Climate Change Adaptation Research for Fish, Wildlife, and Plants in California
California Department of Fish and Game
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DFG Climate Change Adaptation Research

DFG Vulnerability assessments

California Bird Species of Special Concern climate change vulnerability assessment
The DFG has updated the California Bird Species of Special Concern report and conducted a climate change vulnerability assessment. Information on vulnerability criteria and the results of the vulnerability assessment ranking can now be viewed online.
Partners: PRBO Conservation Science

Climate change vulnerability assessment of rare plants in California
An assessment of the vulnerability of 156 rare plants in California to climate change using NatureServe's climate change vulnerability index.

Climate change vulnerability assessment for amphibians and reptiles in California
Planning is in progress; details TBD.

Climate change vulnerability assessment for California wildlife (TBD)
We are planning to conduct a state-wide vulnerability assessment on a range of taxa in 2012. Details TBD.

DFG Climate change impacts on species and habitats

California Bat Conservation Plan
Development of a state-wide conservation strategy for all bat species in California. The report will contain qualitative expert opinion on climate change impacts to CA bat species, and will result in specific recommendations by species, ecoregion, and conservation issue.
Partners: UC Berkeley

Ocean Acidification Exacerbated by Coastal Upwelling: Monitoring of CO2 and O2 on the California Shelf, and Studies of Their Effects on Red Sea Urchins, California Mussels and Abalone
DFG is one of eight co-investigators participating on a multi-disciplinary team that is conducting field and laboratory experiments to investigate the extent of ocean acidification at a site in coastal California. The project explores whether upwelling exacerbates acidification of California's shelf waters and the thresholds at which changes in ocean pH will impair calcification rates of native bivalves.
Partners: NOAA, Scripps, UC San Marcos, UC Santa Barbara, Humboldt State, Monterrey Bay Aquarium Research Institute

Effects of climate change on inland fishes of California: tools for adaptation
Analyses of status and trends of inland fishes of California with different vulnerabilities to climate change will be produced using the most recent models of climate change effects. Adaptation strategies for the major aquatic zoogeographic regions of California will be developed, through identification of key refuge streams for fish assemblages, including streams that could benefit from improved regulation by dams. Supported by the California LCC.

<u>Lead/Partners:</u> UC Davis, US Forest Service; California Energy Commission; Trout Unlimited; California Trout; Resource Renewal Institute; Center for Watershed Sciences (UCD)

State Wildlife Action Plan revision
We are currently compiling information on climate change impacts to 20 ecoregions in California. This database will be used to support the revision of the California's wildlife action plan. The revision will be completed by 2015.

Tidal marsh bird population and habitat assessment for SF Bay under future climate change conditions
This project will assess the potential effects of climate change on tidal marsh habitats and bird populations; identify priority sites for tidal marsh conservation and restoration; and develop a web-based mapping tool for managers to interactively display and query results. Supported by the California LCC.
<u>Lead/Partners:</u> PRBO Conservation Science; SF Bay Joint Venture; Bay Area Ecosystem Climate Change Consortium; USFWS; CA Coastal Conservancy; SF Estuary Institute; SF Estuary Partnership; BCDC; Sonoma Land Trust; UC Berkeley; San Francisco State Unviersity; University of San Francisco; USGS

DFG Base-line data and monitoring

Elkhorn Slough National Estuarine Reserve projects
Research projects include investigating salt marsh sustainability in the face of sea level rise, water quality monitoring, breeding bird monitoring, and early detection of invasions by non-native species via regular surveys.
<u>Partners:</u> NOAA, Elkhorn Slough Foundation

State-wide vegetation mapping
We are currently working to create state-wide vegetation maps for California. These maps provide a baseline of current habitat and conditions against climate change can be monitored.
<u>Partners:</u> California Native Plant Society; Wildlife Conservation Board; CA Department of Water Resources; Strategic Road Council; Sand Diego County; Sonoma County; Sierra Nevada Conservancy

Species range mapping
We are currently developing range maps for California species. This baseline information is also imperative for monitoring the effects of climate change and for use in many projection modeling exercises.
<u>Partners:</u> Funded by US Department of Energy (through the Western Governor's Association); USFWS

Association of Fish and Wildlife Agencies (AFWA and Western Association of Fish and Wildlife Agencies (WAFWA) state surveys on climate change adaptation
As chair of the WAFWA climate committee and co-chair of the AFWA climate committee, DFG has been working with other states for the past four years to annually survey state agencies to determine what climate change adaptation efforts are taking place within state agencies and

partner organizations with the goal of tracking regional accomplishments and collaborative efforts over time

Vulnerability analysis and monitoring program for detecting changes in San Francisco Bay tidal marsh bird populations resulting from climate change
This project will design a monitoring program and protocol to detect the effects of climate change on tidal marsh bird population abundance and distribution. It is a companion to "Tidal Marsh Bird Population and Habitat Assessment for San Francisco Bay under Future Climate Change Conditions" and will build on its products, enabling evaluation of the long-term viability of four tidal-marsh bird species threatened by impacts of climate change: Clapper Rail, Black Rail, Common Yellowthroat, and Song Sparrow (three endemic subspecies: San Pablo, Suisun, and Alameda). Information will be available through the California Avian Data Center. Supported by the California LCC.
Lead/Partners: PRBO Conservation Science; San Francisco Bay Joint Venture; USFWS; SF Bay Bird Observatory; San Francisco Estuary Institute; Invasive Spartina Project; CA DFG

DFG Connectivity and decision support tools

Areas of Conservation Emphasis (ACE-II)
ACE-II was developed to compile and analyze spatial information on California's biological richness, including species diversity, rarity, and sensitive habitat. The resulting set of tools and maps are used to summarize and display this information for use in conservation decision-making. This spatial model can be used to identify areas of biological or conservation interest throughout the state. ACE II can be a platform to aid climate change adaptation planning and can directly support efforts to create a system of sustainable, well connected habitat conservation areas across California as detailed in the 2009 California Climate Adaptation Strategy (CAS)[1].

Essential Habitat Connectivity Plan
Completed in 2010, the Connectivity plan is a statewide assessment of essential habitat connectivity that was conducted using the best available science, data sets, spatial analyses and modeling techniques. The plan was used to identify large remaining blocks of intact habitat or natural landscape and model linkages between them that need to be maintained, particularly as corridors for wildlife. This information will also support climate change adaptation planning efforts and implementation of the CAS.
Partners: CalTrans and over 60 local, state, federal, tribal, and NGO collaborators

Determining landscape connectivity and climate change refugia across the Sierra Nevada
This project will use species distribution modeling, population genetics, and geospatial analysis of historical vs. modern vertebrate populations to identify climate change refugia and population connectivity across the Sierra Nevada. Results will help Sierra Nevada land managers allocate limited resources, aid future scenario assessment at landscape scales, and develop a performance measure for assessing resilience. Supported by the California LCC.
Lead/Partners: UC Berkeley; United States Forest Service; United States Geological Survey; National Park Service; United States Fish and Wildlife Service

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[1] http://www.climatechange.ca.gov/adaptation/

Developing an online invasive species risk-mapping tool: Climate change adaptation through strategic management of a top ecological stressor
The California Invasive Plant Council (Cal-IPC) developed a "risk mapping" approach that combines comprehensive distribution maps with maps of current and future suitable range to show where each (invasive) species is likely to spread. The distribution maps are based on a new dataset created through a major campaign to collect expert opinion data from local resource managers across the state. From this dataset, Cal-IPC recently completed risk maps and management recommendations for 43 invasive plant species in the Sierra Nevada. The proposed project will build an online tool for these data. The tool will allow natural resource managers to generate risk maps and summary statistics for areas they select, and to determine management priorities. Supported by the California LCC.
Lead/Partners: California Invasice Plant Council; National Park Service, Pacific West Region; Climate Central; Technical advisors: UC Berkeley; Cal. Academy of Sciences; PRBO Science; Carnegie Institution Online tool design team: GreenInfo Network; Terra GIS Online tool reviewers: NPS restoration ecologists from CA national parks, Weed Management Area (WMA) participants

DFG-LCC Partnership: Regional Climate Adaptation Research

Landscape Conservation Cooperatives are science-management partnerships developed to support collaborative, adaptive, and science-based conservation efforts across the United States. California is home to four different Landscape Conservation Cooperatives including the California LCC, Desert LCC, Great Basin LCC, and the North Pacific LCC. The DFG participates on the steering committees of each of these LCCs in order to support their missions and remain engaged in their development. Through data management and science working groups, many LCCs are already working to assimilate the vast amount of existing information on conservation and climate change research, tools, and case studies to serve as a resource for end-users.

California LCC

DFG staff are active members of this collaborative partnership through roles on the steering committee and subject area working groups. Note: The CA LCC is almost entirely within the state of California

Projects funded in 2011

(http://californialcc.org/projects.html)

Climate Adaptation Commons
Project will create an online environment in which land managers and their technical support staff can quickly find the climate adaptation information they need, communicate with each other and with the researchers producing the data, and then share lessons learned.
Lead/Partners: Sonoma Ecology Center; UC Davis, PRBO Conservation Science

How do we monitor the ecological consequences of environmental change? Developing an Environmental Change Network in the California LCC: PHASE II
Project will establish an Environmental Change Network (ECN) for all of California. An ECN is an integrated, multidisciplinary network of long-term monitoring stations that gather and share information using standardized protocols. An ECN has already been created for the San Francisco Bay in Phase I of the project (http://data.prbo.org/apps/ecn/).
<u>Lead/Partners:</u> Pacific Coast and Central Calley Group and PRBO Conservation Science; Dwight Center for Conservation Science; Bay Area Early Detection; Conservation Commons; San Francisco Bay, Central Valley and Sonoran Joint Ventures

Confronting uncertainty in species distribution projections: Increasing the applicability of an essential climate change adaptation planning
The authors conduct a systematic analysis of uncertainty in modeling the future distributions of ~50 California endemic plant species and ~50 California land birds, explicitly partitioning among 5 alternative sources of variation and testing for their respective contributions to overall variation among modeled outcomes. They will map the uncertainty from identified sources, which can guide decisions about monitoring, restoration, acquisition, infrastructure, etc., in relation to climate change.
<u>Lead/Partners:</u> Center for Applied Biodiversity Informatics California Academy of Sciences; PRBO Conservation Science

Sustaining healthy ecosystems in the face of sea level rise: Ensuring the Baylands Ecosystem Habitat Goals Report continues to inform acquisition, restoration, and management of the region's baylands
The main goal of this project is to ensure that the 2011-13 climate change update to the Baylands Ecosystem Habitat Goals Report (Baylands Goals) and other key, ongoing conservation activities in the San Francisco Bay region use the latest information about the current and future status of San Francisco Bay tidal marsh ecosystems, particularly in the context of sea-level rise. The main product of the project will be the improved Sea Level Rise (SLR) Tool, specifically upgraded to inform the Baylands Goals Report update.
<u>Lead/Partners:</u> State Coastal Conservancy, Bay Area Ecosystem Climate Change Consortium, PRCO Conservation Science, SF Bay NERR; USFWS SF Bay Refuge Complex; East Bay Regional Parks; and South Bay Salt Pond Restoration Project

Decision support for climate change adaptation and fire management strategies for at risk species in southern California
Project will integrate fire risk models, species distribution models (SDMs) and population models with scenarios of future climate and land cover to project how the effects of climate-induced changes to species distributions and land use change will impact threatened species in fire-prone ecosystems. This project will also identify and prioritize potential management responses to climate change (e.g. assisted colonization, fire management, land protection, dispersal corridors).
<u>Lead/Partners:</u> UC Riverside; Arizona State University; Conservation Biology Institute; U.S. Fish & Wildlife Service; San Diego Association of Governments

Assessing climate change vulnerability and developing a climate change adaptation strategy for Sierra Nevada birds
This project will use the NatureServe Climate Change Vulnerability Index tool to assess vulnerability of 140 bird species that breed in the Sierra Nevada and will develop a peer-reviewed Climate Change Adaptation Strategy for Sierra Nevada bird species that are most vulnerable to climate change.
<u>Lead/Partners:</u> The Institute for Bird Populations; US Forest Service; Yosemite National Park; UC Davis

Pacific Coastal Fog: Using data assimilation techniques to develop ecologically relevant fog data sets, phase 1
Goal of this project is to create critically needed coastal fog datasets. Anticipated products include: 1) a compilation of existing fog related data from multiple sources, 2) USGS Open File report documenting the results of a multiday working session with climatologists, remote sensing specialists, fog modelers, statisticians, and natural resource managers, convened to review the data, examine and assess the correlations between data streams and models, specify initial parameters to be extracted from the data fusion, and define the data assimilation framework for deriving interpolations and projections, 3) an internet-based collaboration platform to share the data, and 4) a second working session to review assimilated product, discuss a longer-term strategy for operational continuity and product refinement.
<u>Lead/Partners:</u> USGS; University of Washington; University of California Santa Cruz; National Park Service.

Integrating science into decisions: Climate change/land use change scenarios and outreach for habitat threat assessments on california rangelands
This project will aid conservation of California rangelands by identifying future integrated threats of climate change and land use change, and will quantify two main co-benefits of rangeland conservation – water supply and carbon sequestration. Through a multi-stakeholder partnership, the project proponents will develop integrated climate change/land use change scenarios for the Central Valley and Chaparral and Oak Woodland eco-regions, and disseminate information about future potential threats to high priority conservation areas within the California Rangeland Conservation Coalition (CRCC) study area, which includes the foothills around the Central Valley and most of the southern Inner Coast Range.
<u>Lead/Partners:</u> USGS Western Geographic Science Center; Defenders of Wildlife; USGS Center for Science, Decisions, and Resource Management; USGS California Water Science Center

A broad-scale, multi-species monitoring protocol to assess wintering shorebird population trends in response to future land use and climate change – PHASE II
PRBO Conservation Science is developing a broad-scale monitoring program to detect trends and quantify habitat relationships for Pacific Flyway shorebird populations across the entire CA LCC.
<u>Lead/Partners:</u> PRBO Conservation Sience; USFWS; US Navy; Sonoran Joint Venture; CICESE

Maximizing evolutionary potential under climate change in southern California protected areas

The project objective is to transfer to California a previously developed prioritization framework that combines intraspecific genetic and morphological variation with traditionally used indices of biodiversity, and test its general utility for conservation prioritization. This project will integrate existing data on intraspecific variation of multiple species in the Santa Monica Mountains National Recreational Area with climate data and space-borne measurements of the environment to identify areas with high intraspecific variation.
Lead/Partners: Institute of the Environment and Sustainability, UCLA; National Park Service

Sea-level rise modeling across the California salt marsh gradient for resource managers: evaluation of methodology
This project uses bottom-up modeling at a parcel scale to measure the effects of sea-level rise (SLR) on coastal ecosystems and tidal salt marshes. The ultimate goal is to provide science support tools for local adaptation planning from the bottom-up that may be implemented under a structured decision-making framework.
Lead/Partners: USGS, North Pacific LCC; FWS Inventory and Monitoring Program, R8 and R1; NOAA National Estuary Research Reserves, Pacific coast; San Diego National Wildlife Refuges; San Francisco Bay National Wildlife Refuges; San Francisco Bay Joint Venture; South Bay Salt Pond Restoration Project; University of California, Davis, Center for Spatial Technology and Remote Sensing, Geography

Understanding impacts of climate change on ecology and habitats of waterfowl, shorebirds, and other waterbirds: Guidance for the California LCC and other wetland habitat conservation programs in the Pacific Flyway (Continuing Project)
This is Phase 2 of a project that is developing landscape change scenarios based upon downscaled climate models and projected urbanization to investigate impacts of these changes on habitats and ecology of waterfowl, shorebirds, and other waterbirds in the Central Valley. One project objective includes developing adaptive management strategies to account for climate change in waterbird habitat conservation planning in the Central Valley.
Lead/Partners: USGS; Ducks Unlimited, Inc., Central Valley Joint Venture, PRBO Conservation Science, Stockholm Environment Institute, University of California- Davis, Delta Waterfowl Foundation

Projects funded in 2010

(http://californialcc.org/projects2010.html)

Avian demographic response to climate change: a multi-species and multi-landscape approach to synthesizing risk factors
This project will provide natural resource managers with a web-based tool to easily access information on the expected variation in avian demographic responses to environmental change across a gradient of species and landscapes from the San Francisco Bay to the Central Valley of California.
Lead/Partners: USGS; PRBO Conservation Science; California Waterfowl Association

Tracking landscape change in the Central Valley: Developing critical capability, strategies, and data to guide conservation and management of birds and their habitats

This project will help the Central Valley Joint Venture (CVJV) track gains and losses of key bird and waterfowl habitats at a landscape scale. This will allow the CVJV to effectively monitor and evaluate habitats essential to conservation planning for wildlife species. This work is important for identifying, assembling, and analyzing data for key habitats of concern and will provide a foundation for future monitoring.
<u>Lead/Partners:</u> USGS; Ducks Unlimited Inc., Central Valley Joint Venture

Understanding impacts of climate change on ecology and habitats of waterfowl, shorebirds, and other waterbirds: Guidance for the California LCC and other wetland habitat conservation programs in the Pacific Flyway
This project will develop landscape change scenarios based upon water availability and precipitation and temperature patterns projected from downscaled models and investigate impacts of these changes on habitats and ecology of waterfowl, shorebirds, and other waterbirds in the Central Valley. This project will provide critical information and support to understand and incorporate likely impacts of climatic change in conservation planning.
<u>Lead/Partners:</u> USGS; Ducks Unlimited Inc.; Central Valley Joint Venture; PRBO Conservation Science

Climate-driven geomorphic alteration of intertidal foraging habitats for migratory birds in the San Francisco Bay Estuary
This project will evaluate the effects of global climate change and sea level rise on estuarine intertidal habitats in the San Francisco Bay estuary and the Pacific Flyway migratory waterbirds that rely on this critically important habitat. This work will provide valuable information through downscaling global climate modeling and conducting geomorphic modeling.
<u>Lead/Partners:</u> USGS

Incorporating the geography of climate change into conservation planning for theCalifornia Landscape Conservation Cooperative
This project will analyze downscaled climate model data to assess the geography of climate change at scales relevant to actual conservation actions. This work will analyze the California Essential Habitat Connectivity products to determine which protected lands are most vulnerable and which of the proposed corridors would partially mitigate climate change threats.
<u>Lead/Partners:</u> USGS; Bay Area Climate Change Conservation workgroup

San Francisco Bay Area Upland Habitat Goals
The Upland Habitat Goals project, now nearing completion, is a science-based process using existing data supplemented by expert opinion to identify a Conservation Lands Network for biodiversity preservation to inform conservation investments. The final report will recommend the types, amounts and distribution of habitats, linkages, compatible uses and the ecological processes needed to sustain diversity. Other products include an online decision support tool and access to a GIS database.
<u>Lead/Partners:</u> Bay Area Open Space Council; 23 agencies and non profits that have participated on the Upland Habitat Goals steering committee

A broad-scale, multi-species monitoring protocol to assess wintering shorebird population trends in response to future land use and climate change

This project will develop a sampling design and monitoring protocol for wintering shorebirds in the Central Valley and in the San Francisco Bay Estuary and develop an online shorebird monitoring portal at the California Avian Data Center. The project will document baseline conditions which is important for effectively tracking change. The work is part of a larger project to develop a statewide shorebird monitoring program in California.
Lead/Partners: PRBO Conservation Science; Ducks Unlimited, Inc.; USGS

North Pacific LCC

DFG staff are active members of this collaborative partnership through roles on the steering committee and subject area working groups. Note: The North Pacific LCC includes part of northern California.

Projects funded in 2011
(http://www.fws.gov/pacific/Climatechange/nplcc/fundedprojects2011.html)

Effects of sea-level rise on salt marshes along the Pacific coast gradient: evaluation of methodology for resource managers
The goal of this project is to apply sea-level rise (SLR) modeling approaches along the Pacific coast tidal gradient (Fig. 1) at a parcel scale through improved data collection tools and collaboration relevant to land managers. The design will include providing resource managers with information on the value of different datasets and methods including their uncertainty, as well as determining their usefulness in climate change adaptation planning in tidal marsh habitats.
Lead/Partners: USGS; UC Davis, Humboldt Bay NWR, NOAA, USFWS, CA LCC

Predicting the vulnerability of nearshore species and habitats to climate change effects
The primary objective of the research is to develop a rule-based decision support system to predict the relative vulnerability of nearshore species to climate change. By evaluating multiple species and climate stressors, the approach allows an assessment of climate vulnerability across habitat types and the impact of specific climate alterations as well as their cumulative impacts.
Lead/Partners: USGS; USFWS; EPA

Current and future distribution and abundance of North Pacific birds in the context of climate change
The project will aggregate the avian datasets for a large portion of the North Pacific LCC (Northern California, Oregon, and Washington) and use these data to model current and future distributions and abundance under three future climate models representing scenarios of low, medium and high projected temperature increases for the Pacific Northwest (Salathé et al, 2007) to provide example outcomes and interactive tools essential for conservation planning.
Lead/Partners: PRBO Conservation Science; American Bird Conservancy; Klamath Bird Observatory

A Conservation Priorities Tool for the North Pacific LCC
Project to develop an open source, spatially explicit, conservation and restoration priorities tool that will assist the North Pacific LCC and other natural resource managers, individuals, and

community organizations in accessing disparate data sources for understanding and visualizing the potential effects of climate change on freshwater and forest ecosystems throughout the North Pacific LCC geographic area.
<u>Lead/Partners:</u> Ecotrust; USFWS; Earth Systems Institute

The North Pacific forest landscape corridor and connectivity project: Assessing landscape and species vulnerability
The North Pacific Forest Landscape Corridor and Connectivity Project will utilize a landscape connectivity simulator (UNICOR) and a genetic simulation program (CDPOP) to model the functional (dispersal and genetic) connectivity in the North Pacific Landscape. This project will provide land managers and researchers with spatial corridor and connectivity pathway products that can be used to assist in conservation and management decisions.
<u>Lead/Partners:</u> University of Montana

Moving from impacts to action: Expert focus groups for climate change impacts and adaptation strategies in marine and freshwater ecosystems of the North Pacific LCC
NWF will create twelve expert focus groups to meet the need for a comprehensive (multi-taxa, multi-trophic level), cross-disciplinary (linking biological, physical, and ecological data) discussion of the most up-to-date information on climate change effects and adaptation strategies in marine/coastal and freshwater ecosystems across the NPLCC landscape. This project would connect NPLCC members and stakeholders with information they need in order to identify, support, and coordinate conservation actions that address climate change in marine/coastal and freshwater ecosystems across the NPLCC landscape. Note: The CDFG is participating in these focus groups.
<u>Lead/Partners:</u> National Wildlife Federation; University of Washington