Ecology, Conservation Biology, Climate Change, and the Berryessa – Snow Mountain National Conservation Area

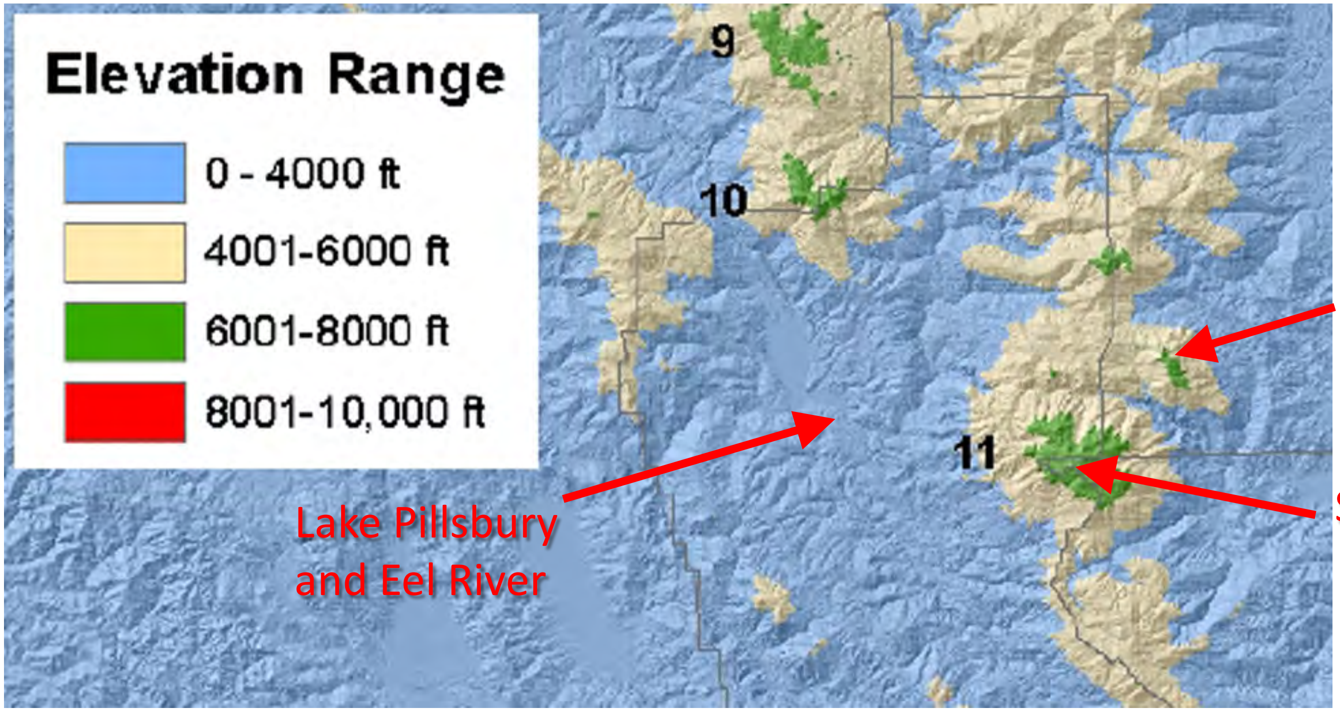
Chad Roberts, Ph.D.
Roberts Environmental and Conservation Planning LLC, Davis, CA

AEP - Sacramento, 24 Jan 2012

The Inner Coast Range: Lake Berryessa to Snow Mountain


Snow Mountain
Lake Pillsbury
and Eel River
Lake
Clear Lake
20
Indian Valley
Reservoir
53
281
North Fork Cache Creek
Cache Creek
5.63 km
© 2011 Google
Image © 2012 DigitalGlobe
Image © 2012 GeoEye
Google earth
Imagery Date: 8/17/2011
lat 39.108854° lon -122.668540° elev 966 m
Eye alt 25.95 km

Land Elevations in the BSM Region Accommodate "Poleward and Up" Climate Adaptation Movements

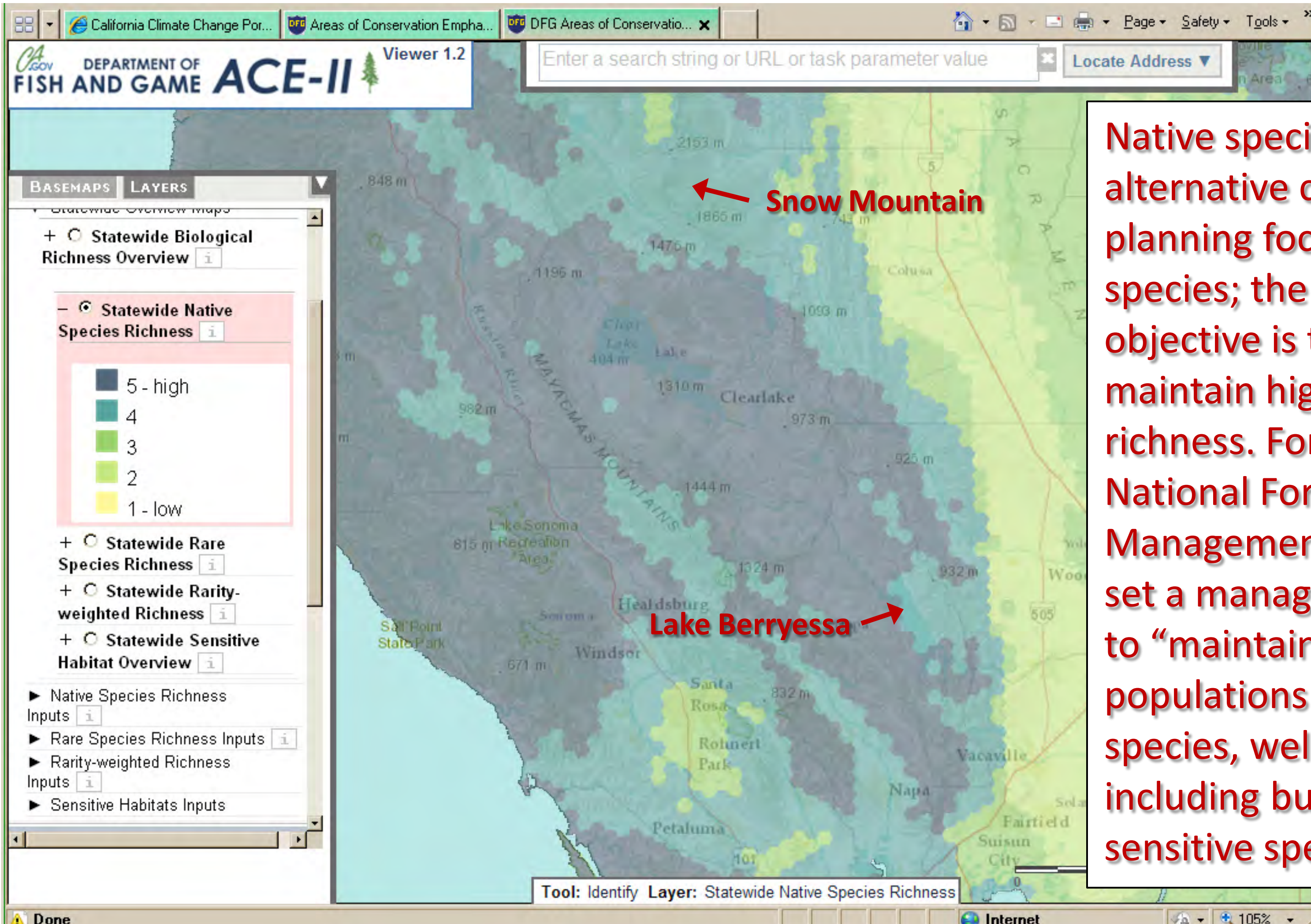


Lowland areas in public lands near Lake Berryessa occur at 100 feet above sea level. Elevations increase in a South-to-North gradient from Lake Berryessa to Snow Mountain. At 7xxx feet, Snow Mountain is the highest landscape element in the region proposed for NCA inclusion. Snow Mountain is the southernmost high-elevation landscape element in the Klamath-Siskiyou bioregion.

Sensitive Biological Elements Are Abundant in the Berryessa – Snow Mountain Region

- Parts of the Berryessa-Snow Mountain region have yet to be fully surveyed for sensitive species and other elements; reported results (e.g., CNDDB) should be considered partial and incomplete.
- As of 2008, the region included 550 mapped occurrences of 108 sensitive elements (69 plants, 8 invertebrates, 2 fish, 3 herptiles, 10 birds, 9 mammals, and 7 community types).
- Elements are associated with serpentinitic substrates, Pleistocene-relict vegetation occurrences, and uncommon habitat elements (e.g., older-age forests).

The BSM Region is Biologically Species-Rich, with Many Native Species



Native species are an alternative conservation planning focus to sensitive species; the conservation objective is to protect and maintain high native species richness. For example, the National Forest Management Act formerly set a management objective to "maintain viable populations of native species, well distributed," including but not limited to sensitive species.

Biological Diversity Elements in the Berryessa – Snow Mountain Region and Adjacent Lowlands

Group	Agricultural/Floodplain Basins [A]	Woodlands/Chaparral	Coniferous Forests
Native Plant Species	719-838	1409 – 1705 [B]	1409 – 1705 [B]
Vegetation Richness [C]	26-35	36 - 53	54 - 82
Amphibian Species	4 - 6	7 -10	7 -10
Reptile Species	6 - 11	12 - 18	19 - 25
Bird Species (Summer)	(91 – 108) [D]	91 - 108	109 – 127
Bird Species (Winter)	144 - 187	118 - 143	91 - 117
Mammal Species	22 - 39	40 - 47	48 - 55

Source: *Atlas of the Biodiversity of California*. CDFG (2003).

Notes:

A Presumed to include species of riparian affinity.

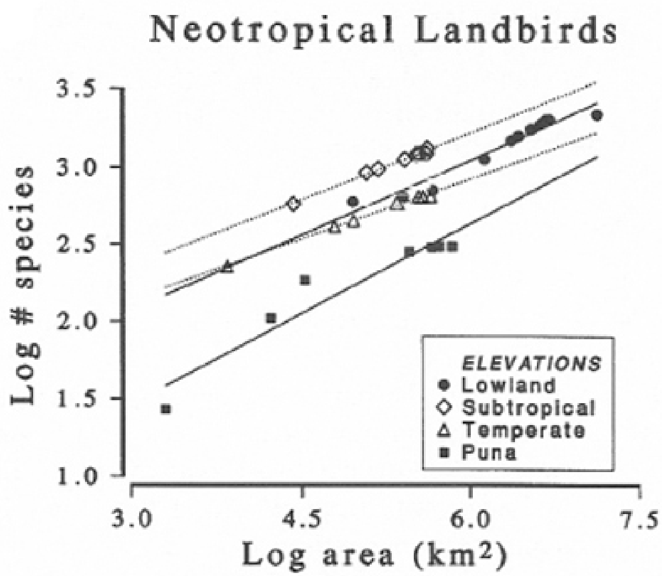
B Mapping in the Atlas does not identify a diversity difference between woodland and forest areas in this region.

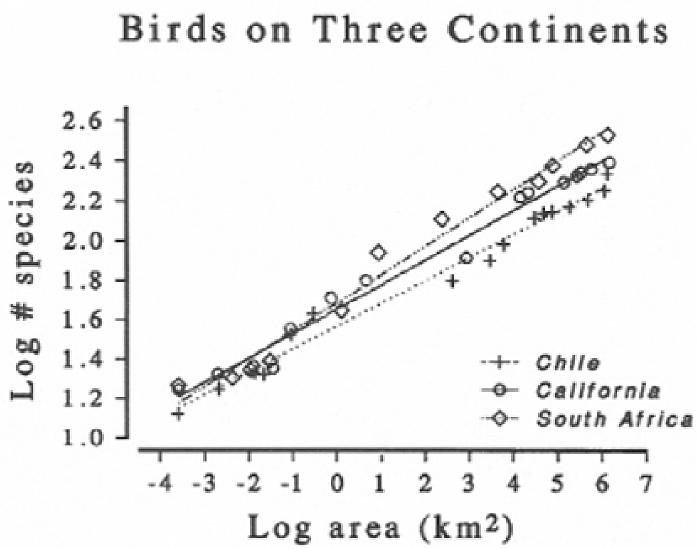
C Numbers of “Plant Alliances.”

D Most breeding birds in agricultural regions are associated with remnants of natural habitat types, rather than with agricultural areas *per se*.

What lessons does science offer about the effects of past climate change? What guidance does science provide for conservation planning in response to current and future climate change?

Good Conservation is Based on Well-Established Ecological Principles

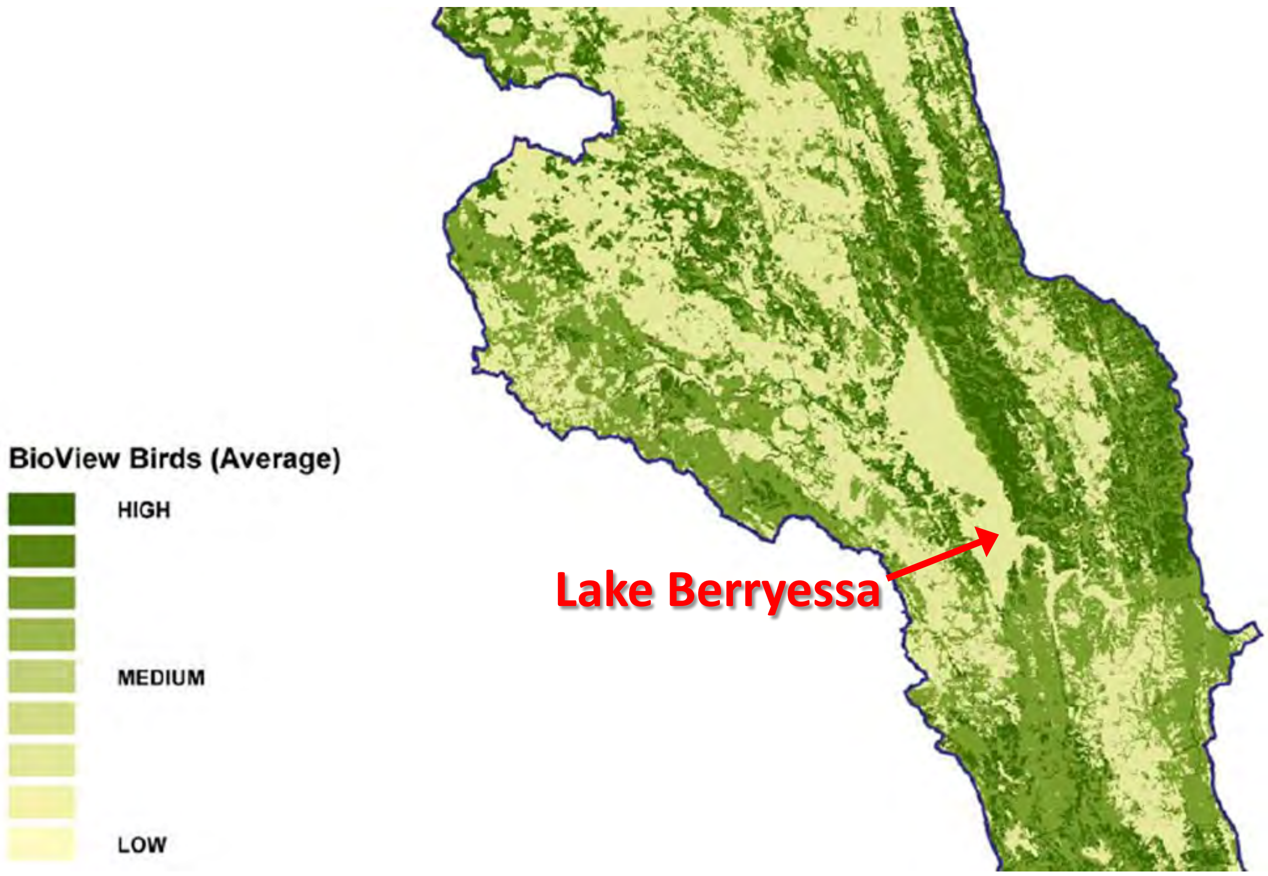




- A fundamental conservation planning precept stems from a basic biogeographical phenomenon called the ***Species-Area Relationship*** (SAR), which states (in the simplest way) that ***larger land areas always provide habitat for more species***.
- The upper panel shows an increase in bird species diversity with increasing area in four general habitat types in areas that range over more than three orders of magnitude. The differing curves indicate that different habitat types provide differing intrinsic habitat values.
- The lower panel indicates that the S-A relationships for birds in similar habitats (chaparral) on several continents are fundamentally similar for similar habitat or plant association types.
- The SAR is related to other fundamental ecological relationships indicating that additional individuals (which are expected in larger habitat areas) include increasing numbers of rare species.
- The net result of basic ecological relationships such as these is that ***protecting areas as large as possible is a basic means of conserving biological diversity***.

Habitat Suitability is Determined by Species Preferences, and Is Not Uniform

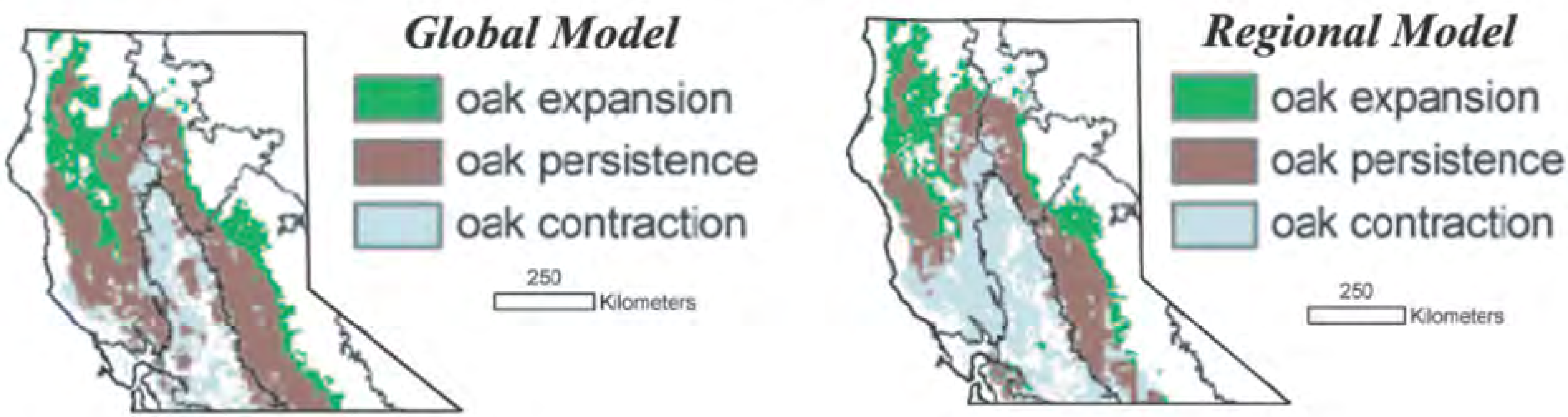
- CWHR GIS-data map for average bird habitat suitability in the Lake Berryessa region.
- Darkest areas are oak woodlands and riparian areas, known to be preferred by many bird species (maps for other taxon groups are similar).
- These areas form the essential core of a regional landscape conservation planning framework for maintaining biodiversity.



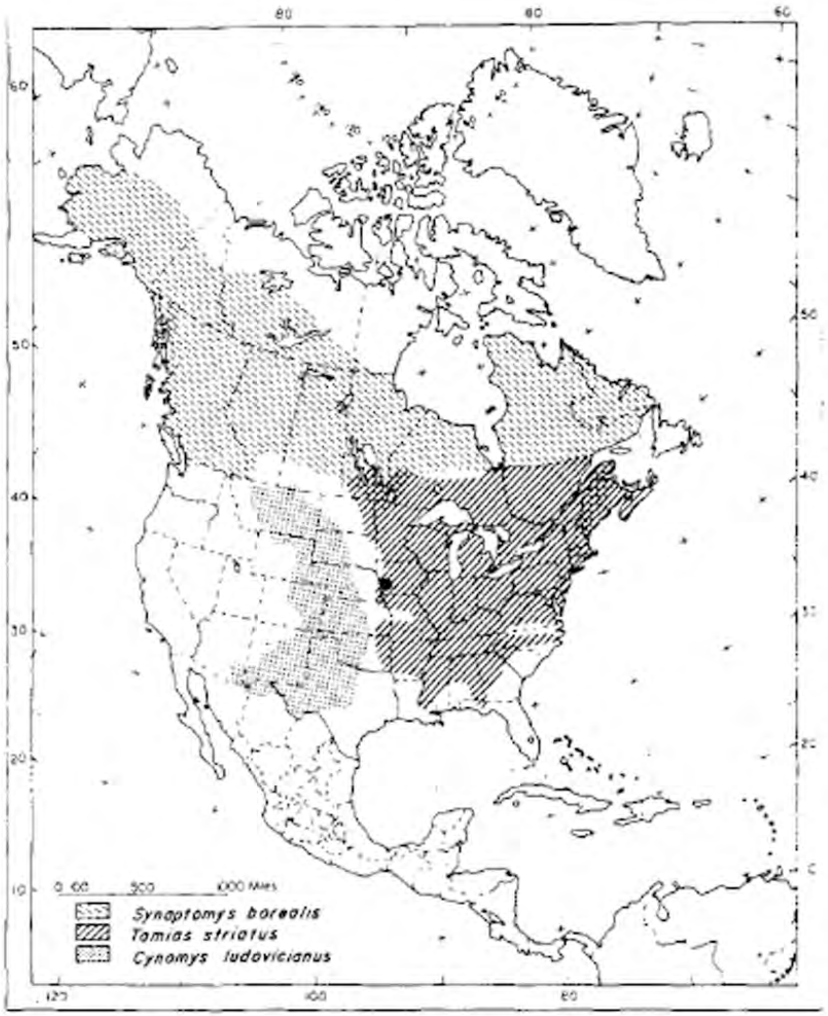
Bioclimate-Envelope Modeling Results for Oaks in Northern California

- Left panel represents typical results from modeling using “global” models such as those used by the International Panel on Climate Change (IPCC).
- Right panel was simulated by regionalized climate modeling (Kueppers et al 2005).
- Both projections suggest a reduction in the future occurrence of oaks (including valley oak as well as blue oak) in the Berryessa – Snow Mountain region, with the regional projection suggesting significant reductions.

Modeled Blue Oak Range Shifts Resulting From Climate Change



Post-Pleistocene Dissociation of Plant and Animal Associations is Well-Documented

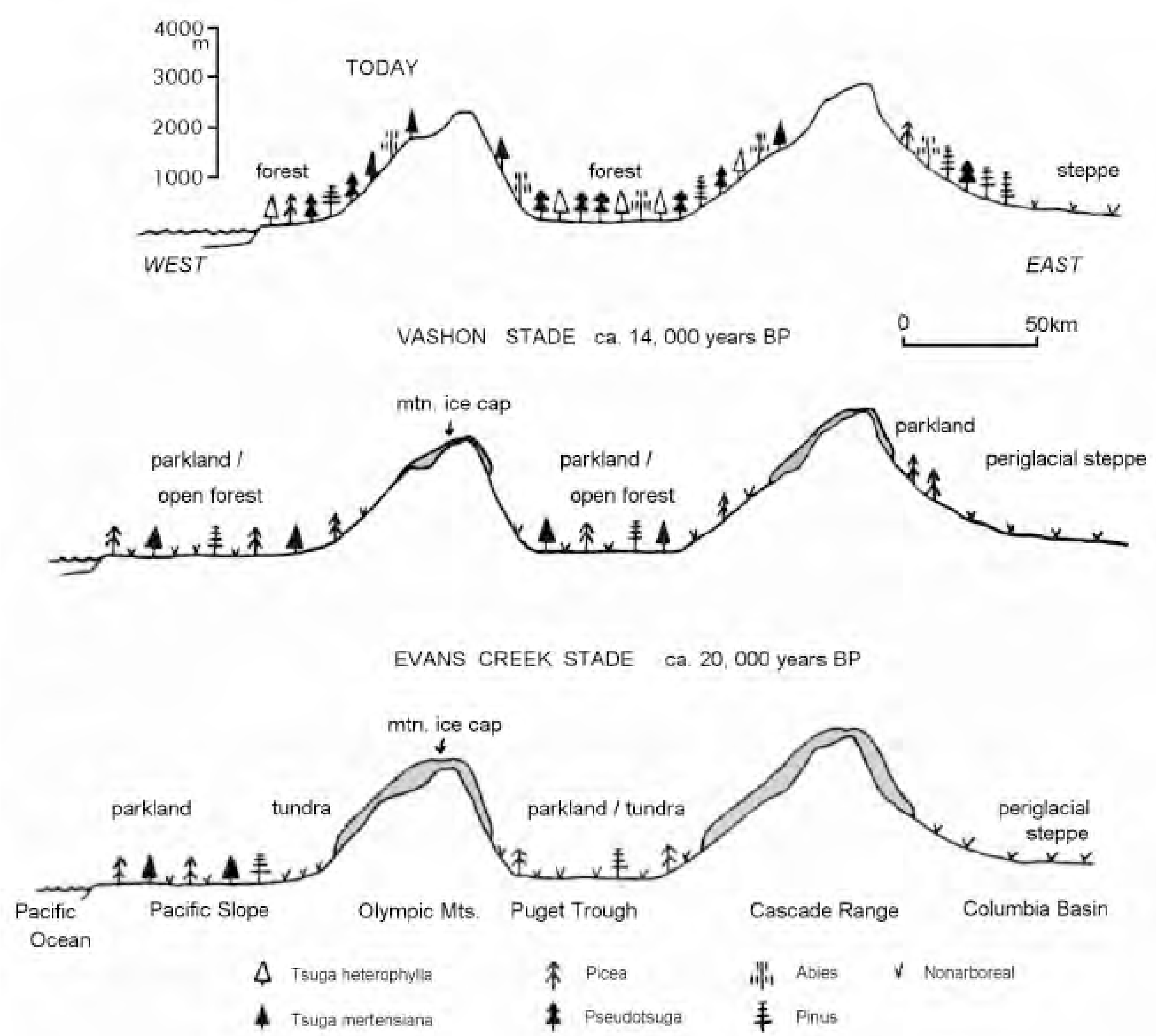


- 23,000 years ago eastern chipmunks (*Tamias striatus*), northern bog lemmings (*Synaptomys borealis*), and black-tailed prairie dogs (*Cynomys ludovicianus*) occurred together in southwestern Iowa (at the dot). Their current ranges are shown in the figure [Graham (1986) based on Rhoades (1984)].
- Similar results have been documented for forest tree species in the eastern US (e.g., Davis and Shaw (2001) and for shrub species in SW American deserts (e.g., van Devender 1986).

Climate Change in the Pacific Northwest Reassorted Local Plant Associations

- *"Paleoecologic data from the Pacific Northwest and elsewhere suggest that modern communities are loose associations composed of species independently adjusting their ranges to environmental changes on various time scales.*
- *"Periods of rapid environmental change in the past are generally characterized by increases in species richness, and analogs for these intervals are often modern ecotones between communities or vegetation types."*

Cathy Whitlock, *Northwest Environmental Journal* (1992)



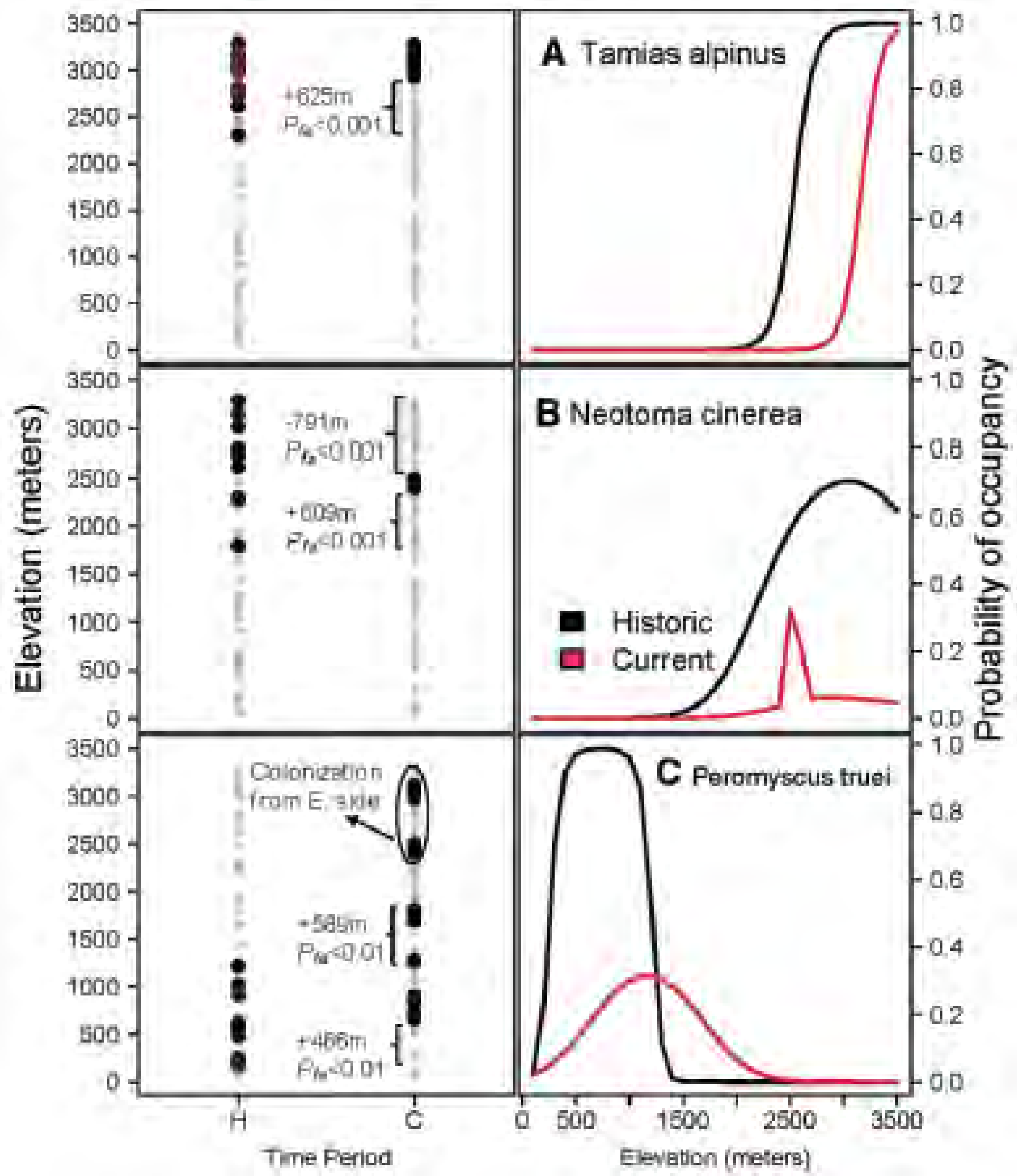
Observed Effects of Climate Change on Small Mammals in Sierra Nevada (1)

Abstract: We provide a century-scale view of small-mammal responses to global warming, without confounding effects of land-use change, by repeating Grinnell's early–20th century survey across a 3000-meter-elevation gradient that spans Yosemite National Park, California, USA. Using occupancy modeling to control for variation in detectability, **we show substantial (~500 meters on average) upward changes in elevational limits for half of 28 species monitored**, consistent with the observed ~3°C increase in minimum temperatures. **Formerly low-elevation species expanded their ranges and high-elevation species contracted theirs, leading to changed community composition at mid- and high elevations**. Elevational replacement among congeners changed because **species' responses were idiosyncratic**. Though some high-elevation species are threatened, **protection of elevation gradients allows other species to respond via migration**. (*emphases added*)

Moritz et al. 2008. Impact of a Century of Climate Change on Small-Mammal Communities in Yosemite National Park, USA. *Science* 322:261-264.

Effects of Climate Change on Small Mammals in Sierra Nevada (2)

Example elevation plots from the west slope transect of upward range expansion (*T. alpinus* and *P. truei*) (A and C), and range collapse (*N. cinerea*) (B). Shown are occupied (black) and unoccupied (gray) sites, probability of false absence (Pfa), and model-averaged occupancy-elevation profiles . *P. truei* colonized high elevations west of the Sierra crest from the eastern slope. Red marks for historical elevation profile of *T. alpinus* refer to ad hoc records.



Moritz et al. 2008. Impact of a Century of Climate Change on Small-Mammal Communities in Yosemite National Park, USA. *Science* 322:261-264.

Synopsis: Climate Change Erases the Blackboard of Existing Biological Associations

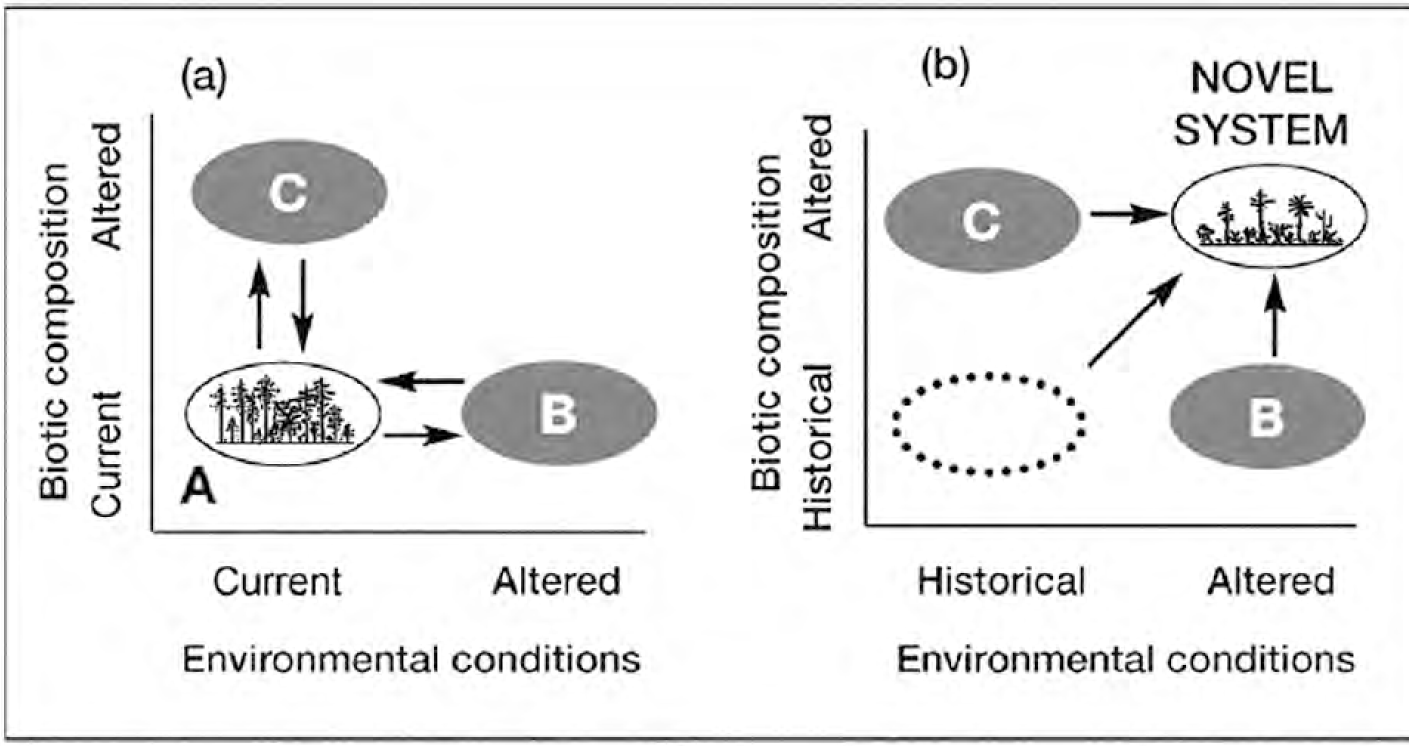
"A conservation strategy that seeks to preserve areas of high species richness in the face of future global warming fails to recognize the ephemeral nature of such associations to climate changes of similar magnitude in the Quaternary.

"Likewise, conservation efforts that emphasize the preservation of communities or vegetation types will probably be unsuccessful because future climate changes quite likely will dismantle the community or vegetation type of concern.

"Present-day reserves will likely be the source area for many of the taxa that will comprise future communities. But these reserves will probably not be the final residence for the communities that form as taxa respond to increasing drought and warming."

Cathy Whitlock, *Northwest Environmental Journal* (1992)

"Novel" Ecosystems Develop as a Consequence of Altered Climate (Seastedt et al 2008)

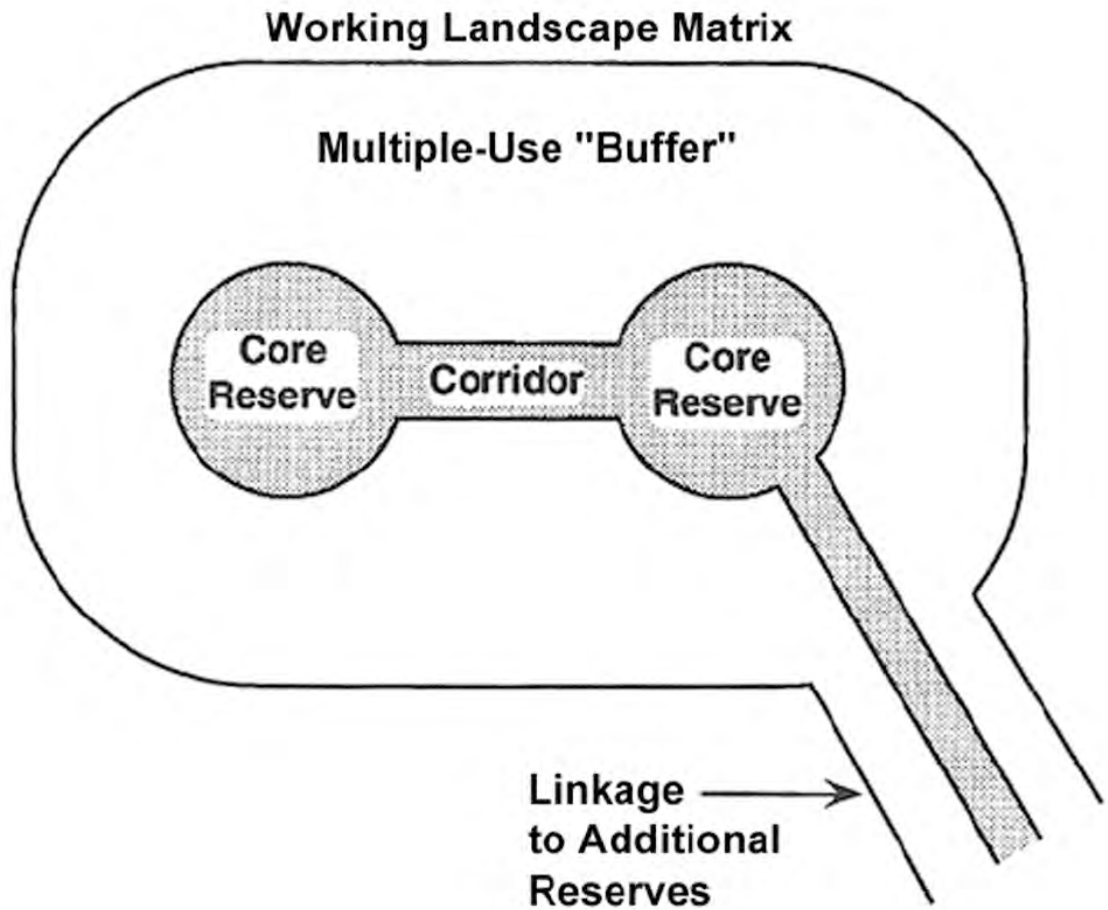


a. The biological composition of a community at a given place on the Earth's surface may be altered (e.g., as by fire) in the current climate regime, but the expected response would be a return to pre-disturbance conditions.
b. In the future the environment is expected to depart from the historical regime; the expected result of these long-term changes is the development of "novel" biotic communities that are adapted to the altered environmental conditions.

Given that the objective of conservation planning in the era of changing climate is to maintain high species richness (including sensitive native species), what does conservation science say would be the best planning approach for the Berryessa – Snow Mountain region?

Landscape-Based Conservation Network Elements

- “Core areas” (“reserves”) are areas with high intrinsic biodiversity value. Core areas are typically linked together with “corridors.”
- The core areas are typically protected from actions outside the reserve network by “multiple-use areas” or “buffer areas,” in which land uses may be limited.
- The landscape conceptually also includes areas that are not specifically protected for biodiversity purposes; these areas are the “matrix” in which the conservation network is embedded.



The “Multiple Use Module” concept was pioneered by Reed Noss and Larry Harris (1986) for building conservation networks in landscapes that have areas with high conservation value in a “working landscape matrix.” See Noss (1992) and Noss and Cooperrider (1994) for additional information. [Based on Noss (1992)]

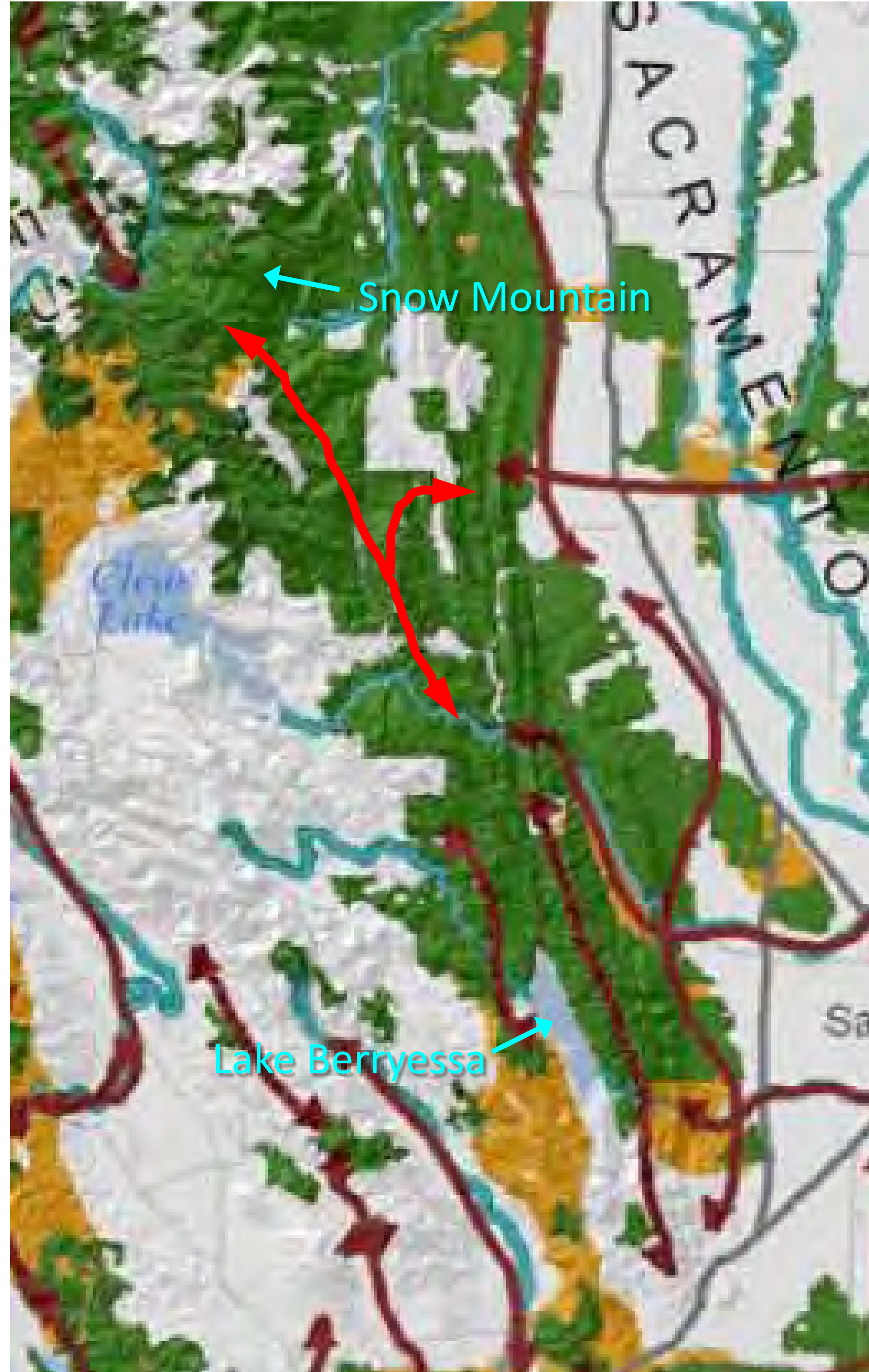
California Essential Habitat Connectivity (CEHC) Map for the BSM Region

- Green areas represent *Natural Landscape Blocks*. These landscape units were at least 2000 acres in size and had >90% of their area in natural landcovers.
- Yellow/red areas represent *Essential Connectivity Areas* that connect the Natural Landscape blocks. Yellow represents "lower ecological cost" (less risk).
- Widened blue line are "Riparian" connections along major streams in areas lacking large Natural Landscape Blocks
- Natural Landscape Blocks may be truncated or separated by roads (e.g., the Highway 20/16 corridors) and by extensively altered land areas. While there are areas of privately owned "inholding" lands, landscape continuity across Natural Landscape Blocks exists through the BSM region.

Source: Spencer et al. 2010. California Essential Habitat Connectivity Project: A Strategy for Conserving a Connected California. Prepared for California Department of Transportation, California Department of Fish and Game, and Federal Highways Administration.

CEHC Map for BSM Region with Missing Linkages Overlay Augmented

- This excerpt from the CEHC map includes an overlay from the “Statewide Linkages Map,” developed by the “Missing Linkages” working group a decade ago.
- Linkages include Putah Creek, Cache Creek, the Napa River, Cedar Roughs and the Cache Creek Wilderness, Bureau of Reclamation lands at Lake Berryessa, Ukiah District BLM lands, Mendocino National Forest lands, and the Snow Mountain Wilderness.
- The red arrow represents a linkage through public lands that was implied by Missing Linkages” group members but omitted from the maps published by the conference organizers.



What does the Department of Fish and Game say about the effects of climate change on managing biodiversity and ecological functionality?

Climate Change Adaptation and Response for Biodiversity Maintenance (DFG)

Unity-Integration- Action: DFG's Climate Change Vision

- **Unity: Creating and maintaining climate change partnerships**
  - *Objective 1: Pursue and Maintain Collaborative Partnerships.*
- **Integration: Integrating climate change into Department activities**
  - *Objective 2: Reevaluate existing policies and programs to incorporate climate change and seek regulatory changes as appropriate*
- **Action: Conservation practices to maintain and enhance ecosystem function**
  - *Objective 3: Create a large scale well connected, sustainable system of conservation areas across the State's terrestrial and marine landscapes.*
  - *Objective 4: Manage for restoring and enhancing ecosystem function to conserve both species and habitats in a changing climate.*
  - *Objective 5: Adjust management actions as appropriate to stabilize declining and vulnerable populations.*

Source: **Unity, Integration, and Action: DFG's Vision for Confronting Climate Change in California**
DFG September 2011

Climate Change Adaptation: Maintain Reserve System for Biodiversity Protection (DFG)

Objective 3: State-wide System of Terrestrial and Marine Conservation Areas

- An important objective of the DFG's vision is the need to maintain and create where needed a **network of terrestrial and marine reserves (conservation areas) across the state** that builds on existing conservation investments and the wide array of projects and planning efforts undertaken by partners.
- To fully promote persistence of species and key populations in the face of climate change, **conservation areas should support all aspects of ecosystem structure, composition, and function** within aquatic, terrestrial, marine, and near-shore marine habitats.
- A periodic reexamination of the conservation area network will be needed, and modifications made, as more is learned about the full impacts of climate change and species migration/movement in response to these changes. (*emphases added*)

Source: **Unity, Integration, and Action: DFG's Vision for Confronting Climate Change in California**
DFG September 2011

Climate Change Adaptation: Management Options for Maintaining Ecosystem Function (1)

Objective 4: Manage for Enhanced Ecosystem Function

- Actions intended to **resist** climate change forestall undesired effects of change and/or manage ecosystems so they are better able to resist changes resulting from climate change.
- **Resilience** focuses on managing for viable ecosystems to increase the likelihood that they will accommodate gradual changes related to climate and tend to return to pre-disturbance conditions.
- **Response** is an intentional management action intended to accommodate change rather than resist it by actively or passively facilitating ecosystems to respond as environmental changes occur.
- **Realigning** management activities focuses on the idea that rather than restoring habitats to historic conditions, or managing for historic range of variability the managing entity would realign restoration and management approaches to current and anticipated future conditions.

Source: **Unity, Integration, and Action: DFG's Vision for Confronting Climate Change in California**
DFG September 2011

Climate Change Adaptation: Management Options for Maintaining Ecosystem Function (2)

Objective 4: Manage for Enhanced Ecosystem Function

- ~~Actions intended to **resist** climate change forestall undesired effects of change and/or manage ecosystems so they are better able to resist changes resulting from climate change.~~
- ~~**Resilience** focuses on managing for viable ecosystems to increase the likelihood that they will accommodate gradual changes related to climate and tend to return to pre-disturbance conditions.~~
- **Response** is an intentional management action intended to accommodate change rather than resist it by actively or passively facilitating ecosystems to respond as environmental changes occur.
- **Realigning** management activities focuses on the idea that rather than restoring habitats to historic conditions, or managing for historic range of variability the managing entity would realign restoration and management approaches to current and anticipated future conditions.

Source: **Unity, Integration, and Action: DFG's Vision for Confronting Climate Change in California**
DFG September 2011

What guidance does conservation planning suggest for managing the BSM National Conservation Area to "respond" to climate change and provide ecological functions? What is the best approach to conservation planning for the region?

Landscape-Scale Conservation Planning for Responsive NCA Management (1)

- Establish a landscape-based conservation framework within the NCA:
  - Include all areas subject to existing administrative management for conservation-related reasons (Late Seral Reserves, Research Natural Areas, Areas of Critical Environmental Concern, etc.) as protected "reserves."
  - Identify and map all other species-rich locations in the NCA without respect to current administrative status; incorporate as "reserves" all biologically significant locations not already in the conservation framework.
  - Establish "landscape linkages" interconnecting all "reserves," with "buffers" that shield conservation lands from adverse effects of activities in the landscape matrix.
  - Bridge gaps in managed lands (e.g., roads, private-land inholdings) that block linkages; seek collaborative management or acquire lands to bridge gaps.

Landscape-Scale Conservation Planning for Responsive NCA Management (2)

- Actively manage the "matrix" to increase intrinsic ecological functions in lands not designated as "reserve," "corridor," or "buffer," with the matrix "permeable" to mobile species while also providing additional habitat. The following actions, for example, increase the value of the matrix as habitat:
  - Restore high-functioning ecological conditions to damaged/degraded/burned areas. Restore instream and riparian functions to aquatic features, while planning for future increases in peak flows and flood events; increase riparian "buffer zones" to be a least "two dominant tree-heights" in width.
  - Include elements that increase the ecosystem functions provided by matrix lands for wildlife; e.g., incorporate oaks throughout the matrix, as well as establishing multi-hectare oak "nodes."
  - Develop management approaches to address invasive species control or eradication.

Landscape-Scale Conservation Planning for Responsive NCA Management (3)

- Based on projected changes in dominant communities, develop management to increase landscape responsiveness and offset fragmentation within reserve and linkage elements.
- Target degraded areas (e.g., logged areas or other altered lands; landslides) for restoration of desired habitat conditions and ecological functions.
- Address the loss of “keystone” species throughout the landscape (such as oaks), and potential increases in stressors such as fire (both frequency and severity).
- Consider the potential need for introducing selected native species not currently present in order to maintain functional ecological dynamics (i.e., identify functional roles and assure that species are available to fill them).


Thank You