

# 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.

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## 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.

<sup>1</sup> <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 2015<sup>2</sup>). 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 California<sup>3</sup>, bird species of special concern<sup>4</sup>, rare plants<sup>5</sup>, and California amphibians and reptiles<sup>6</sup>

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 website<sup>7</sup>.

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## Current Actions

**N**umerous 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.

<sup>2</sup> [http://www.ppic.org/main/publication\\_quick.asp?i=1160](http://www.ppic.org/main/publication_quick.asp?i=1160)

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

<sup>4</sup> 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.

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

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

<sup>7</sup> <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.<sup>9</sup>

### **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

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<sup>8</sup> <https://www.wildlife.ca.gov/SWAP>

<sup>9</sup> <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.

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### **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

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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.

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.<sup>10</sup>

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.

### **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

<sup>10</sup> <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'<sup>11</sup> 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.

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

<sup>12</sup> [http://www.dfg.ca.gov/Climate\\_and\\_Energy/Climate\\_Change/Climate\\_College/](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 College<sup>12</sup>:** 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

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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.

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## Next Steps

**W**hile 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)

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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 website<sup>13</sup> 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

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<sup>13</sup> [http://www.dfg.ca.gov/Climate\\_and\\_Energy/Climate\\_Change/](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.

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## Monitoring and Evaluation

**M**onitoring 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 indicators<sup>14</sup> 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

<sup>14</sup> <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.

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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.