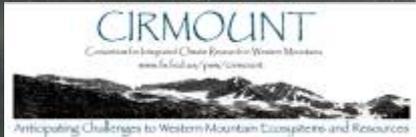


Managing for Climate and Climate Impacts

A Conceptual Framework for Western Public Lands

Connie Millar

US Forest Service
Sierra Nevada Research Center
Albany & Lee Vining, CA



With Sharon Yeh, Nikola Smith
and Toni Lyn Morelli, USFS



Ecosystems of the Future

Embracing Change

Accept Uncertainty Yet Certain Change
as Premises for Decision-Making

Practice ecological management outside the box

- existing management paradigms have limited value

Manage for desired future processes

- ecosystem services writ large

TOOLBOX APPROACH

- ✧ No single solution fits all cases
 - ✧ Range of options for short & long term
 - ✧ Mix & match tools
 - ✧ Be flexible, experimental (learn-as-you-go), innovative, bridges kept intact, small steps, risk-taking, course-correcting
- “eggs in one basket” vs “bet-hedging” strategies

Confronting Climate Change

I. Adaptation Strategies

Assist resources & ecosystems to accommodate changes imposed by climate



II. Mitigation Strategies

Reduce human effects on climate by sequestering CO₂ & decreasing greenhouse gas emissions



Complementary

↔ Conflicting

Strategic & Tactical: 5-R + 1 Strategies

“Adaptation” in a climate-change context is not the same as “Adaptive Management”

As interpreted in forestry contexts, AM derives from Holling’s classic 1978 book

- AM:
- implement policy as experiment
 - monitor
 - learn from monitoring
 - adjust policy accordingly



E.g., SNAMP

→ repeat cycle...

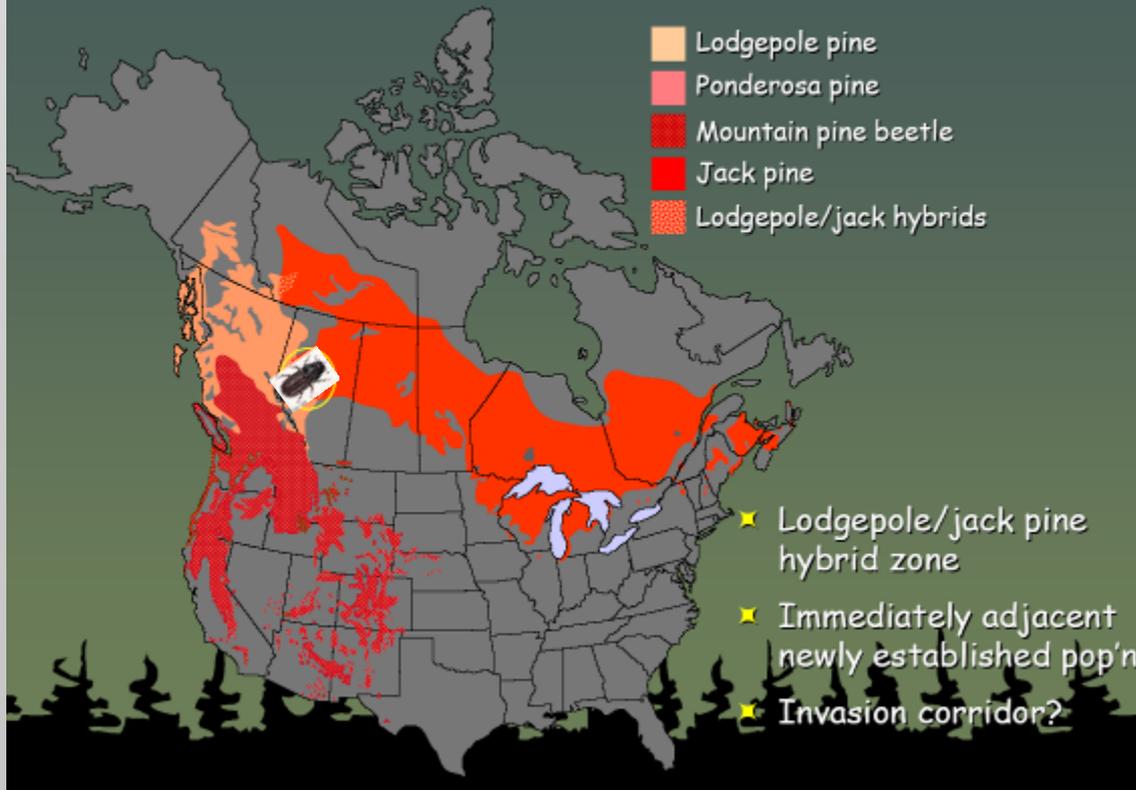


1. Increase **Resistance** to Change

“Homeland Security Approach”

Defend high-value resources
against change

Climate change induced-range expansion: invasion of the boreal forest?



BC: lodgepole pine &
mountain pine beetle

Carroll et al. 2003

Adaptation strategy

Resisting the effects of climate change might be possible only in the short term

* Lodgepole pine colonization in Tuolumne Meadows, Yosemite National Park



Be Aware of “Paddling Upstream” Decisions

* Resist projects that may fail or are inappropriate under future climates



Adaptation strategy

2. Promote **Resilience** to Change

"Health-Care Approach"

- Improve the capacity of ecosystems to return to prior conditions after disturbance
- Minimize stress; promote health, alternatives, & surplus

Mgmt Examples

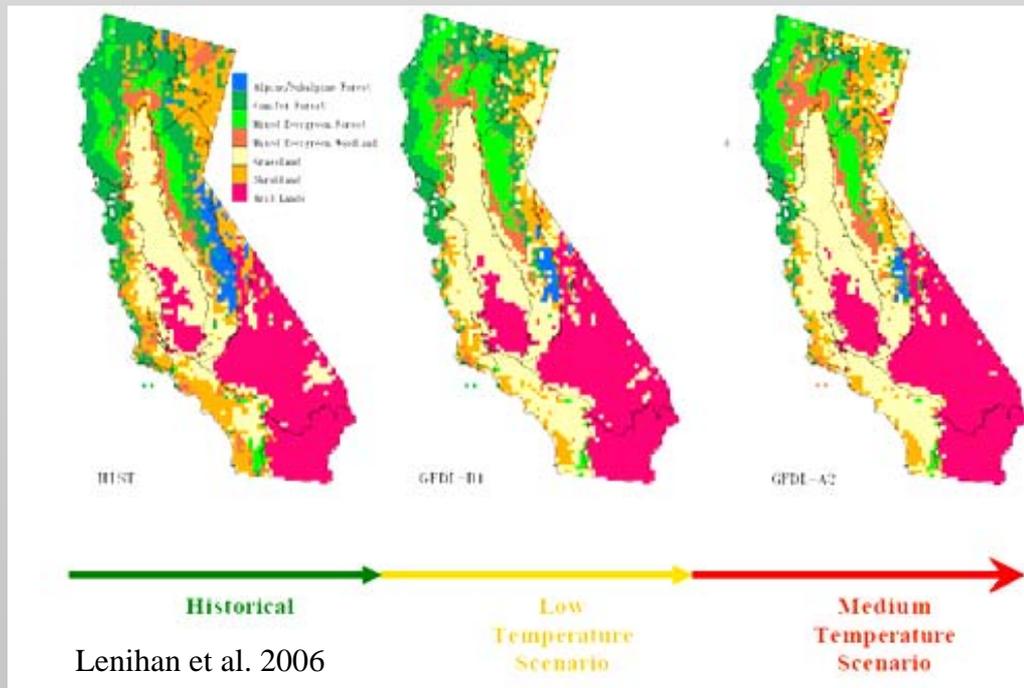
- Thin Forest Stands
- Prescribe Fires
- Stock Seed Banks
- Make Snow at Ski Areas
- Increase Rare Species Population Targets

Adaptation strategy



3. Enable Ecosystems to **Respond** to Change *“Beginner’s Mind Approach”*

- * Assist Ecosystems to Follow Changing Climates
- Use climate projections at coarse scale to plan options



e.g., “off-site” plantations



Beware:

“Eggs-in-One-Basket”

Adaptation strategy

Assisted migration

Move germplasm to favorable location



“The climate models show little chance that the climate anywhere in the western US will be suitable for Brewer spruce by 2060. However, all GCMs show suitable climatic niche in south-eastern Alaska and coastal British Columbia. My Canadian colleagues are planning for genetic resource planting sites near Prince Rupert, British Columbia.”

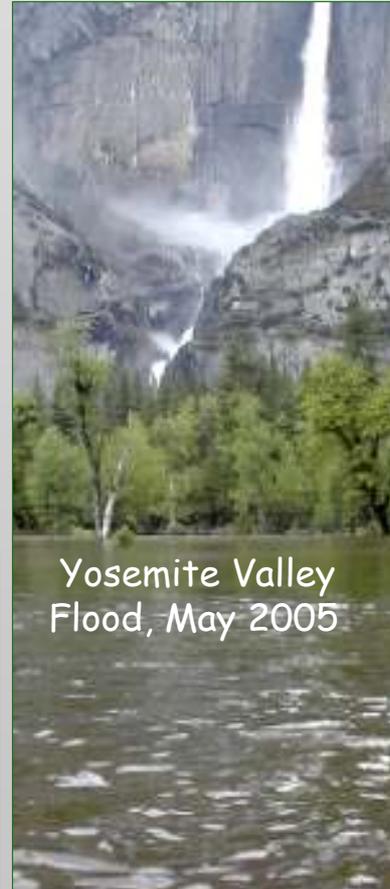
Be wary: A hasty recommendation?



* Anticipate and Plan for Associated Risks

Forest Dieback; Fires in Subalpine Forests; Off-Season & Year-Round Fires; Extreme Wind and Flood Events...

3 Sisters Wilderness, OR
2008



Yosemite Valley
Flood, May 2005



Whitebark pine, 9500', E SN, 2008

Cascade Crest Complex, OR, 2006



Fire at Big Bear Mtn, CA, 2005



* Experiment Creatively & Learn From Experiments

1. Use Redundancy



*Spread-the-risk
and bet-hedging
approaches*

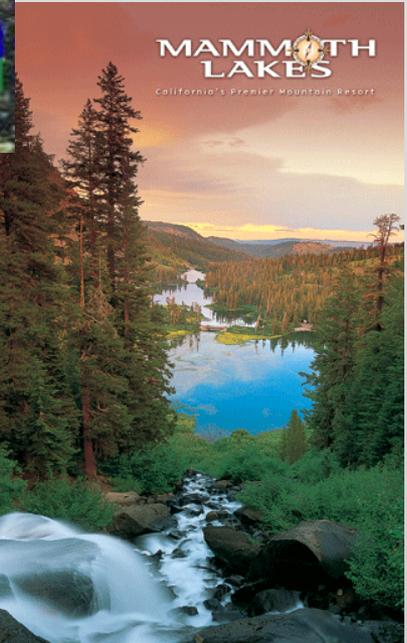
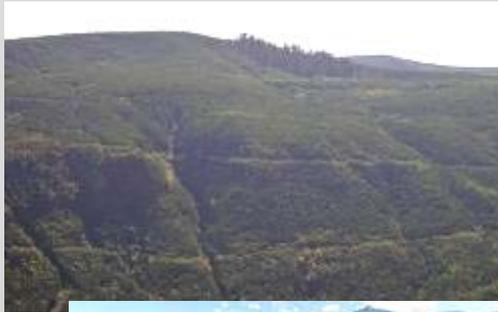
2. Relax Genetic Management Guidelines



* Increase Diversity

In resort communities...

In the forest...



* Promote Connected Landscapes

- Larger mgmt units; land trades
- Lower fragmentation
- Higher mgmt decision flexibility
- Continuous riparian zones

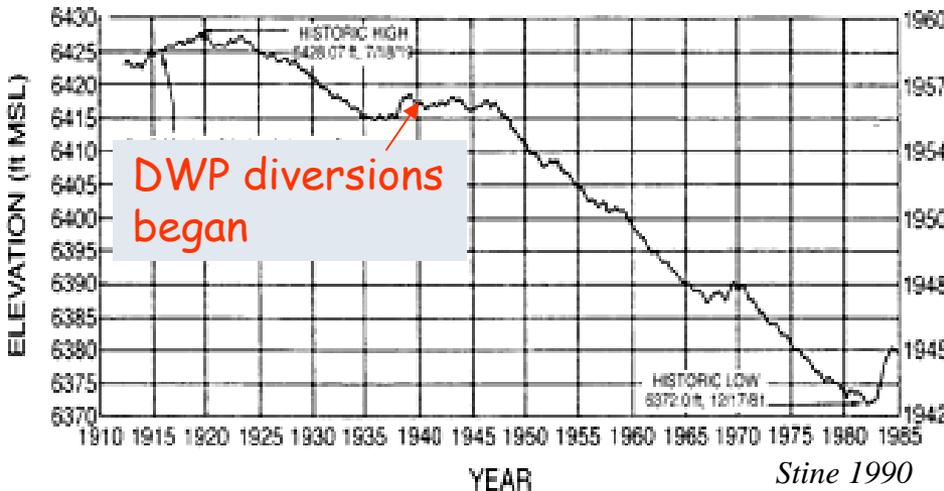


4. **Realign** Conditions to Current Dynamics

“Auto Mechanic’s Approach”

For systems far out of the range of natural variability this may be a useful restoration approach

“Historic range of variability” (pre-settlement conditions) as management target will mostly be inappropriate



Mono Lake, CA
Aquatic Ecosystem

Adaptation strategy

5. **Reduce** Greenhouse Gases & **Reduce** Ecological Footprint

"Good Samaritan Approach"

- **Forestry Sector**

- Sequester Carbon
- Reduce Emissions



- **Energy Sector – Conservation & Alternative Energy**



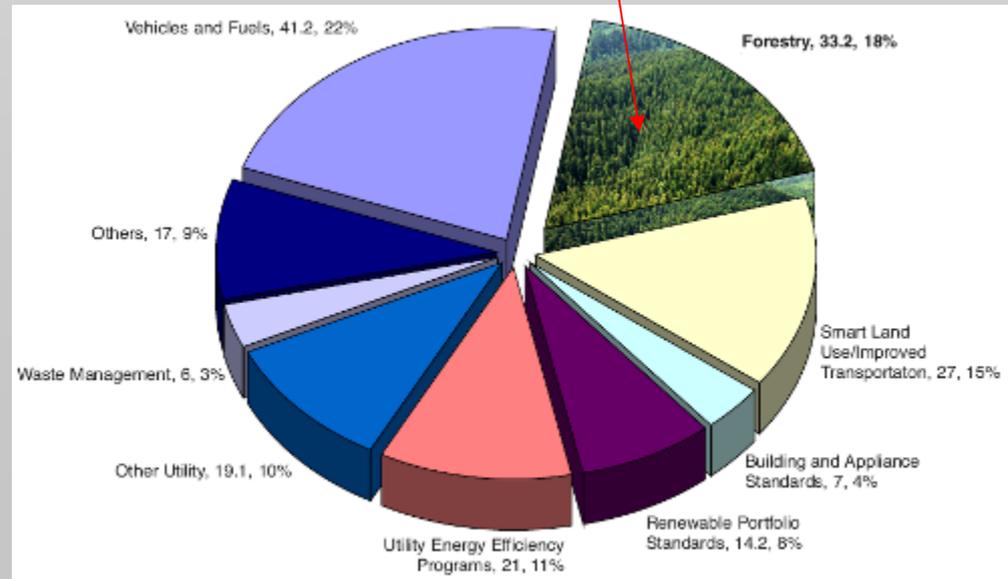
Mitigation strategy

Policy & Carbon Management California-Style

AB-32, The California Global-Warming Solutions Act Signed 27 September 2007 by Governor Schwarzenegger

- Mandates statewide reduction of greenhouse gases to 1990 levels by 2020
- Forestry sector could provide ~18% of needed reduction in total tons carbon

Sources of Potential
Reductions of 187.2
MMT CO₂ by 2020



Overall: Setting **Priorities**

Management
Decisions

Do Nothing:
No Advance Action

Be Proactive:
Act in Advance

React after Disturbance
or Extreme Events



Tiered Approaches to Priority Setting

From Amy Luers & Susi Moser, 2006

- I. **“No Regrets”** - Actions that provide benefits in current and future climate conditions even if no climate change occurs
- II. **“Low Regrets”** - Actions that provide important benefits at relatively little additional cost or risk
- III. **“Win-Win”** - Actions that reduce the impacts of climate change while providing other benefits



Triage Approaches to Priority-Setting

triare (Fr): to sort



Condor: Should it be sorted red or black?

TRIAGE Categories:

Red Urgent, treatable: immediate priority

Yellow Mid urgency; soon to become red

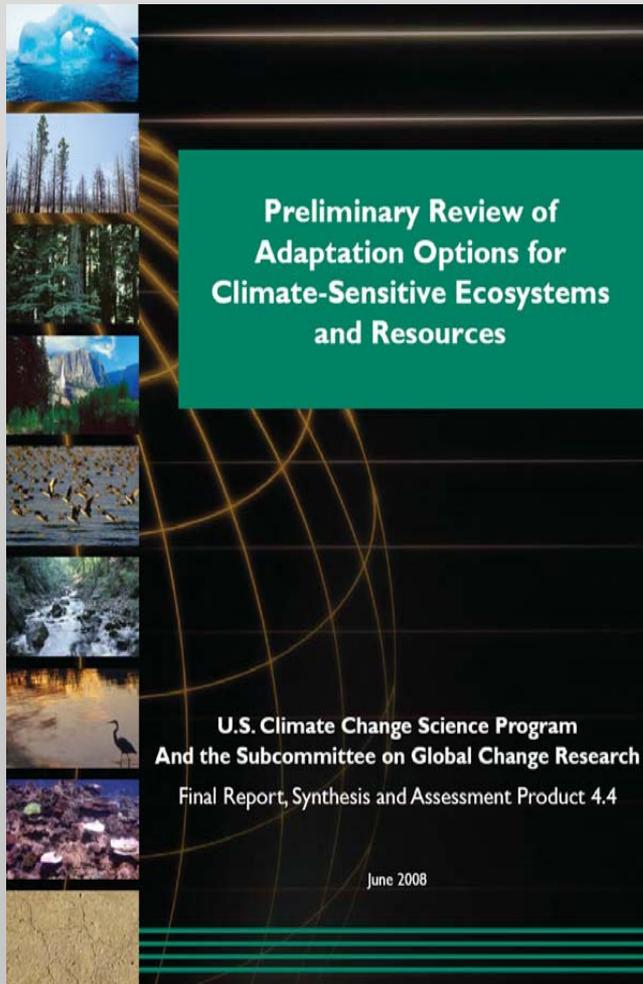
Green Stable, low priority

Black Urgent, untreatable with available resources:
→ no action

Re-assess & re-sort

Taking these ideas to the ground...

U.S. Climate Change Science Program: 2008 SAP 4.4 Reports



SAP 4.4. Adaptation Options for Climate-Sensitive Ecosystems and Resources | **National Forests**

1	3 National Forests
2	
3	
4	
5	
6	Authors
7	
8	Lead Author
9	Linda A. Joyce, U.S.D.A. Forest Service
10	
11	Contributing Authors
12	Geoffrey M. Blate, AAAS Fellow at U.S. Environmental Protection Agency
13	Jeremy S. Littell, JISAO CSES Climate Impacts Group, University of Washington
14	Steven G. McNulty, U.S.D.A. Forest Service
15	Constance I. Miller, U.S.D.A. Forest Service
16	Suzanne C. Moser, National Center for Atmospheric Research
17	Ronald P. Neilson, U.S.D.A. Forest Service
18	Kathy O'Halloran, U.S.D.A. Forest Service
19	David L. Peterson, U.S.D.A. Forest Service

SAP 4.4. Adaptation Options for Climate-Sensitive Ecosystems and Resources | **National Parks**

1	4 National Parks
2	
3	
4	
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6	
7	Authors
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9	Lead Author
10	Jill S. Baron, U.S. Geological Survey and Colorado State University
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16	Don McKenzie, U.S.D.A. Forest Service
17	Laura Meyerson, University of Rhode Island
18	Jill Oropeza, Colorado State University
19	Nate Stephenson, U.S. Geological Survey

www.climatescience.gov/Library/sap/sap4-4/final-report/

Two Case Studies on National Forests 2006+

Tahoe National Forest (CA) & Olympic National Forest (WA)

Challenges & Barriers

- Checkerboard ownership
- Existing environmental laws
- Crisis reaction
- Agency target and reward system
- Small landscape management units

Opportunities

- Rapid assessments of existing plans
- Pilot for USFS ecosystem services
- Disturbance-event recovery
- Policy flexibility
- Public education

Needs

- Integrated management practices
- Case studies & demonstrations
- Prioritization tools
- Clearing house on science information



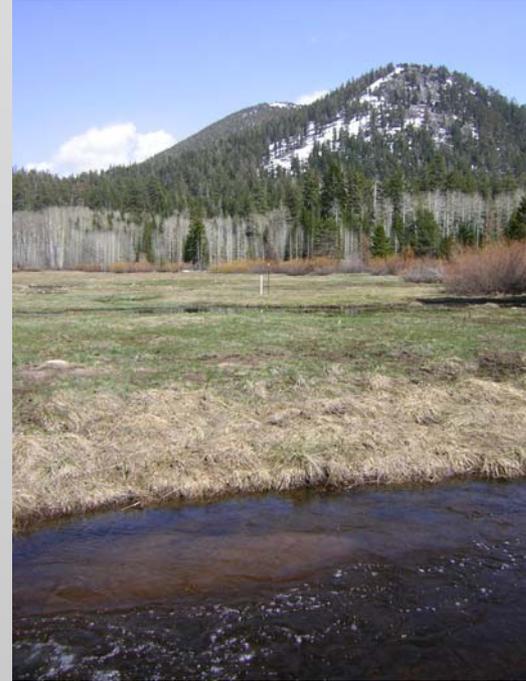
Next Phase: Stocking the Toolkit

CLIMATE TOOLKIT PROJECT

Millar, Joyce, Nielson, Peterson, et al. (USFS Western Research Stations): 2008-2010

Tools for resource planning at short, mid, and long-term scales:

- Access to Relevant Science
- Evaluate Existing Paradigms
- Scenario & Uncertainty Exercises
- Tools for Resource Planning



Case Studies on Sierran National Forests and National Parks:

- Tahoe NF (Sharon Yeh & Nikola Smith)
- Devils Postpile NM (Deanna Dulen)
- Inyo NF (Toni Lyn Morelli)

Web Tools for Forest Managers: The USFS "Climate Change Resource Center"

A one-stop reference website for USFS (& other) managers (Michael Furniss)

US Forest Service

Search

CLIMATE CHANGE RESOURCE CENTER

Back to Forest Service >>> Home About News Jobs Maps

Climate Change Primer
Management Options

Climate Change and...

- Air Pollution
- Amphibians and Reptiles
- Assessments
- Bark Beetles
- Biodiversity
- Cumulative Effects
- Forests and Carbon Storage
- Genetic Resources
- Invasive Plants
- Landscape Analysis
- Natural Resource Strategies
- Plant Diseases
- Policy Analyses
- Salmon and Trout
- Silviculture
- Vegetation Distribution
- Water
- Wilderness
- Wildland Fire
- Wildlife
- About these pages

Information and Tools for Land Managers

The **Climate Change Resource Center (CCRC)** is a reference Web site for resource managers and decisionmakers who need information and tools to address climate change in planning and project implementation on lands in the West. Changing climates have already catalyzed changes in environments throughout the West, and future effects are expected to be greater. Although future scenarios are daunting, managers can do much to promote adaptation to climate change and encourage reduction of human effects on climate.

The CCRC addresses the manager's question "What can I do about climate change?" by providing information about basic climate sciences and compiling knowledge resources and support for adaptation and mitigation strategies. The site offers educational information, including basic science modules that explain climate and climate impacts, decision-support models, maps, simulations, case studies, and toolkits. The site is a joint project of the three western Forest Service Research Stations: **Pacific Northwest Research Station (PNW)**, **Pacific Southwest Research Station (PSW)**, **Rocky Mountain Research Station (RMRS)**, and the **Western Wildland Environmental Threat Assessment Center**.

What's new?

- ◆ **State of Wyoming Climate Change Workshop:** Biologists, scientists, policy-makers, sportsmen and members of the media came together in Cheyenne on Monday, June 16 to learn more about climate change and how it could potentially affect Wyoming's resources. Slides and contact information are posted.
- ◆ **Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems (SAP 4.6)** This Synthesis and Assessment Product 4.6 (SAP 4.6) focuses on impacts of global climate change, especially impacts on three broad dimensions of the human condition: human health, human settlements, and human welfare.
- ◆ **MTNCLIM 2008 Mountain Climate Research Conference.** Talks, Posters, and Webcasts from the conference held June 9-12 in Silverton, CO
- ◆ **Bull Trout and Climate Change.** Multimedia production of a 2008 symposium at the Western Division Meeting of the American Fisheries Society. Sponsored by the US Forest Service-Rocky Mountain Research Station, US Fish and Wildlife Service, and the US Geological Survey.
- ◆ **Preliminary review of adaptation options for climate-sensitive ecosystems and resources: Final Report, Synthesis and Assessment Product 4.4.** Chapter 3 addresses National Forests
- ◆ **Climate Change and Water: In Brief.** A new publication from the Forest Service National Headquarters
- ◆ **Woody Biomass Utilization.** New USFS site on using woody biomass for energy and other uses
- ◆ **Pacific Southwest Region (R-5) Climate Change site**
- ◆ **Climate Change, Water, and Kids.** Comments by Abigail R. Kimbell, Forest Service Chief
- ◆ **USFS Climate Research Strategy**
- ◆ **Sustainable Forest Resource Management**
- ◆ **Sustainable Operations**
- ◆ **Carbon Sequestration.** National "Ecosystem Services" site

Toolbox and library

- Video lectures
- Annotated bibliography
- FAQs about climate
- NASA animations
- Resources and documents

Current projects

Research roundup

Case studies

- ◆ Olympic National Forest
- ◆ Mendocino National Forest
- ◆ Tahoe National Forest

Vegetation maps, current and future scenarios

Other Forest Service Web sites

- WD Climate
- National R & D Climate
- PNW Climate
- PSW Climate
- RMRS Climate

USDA USFS PNW WWETAC

The Climate Change Resource Center welcomes your comments and suggestions. ccrc@fs.fed.us
US Forest Service - Climate Change Resource Center
Last Modified: Aug 28, 2008 04:32:32 PM

<http://www.fs.fed.us/ccrc/>

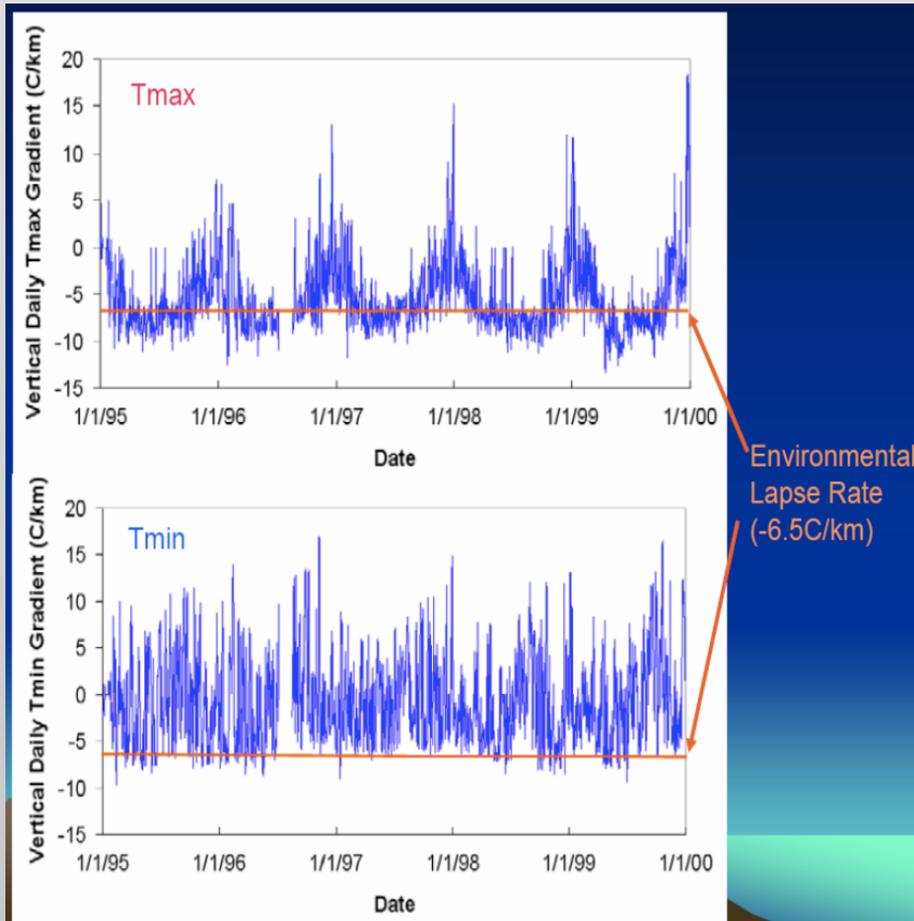
Devils Postpile National Monument: A Pilot Study

Incorporating Climate into the New GMP:
Manage DEPO as a Refugium Park –
A “Resistance” Strategy

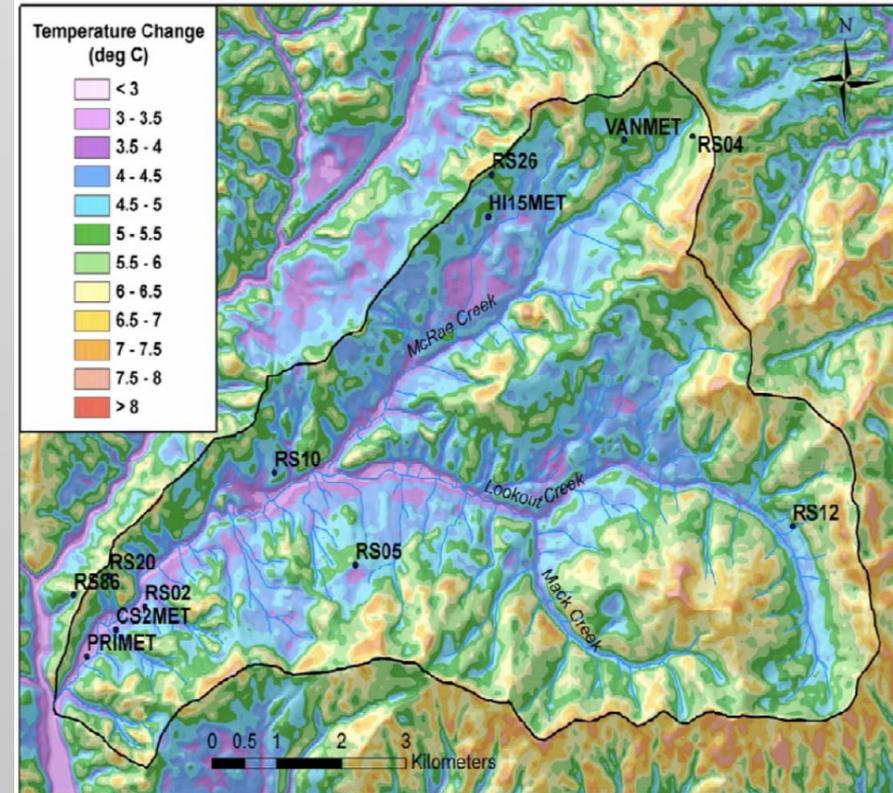
**What Role:
Cold-air Pooling &
Biodiversity Hotspot?**



Complex Climatology Rules in Mountains



Cold-air pooling (CAP) & inversions are common, and define widely varying lapse rates from positive to negative

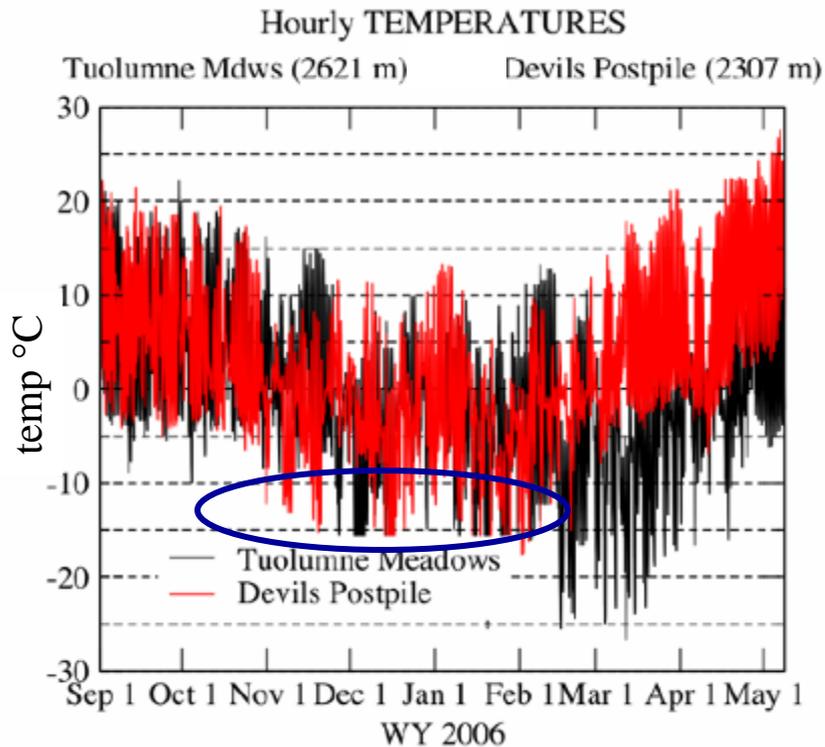
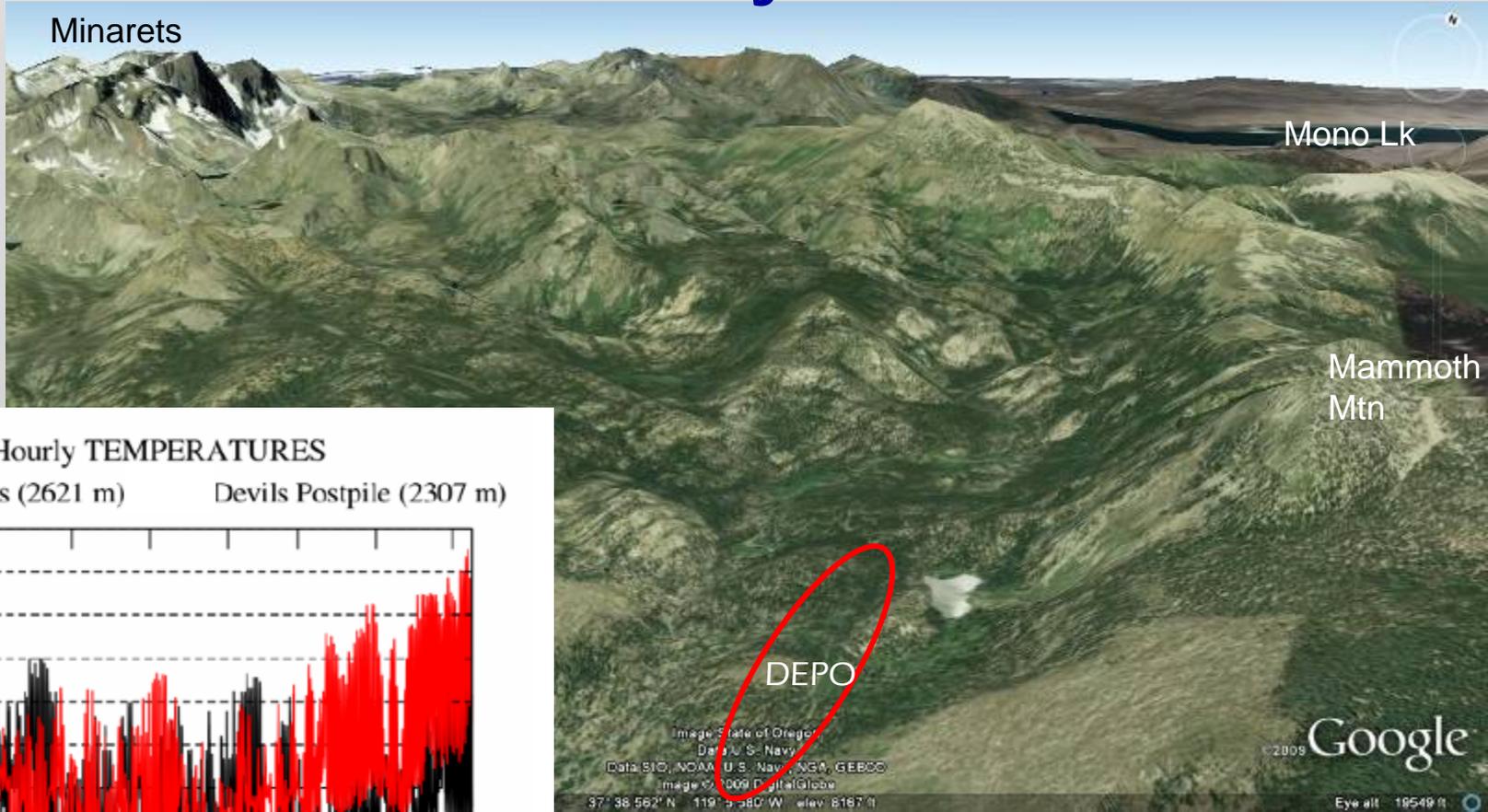


Atmospheric conditions for CAP may increase in the future and overwhelm regional warming

HJ Andrews Forest, OR; Daly 2008

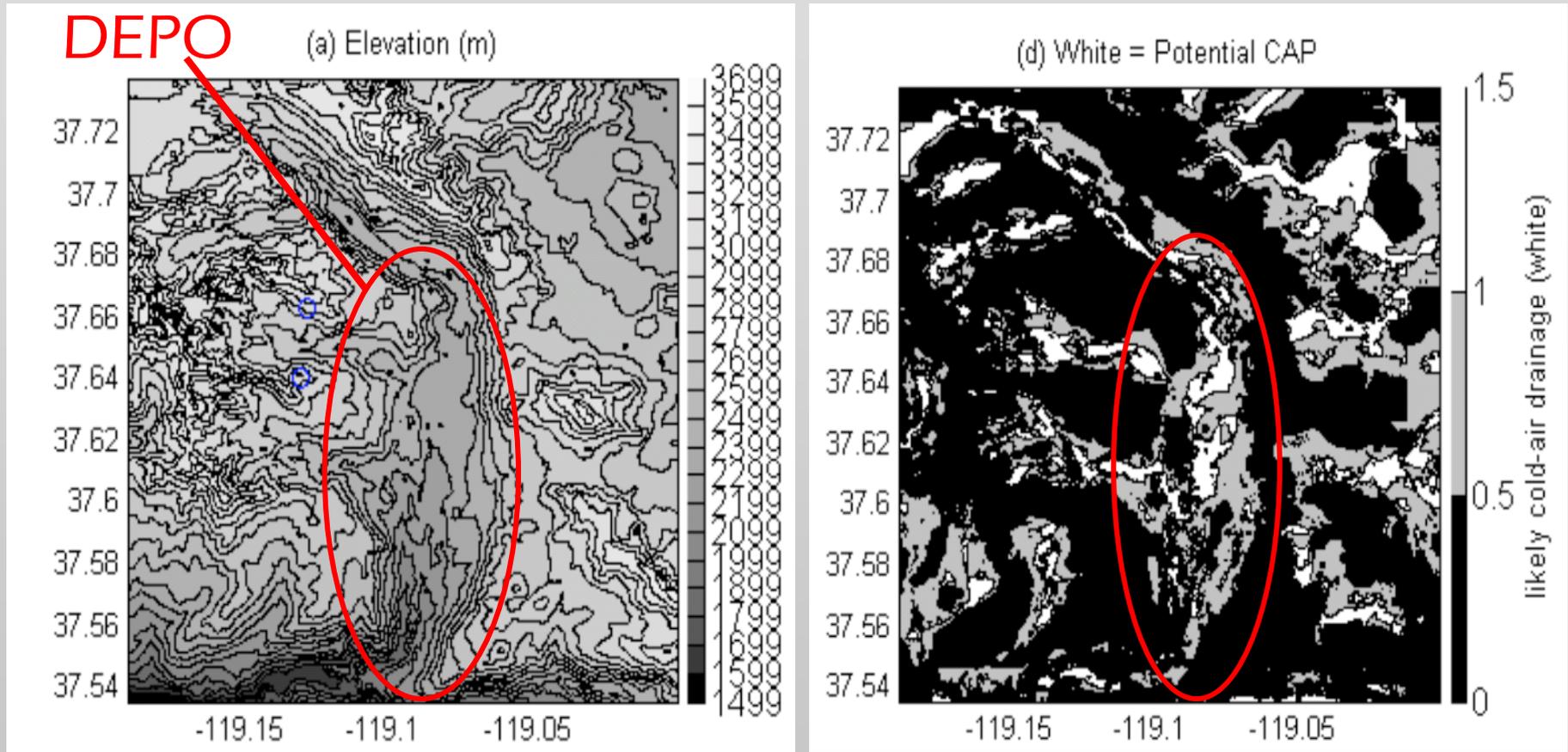
→ Down is often colder

Upper San Joaquin Watershed; "Icebox Canyon"



Dettinger 2008

Modeled Cold-Air Pooling and Drainage, DEPO



White/gray areas are modeled CAP/CAD

Will CAP increase under future conditions???



What Does a CAP-Refugium Imply for DEPO Management?

Preserve Current Biodiversity & Ecologic Functions

Mmt Goals

Maintain wet meadows

Maintain fens, sprgs, wetlands

Minimize invasives

Maintain current veg types

Educate visitors

Maintain mgmt effectiveness
as climate changes

Mgmt Actions

Remove invading lodgepole pines

Limit use of meadow during wet seasons

Constrain groundwater pumping

Manually remove invasives

Treat exotic insect & disease outbreaks

Reforestation & restoration guides
remain as status quo

Interpret CAP in context of climate change

Intensively monitor climate- and CAP

Inyo National Forest: **Pilot Study**

Forest Plan Revisions

* **Jan 13, 2009 Chief's Considerations**

- Address climate issues as “need for change from current direction”

How will Climate Change Modify Conditions?

Uncertainty in climate projections requires that defensible geographic scale will be much broader than appropriate for planning scale

* **Strategic Actions for ‘*Comprehensive Evaluation Report*’**

- What are risks and vulnerabilities?
- Consider potential ecological adaptations

How can Management Adapt and Adjust?

Specific Climate Vulnerabilities: Aspen Decline

Toni Lyn Morelli, David Burton



Protocols: Aspen Location and Condition Data Form Aspen Delineation Project

RISK OF STAND LOSS ANALYSIS

HIGHEST: The clone is being lost from above AND is not being replaced from below.

- Conifer crowns have overtopped the aspen crowns, (primary risk factor), and
- Conifer species comprise at least half the canopy (primary risk factor), *and*,
- Regeneration absent or unsuccessful due to excessive browsing or other factors (primary risk factor)

(If both **primary** risk factors are indicated on field form, then the ranking = highest)

HIGH: The clone is being lost from above OR is not being replaced from below.

(If at least one of the primary risk factors affecting crown and regeneration is indicated on field form, then the ranking = high)

MODERATE: One or more risk factors below is present, but clone not in immediate danger.

May include one or more of the below:

- conifer closure >25%, but <50% [if >50%, rating is High or Highest]
- aspen cover <40%
- dominant aspen are decadent
- aspen regeneration 5-15' tall is <500 stems per acre
- regeneration being excessively shaded by conifers
- browsing is limiting extent and numbers of successful (>5' tall) regeneration

(If one or more of these risk factors is indicated on field form then ranking = moderate)

LOW: Clone essentially healthy, either mature trees and/or regeneration for the most part healthy and vigorous, no obvious signs that the clone has receded, <15% of the clone affected by risk factors.

NONE: None of the above risk factors present, mature trees vigorous, regeneration 5-15' tall



A New & Distinct Threat? Sudden Aspen Decline/Dieback (SAD) Appearing in SW Colorado after 2006...

San Juan Mtns , CO

Predisposing Factors

- Old-age stands
- S/SW aspects
- Low-mid elevations

Climatic Factors

- Drought
- Warming

Secondary Factors

- Insects, pathogens



Photo A. Watkins



Photo P. Kemp

SAD has not risen on the radar in the Sierra Nevada

...not occurring here (yet)?

...not recognized?

...insects/disease different?

...little aspen monitoring?

Important to detect because treatment likely differs from general aspen health management

SAD? Sierra Nevada, Mono Co



Early Detection

- thinning, fires, livestock exclusion

Late Detection

- root death means no sprouting, thus stand treatments are ineffective

→ Incorporating SAD detection guidelines into SN Aspen Monitoring Protocols

→ Assessing climate relationships of Inyo NF aspen inventory with PRISM

Managing In The Face of Change

A Toolbox of Options

Adaptation Strategies

- * Practice *Resistance*
- * Increase *Resilience*
- * Allow Forests to *Respond*
- * *Realign* Highly Altered Ecosystems

Mitigation Strategies

- * *Reduce* Greenhouse Gases & Ecologic Footprint

Overall

- * *Set Priorities* (Tiered, Triage, Vulnerabilities)
- * *Evaluate* Existing Projects
- * *Assess* Projected Changes
- * *Set New* Mid- & Longterm Objectives
- * *Revise* Existing Plans

For more information & pdf copies of
publications & presentations:

www.fs.fed.us/psw/programs/snrc/staff/millar/

Climate Change Resource Center:

www.fs.fed.us/ccrc/

