriately frame requests to technical experts to ensure receipt of needed inputs. • Improve state agency websites to incorporate the latest recommendations on climate communications. • Improve the availability of relevant data, guidance, and technical resources related to armoring. <ul style="list-style-type: none"> o Compile comprehensive statewide data and information regarding the use, locations, and consequences of armoring. o Support the development of legal guidance that helps state and local entities comply with constitutional requirements and avoid “takings” liability when they promote non-armoring responses to sea-level rise and related coastal hazards. o Support consistent statewide monitoring of armoring impacts. o Support the development of standard methodologies for calculating impacts and identifying mitigation measures that account for the full value of impacts caused by armoring, including impacts to neighboring properties. o Support pilot projects that demonstrate the feasibility and value of non-armoring solutions at the community scale.



APPENDIX E. DRAFT SCC INDICATORS FOR PLANNING PROJECTS – VULNERABILITY ASSESSMENT AND ADAPTATION PLANNING

INDICATORS: PLANNING PROJECTS - VULNERABILITY ASSESSMENTS		
Logic Level	Result (goal, outcome, output)	Indicators
Goal: SCC Strategic Plan	Strategic Plan, Goal 7: Resilience of coastal communities and ecosystems to the impacts of climate change enhanced	Objective 7A: (Whether or not) Significant climate-related threats, management challenges, and priority technical assistance needed (to maintain resilient coastal communities and natural resources) identified.
		Objective 7B: (Whether or not) Vulnerability assessments conducted and adaptation plans and strategies developed (that address threats to coastal communities and public infrastructure in ways that protect natural resources and provide maximum public benefits).
		Objective 7C: (Whether or not) Vulnerability assessments of uplands and waterways conducted, and adaptation plans developed, (that address impacts to natural resources, biodiversity, and critical habitat).
		Objective 7F: (Whether or not) Projects that reduce GHG emissions (by increasing carbon sequestration or supporting land uses that reduce energy consumption including vehicle miles traveled) implemented.
Goal: SCC Strategic Plan	Strategic Plan, Goal 1: Develop the California Coastal Trail as a major recreational amenity, tourist attraction, and alternative transportation system	Objective 1F: Improve [planning for] accessibility for people with disabilities [and disadvantaged communities].
Goal: SCC Strategic Plan	Strategic Plan, Goal 9: Expand environmental education efforts to improve public understanding, use, and stewardship of coastal resources	Objective 7F [Plan to] Implement projects that reduce greenhouse gases by increasing carbon sequestration, or by supporting land uses that reduce energy consumption including vehicle miles traveled.
Outcome	Follow-up action taken	Whether or not follow-up action taken, and descriptive details of what that follow-up action was.
Outcome	Economic risk reduction achieved	# (Amount) in \$ of the portion of the economy that was/will be at risk, but is now/will be protected, by this project.



APPENDIX E. DRAFT SCC INDICATORS FOR PLANNING PROJECTS – VULNERABILITY ASSESSMENT AND ADAPTATION PLANNING – CONTINUED

INDICATORS: PLANNING PROJECTS - VULNERABILITY ASSESSMENTS		
Logic Level	Result (goal, outcome, output)	Indicators
Output	Key issues addressed	# of key issues addressed through project. Key issues include: Agriculture, Greenhouse gas reduction/mitigation, sea-level rise, wildlife corridors, carbon sequestration, green infrastructure (e.g. living shorelines), saltwater intrusion, fire intensity, restoration, water recharge, sediment management, protection of land, protection of open space, conservation/restoration/enhancement of habitats, trail development, invasive species management, riparian protection/enhancement/restoration, and adaptive management.
Output	Key decision-makers participated and informed	# of key decision-makers participating and informed (through project)
Output	Community members reached	# of people reached through project, disaggregated by age (children vs. adults) and income (advantaged vs. disadvantaged communities)
Output	Data is accessible to the public	Whether or not data made available
Output	Facilities constructed	# of facilities constructed
Output	Educational seminars held	# of educational seminars held
Output	Sites addressed	# of sites addressed through project
Output	Greenhouse gas strategies developed	Whether or not greenhouse gas reduction strategies developed
Output	Vulnerability assessments completed	Whether or not vulnerability assessments completed
Output	Adaptation plans/ strategies developed	Whether or not adaptation plans/strategies developed



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References

AGRICULTURE

- Baldocchi, D. and S. Wong (2008). Accumulated winter chill is decreasing in the fruit growing regions of California. *Climatic Change*, 87, S153-S166.
- California Department of Conservation. (2013). *The California Land Conservation Act 2012 Status Report*. Retrieved from: http://www.conservation.ca.gov/dlrp/lca/stats_reports/Documents/2012%20WA%20Status%20Report.pdf
- C DFA. (2013). *Climate Change Consortium: Impacts and Strategies for Resilience*.
- C DFA. (2015). Benefits of Farmland Conservation. California Department of Food and Agriculture. Retrieved from <http://www.cdffa.ca.gov/EnvironmentalStewardship/FarmlandConservation.html>
- C DFA. (2015). California Agricultural Production Statistics.
- C DFA. (2015). *California Dairy Statistics Annual 2014*.
- C NRA. (2014, July). *Safeguarding California: Reducing Climate Risk. An Update to the 2009 California Climate Adaptation Strategy*.
- Deschenes, O. and C. Kolstad (2011). Economic impacts of climate change on California agriculture. *Climatic Change*, S365–S386.
- Farr, T., C. Jones, Z. Liu. (2015). *Progress Report: Subsidence in the Central Valley, California*. NASA JPL.
- Hannah, Lee and Roehrdanz, Patrick R. and Ikegami, Makihiko and Shepard, Anderson V. and Shaw, M. Rebecca and Tabor, Gary and Zhi, Lu and Marquet, Pablo A. and Hijmans, Robert J. (2013). Climate change, wine, and conservation. *Proceedings of the National Academy of Sciences*, 110 (17):6907-6912. doi: 10.1073/pnas.1210127110
- Hatfield, J., G. Takle, R. Grotjahn, P. Holden, R. C. Izaurralde, T. Mader, E. Marshall, and D. Liverman, 2014: Ch. 6: Agri-culture. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 150-174. doi: 10.7930/J02Z13FR.
- Howitt, R.E., Medellin-Azuara, J., MacEwan, D., Lund, J.R. and Sumner, D.A. (2014). Economic Analysis of the 2014 Drought for California Agriculture. Center for Watershed Sciences, University of California, Davis, California. 20p. Available at <<http://watershed.ucdavis.edu>>



- Howitt, R.E., Duncan MacEwan, Josué Medellín-Azuara, Jay R. Lund, Daniel A. Sumner (2015). “Economic Analysis of the 2015 Drought for California Agriculture”. Center for Watershed Sciences, University of California – Davis, Davis, CA, 16 pp.
- Ingram, B. L. (2012, December 18). California Megaflood: Lessons from a Forgotten Catastrophe . *Scientific American*.
- Jackson, Louise, Van R. Haden, Allan D. Hollander, Hyunok Lee, Mark Lubell, Vishal K. Mehta, Toby O’Geen, Meredith Niles, Josh Perlman, David Purkey, William Salas, Dan Sumner, Mihaela Tomuta, Michael Dempsey, and Stephen M. Wheeler. 2012. *Adaptation Strategies for Agricultural Sustainability in Yolo County, California*. California Energy Commission. Publication number: CEC-500-2012-032.
- Lobell, D., C. Field, K. Cahill, and C. Bonfils (2006). Impacts of future climate change on California perennial crop yields: Model projections with climate and crop uncertainties. *Agricultural and Forest Meteorology*, 208-218.
- Luedeling, E., K.P. Steinmann, M. Zhang, P.H. Brown, J. Grant, and E.H. Girvetz. (2011), Climate change effects on walnut pests in California. *Global Change Biology*, 17: 228–238. doi: 10.1111/j.1365-2486.2010.02227.x
- Medellin-Azuara, J., R. Howitt, D. MacEwan, and J. Lund (2011). Economic impacts of climate-related changes to California agriculture. *Climatic Change*, S387-S405.
- Mera, R., N. Massey, D. E. Rupp, P. Mote, M. Allen, and P. C. Frumhoff (2015). Climate change, climate justice and the application of probabilistic event attribution to summer heat extremes in the California Central Valley. *Climatic Change*. doi:DOI 10.1007/s10584-015-1474-3
- Porter, Keith, Wein, Anne, Alpers, Charles, Baez, Allan, Barnard, Patrick, Carter, James, Corsi, Alessandra, Costner, James, Cox, Dale, Das, Tapash, Dettinger, Michael, Done, James, Eadie, Charles, Eymann, Marcia, Ferris, Justin, Gunturi, Prasad, Hughes, Mimi, Jarrett, Robert, Johnson, Laurie, Dam Le-Griffin, Hanh, Mitchell, David, Morman, Suzette, Neiman, Paul, Olsen, Anna, Perry, Suzanne, Plumlee, Geoffrey, Ralph, Martin, Reynolds, David, Rose, Adam, Schaefer, Kathleen, Serakos, Julie, Siembieda, William, Stock, Jonathan, Strong, David, Sue Wing, Ian, Tang, Alex, Thomas, Pete, Topping, Ken, and Wills, Chris; Jones, Lucile, Chief Scientist, Cox, Dale, Project Manager, 2011, Overview of the ARkStorm scenario: U.S. Geological Survey Open-File Report 2010-1312, 183 p. and appendixes.
- Sumner, D., J. Medellín-Azuara and E. Coughlin. (2015). *Contributions of the California Dairy Industry to the California Economy*. UC Davis Agricultural Issues Center.



USDA. (2015). *Southwest Regional Climate Hub and California Subsidiary Hub Assessment of Climate Change Vulnerability and Adaptation and Mitigation Strategies*.

Wallace, M. and B. Lockwood (2010). *Pajaro Valley Water Management Agency. Annual Report 2010. Annual Report*. Watsonville, CA: Pajaro Valley Water Management Agency.

ENERGY

Alfaro, E. J., A. Gershunov and D. Cayan. 2006. Prediction of summer maximum and minimum temperature over the central and western United States: The role of soil moisture and sea surface temperature. *Journal of Climate* 19(8), 1407-1421.

Auffhammer, Maximilian and Anin Aroonruengsawat (California Climate Change Center). 2012. *Hotspots of Climate-Driven Increases in Residential Electricity Demand: A Simulation Exercise Based on Household Level Billing Data for California*. California Energy Commission. Publication number: CEC-500-2012-021.

Baldocchi, Dennis, Eric Waller. 2014. Winter fog is decreasing in the fruit growing region of the Central Valley of California. *Geophysical Research Letters* 41:2014GL060018+

Bartos, M. D., and M. V. Chester. 2015. Impacts of climate change on electric power supply in the western United States. *Nature Climate Change*.

Brooks, Benjamin A., Deepak Manjunath (School of Ocean and Earth Sciences and Technology, University of Hawaii). 2012. *Twenty-First Century Levee Overtopping Projections from InSAR-Derived Subsidence Rates in the Sacramento-San Joaquin Delta, California: 2006–2010*. California Energy Commission. Publication number: CEC-500-2012-018.

California Energy Commission. 2013. 2013 *Integrated Energy Policy Report*. Publication Number: CEC-100-2013-001-CMF.

Climate Action Team. 2015. Climate Change Research Plan for California.

http://www.climatechange.ca.gov/climate_action_team/reports/CAT_research_plan_2015.pdf

Creamean, J. M., Suski, K. J., Rosenfeld, D., Cazorla, A., DeMott, P. J., Sullivan, R. C., White, A. B., Ralph, F. M., Minnis, P., Comstock, J. M., Tomlinson, J. M., and Prather, K. A. 2013. Dust and biological aerosols from the Sahara and Asia influence precipitation in the Western US. *Science* 339, 1572-1578.

Diffenbaugh, N. S., Daniel L. Swain, Danielle Touma. 2015. Anthropogenic warming has increased drought risk in California. *Proceedings of the National Academy of Sciences* 112:3931-3936.



Franco, Guido. 2015. *Potential Indicators for the Energy System*. Presentation at the OEHHA Workshop on Indicators of Climate Change in California. June 16-17, 2015, Sacramento.

Franco, Guido, Mark Wilson. 2005. *Climate Change Impacts and Adaption in California*. California Energy Commission Publication Number: CEC-500-2005-103-SD

Flint, Scott. 2015. *Consideration of Climate Adaption in Renewable Energy Planning and Permitting*. Presentation at the 2015 Joint Agency Workshop on Climate Adaptation Opportunities for the Energy Sector. July 27, 2015, San Francisco.

http://docketpublic.energy.ca.gov/PublicDocuments/15-IEPR-11/TN205511_20150724T142148_Consideration_of_Climate_Adaptation_in_Renewable_Energy_Plannin.pptx

IPCC, 2014. *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 [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Kavalec, C. 2015. *California Energy Demand 2016-2026 Preliminary Electricity Forecast*. Presentation at the IEPR Workshop on the California Energy Demand 2016-2026, Preliminary Electricity Forecast, July 7, 2015.

http://docketpublic.energy.ca.gov/PublicDocuments/15-IEPR-03/TN205241-5_20150703T154548_California_Energy_Demand_20162026_Preliminary_Electricity_Forec.pptx

Lempert, Robert, Ryan L. Sriver, and Klaus Keller (RAND). 2012. *Characterizing Uncertain Sea Level Rise Projections to Support Investment Decisions*. California Energy Commission. Publication Number: CEC-500-2012-056.)

Perez, Pat. 2009. *Potential Impacts of Climate Change on California's Energy Infrastructure and Identification of Adaptation Measures*. California Energy Commission Publication Number: CEC-150-2009-001

Pierce, D. W. and D. R. Cayan. In preparation. *Low stratus as a driver of electrical demand variability independent of temperature in the greater Los Angeles region*.

Radke, J. et al. 2015. *Sea level rise, storm surge, and flooding in the San Francisco Bay and Delta: Risks to Critical Infrastructure*. Presentation at the California Climate Change Symposium. August 24-25, 2015. Sacramento. 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.



OCEAN AND COASTAL ECOSYSTEMS AND RESOURCES

Bay Area Council Economic Institute, 2015. *Surviving the Storm*.

<http://documents.bayareacouncil.org/survivingthestorm.pdf>

California Emergency Management Agency and CNRA. (2012). *California Adaptation Planning Guide. Planning for Adaptive Communities*.

http://resources.ca.gov/climate/safeguarding/adaptation_policy_guide/

Carey, J. (2011, June). Global Warming and the Science of Extreme Weather. *Scientific American*, In Depth Report Extreme Weather and Climate Change.

<http://www.scientificamerican.com/article/global-warming-and-the-science-of-extreme-weather/>

CAT. (2015). Climate Change Research Plan for California.

http://www.climatechange.ca.gov/climate_action_team/reports/CAT_research_plan_2015.pdf

Chan, F., et al. (2008). Emergence of Anoxia in the California Current Large Marine Ecosystem. *Science*, 319, 920.

Climate Central - Surging Seas Risk Finder. (n.d.). Retrieved September 17, 2015.

http://ssrf.climatecentral.org/#location=CA_State_06&state=California&level=5&folder=All&geo=County&pt=t&target=&p=L&protection=

CCC. (2015). California Coastal Commission Sea Level Rise Policy Guidance.

http://documents.coastal.ca.gov/assets/slr/guidance/August2015/0_Full_Adopted_Sea_Level_Rise_Policy_Guidance.pdf

CNRA. (2009). *2009 California Climate Adaptation Strategy*.

<http://www.climatechange.ca.gov/adaptation/>

CNRA. (2014). *Safeguarding California: Reducing Climate Risk*.

http://resources.ca.gov/docs/climate/Final_Safeguarding_CA_Plan_July_31_2014.pdf

CO-CAT. (2013). California Sea-Level Rise Guidance Document.

http://www.opc.ca.gov/webmaster/ftp/pdf/docs/2013_SLR_Guidance_Update_FINAL1.pdf

Diaz, D. and Rosenberg, R. (2008). Spreading Dead Zones and Consequences for Marine Ecosystems. *Science*, 321(5891), 926-929.

Doney, S.C., et al. (2012). Climate Change Impacts in Marine Ecosystems. *Annual Review of Marine Science*, 4, 11-37.



Hall-Spencer, J.M., et al. (2008). Volcanic carbon dioxide vents show ecosystem effects of ocean acidification. *Nature*, 454, 96-99.

Hartmann, D.L., et al., 2013: Observations: Atmosphere and Surface. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., et al. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Heberger, M., et al., 2009. *The Impacts of Sea-level Rise on the California Coast*.
<http://pacinst.org/wp-content/uploads/sites/21/2014/04/sea-level-rise.pdf>

Hutto, S.V., et al. (2015). *Climate Change Vulnerability Assessment for the North-central California Coast and Ocean*.
<http://sanctuaries.noaa.gov/science/conservation/pdfs/vulnerability-assessment-gfnms.pdf>

Kirtman, B., et al., 2013. Near-term Climate Change: Projections and Predictability. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., et al. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Mathis, J.T., et al. (2014). Special Issue on Changing Ocean Chemistry. *Oceanography*, 27(1).

Mathis, J.T., et al. (2015). Ocean acidification risk assessment for Alaska's fishery sector. *Progress in Oceanography*, 136, 71-91.
<http://www.sciencedirect.com/science/article/pii/S0079661114001141#>

Melillo, N., Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014: *Climate Change Impacts in the United States: The Third National Climate Assessment*. U.S. Global Change Research Program: Washington, DC.

Moser, S., Ekstrom, J. and Franco, G., 2012. *Our Changing Climate 2012. Vulnerability & Adaptation to the Increasing Risks from Climate Change in California*.

NOAA Pacific Marine Environmental Laboratory – Ocean Acidification. (n.d.). Retrieved September 17, 2015.
<http://www.pmel.noaa.gov/co2/story/Ocean+Acidification>

NRC. (2012). *Sea Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future*. National Academies Press, Washington, D.C.



OEHHA. (2013). Indicators of Climate Change in California.

<http://oehha.ca.gov/multimedia/epic/pdf/ClimateChangeIndicatorsReport2013.pdf>

Pörtner, H.-O., et al. (2014). Ocean systems. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V et al. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 411-484.

Risky Business Project. (2015). *From Boom to Bust? Climate Risk in the Golden State*.

<http://riskybusiness.org/uploads/files/California-Report-WEB-3-30-15.pdf>

Strauss, B., C. Tebaldi, S. Kulp, S. Cutter, C. Emrich, D. Rizza, and D. Yawitz (2014). *California, Oregon, Washington and the Surging Sea: A vulnerability assessment with projections for sea level rise and coastal flood risk*. Climate Central Research Report. pp 1-29.

Walsh, J., et al. (2014). Ch. 2: Our Changing Climate. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 19-67.

West Coast OAH Science Panel. (2015). *Multiple stressor considerations: ocean acidification in a deoxygenating ocean and warming climate*.

<http://westcoastoah.org/multiple-stressors/>

TRANSPORTATION

Franco, Guido. 2015. *Potential Indicators for the Energy System*. Presentation at the OEHHA Workshop on Indicators of Climate Change in California. June 16-17, 2015, Sacramento.

Heberger et. al. 2009. *Impacts of Sea-Level Rise on the California Coast*. California Climate Change Center.

<http://pacinst.org/wp-content/uploads/sites/21/2014/04/sea-level-rise.pdf>

Porter et. al. 2011. *Overview of the ARkStorm Scenario*. United States Geological Service. Open File Report 2010-1312.

http://pubs.usgs.gov/of/2010/1312/of2010-1312_text.pdf

Rogers, J., J. Barba, F. Kinniburgh. 2015. *Risky Business: From Boom to Bust? Climate Risk in the Golden State*, K. Gordon, Eds., Risky Business Project.

<http://riskybusiness.org/uploads/files/California-Report-WEB-3-30-15.pdf>



Schwartz, H. G., M. Meyer, C. J. Burbank, M. Kuby, C. Oster, J. Posey, E. J. Russo, and A. Rypinski, 2014: Ch. 5: Transportation. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 130-149.

<http://nca2014.globalchange.gov/report/sectors/transportation>

Williams, A. P., R. Seager, J. T. Abatzoglou, B. I. Cook, J. E. Smerdon, and E. R. Cook (2015), Contribution of anthropogenic warming to California drought during 2012–2014, *Geophys. Res. Lett.*, 42, 6819–6828.

<http://onlinelibrary.wiley.com/doi/10.1002/2015GL064924/full>

