An Integrated Climate Change Assessment & Adaptation Framework for Conservation Planning & Management in the Southwestern US: *translating the science*

Jemez Mountains Climate Change Workshop
Carolyn Enquist *et al.*
April 21, 2009
**Key Outcomes of Workshop:**

1. Develop **landscape-scale adaptation pilot projects**;

2. Identify **adaptation options & best climate change management practices**;
   - share, apply, and test these ideas collaboratively across the Southwest;

3. Develop a **regional climate change adaptation network program** for information sharing, networking, professional development, and capacity building.

*(McCarthy, Enquist & Garfin, Eos, 2008)*
An Integrated Assessment Framework

1) Regional climate impacts assessment
   • Assess climate change “exposure” using spatial climate data and available data sets
     (Girvetz et al., ms in prep)

2) Determine vulnerability of conservation priorities
   • Perspective for refining existing priorities or defining new ones
     (Enquist et al. 2008 reports, ms in prep)

3) Landscape scale conservation adaptation planning
   • Implement at a high priority site/landscape where adaptation measures have potential for success (case study workshops)
     (Cross et al, in review)

4) Ancillary Information & Tools
   • Incorporate as become available to inform all stages of framework; such as:
     • NatureServe’s species vulnerability index (Young et al.) & ecosystem national map (Comer et al.); USFS RM Research Station’s species vulnerability analyses (Finch et al.) and climate stress index (Joyce et al.)
Identify research showing climate-linked physical changes across the West:

- Increased aridity
- More rain than snow
- Declines in snowpack
- Changes in the timing of peak stream flows

Look for evidence of this across the state:

*Declines in snowpack*
(NRCS SNOTEL, green dots)

*Earlier peak streamflows*
(Stewart et al. 2004, blue dots)
State-wide impacts assessment

Identified cases of climate-linked ecological changes across New Mexico & environs:

- Population changes
  - Mortality & recruitment
  - Shifts in distributions
    # Cases: 40

- Changes in phenology
  # Cases: 2

- Invasive species
  - Non-native & native
    # Cases: 5

- Altered disturbance regimes
  - Fire, erosion, etc.
    # Cases: 2
State-wide impacts assessment

Recent & future (*forthcoming*) climate change “exposure” using ClimateWizard analysis tool:

Composite of T & PPT departures (relative to 1961-1990)
Base data source: PRISM (Daly et al. 1994), Enquist & Gori 2008, TNC report, ms in prep.

Base data source: PRISM (Daly et al. 1994) Enquist, Girvetz & Gori, TNC report, ms in prep.
Implications on Conservation Priorities

Consider “exposure” to change by geography & ancillary data.

Source: SWreGAP
Case Study Selection
(or “Why the Jemez Mountains?”)

Use results of regional impacts assessment, analysis of conservation implications, & other information as guide.

Catastrophic Fire (2000)

Goat Peak pika

Post-fire Erosion

Jemez Mountains salamander
Recent trends in the Jemez

Snowpack in Jemez watershed (pink dots)

<table>
<thead>
<tr>
<th>NRCS SNOTEL Site</th>
<th>ELEV (m)</th>
<th>Period of Record</th>
<th>Mar 1 SWE (in)</th>
<th>Apr 1 SWE (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senorita Divide #2</td>
<td>2,621</td>
<td>1981-2006</td>
<td>-0.207</td>
<td>-0.308*</td>
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<tr>
<td></td>
<td></td>
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<td>= ~8 in total</td>
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<tr>
<td>Quemazon</td>
<td>2,895</td>
<td>1981-2006</td>
<td>-0.141</td>
<td>-0.298*</td>
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<tr>
<td></td>
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<td>= ~7 in total</td>
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</tbody>
</table>
Recent trends in the Jemez

Timing of peak flow in Jemez River (purple dot)

<table>
<thead>
<tr>
<th>Jemez River</th>
<th>USGS Gage</th>
<th>ELEV (m)</th>
<th>Period of Record</th>
<th>Change in Peak Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10802</td>
<td>1,714</td>
<td>1950-2002</td>
<td>-2 days</td>
</tr>
</tbody>
</table>

Data provided by Iris Stewart, Santa Clara U (Stewart et al. 2005)
Regional vegetation die-off in response to global-change-type drought

(PNAS 2005)

David D. Breshears\textsuperscript{a,b}, Neil S. Cobb\textsuperscript{c}, Paul M. Rich\textsuperscript{d}, Kevin P. Price\textsuperscript{e,f}, Craig D. Allen\textsuperscript{g}, Randy G. Balice\textsuperscript{h}, William H. Romme\textsuperscript{i}, Jude H. Kastens\textsuperscript{j,1}, M. Lisa Floyd\textsuperscript{k}, Jayne Belnap\textsuperscript{l,m}, Jesse J. Anderson\textsuperscript{e}, Orrin B. Myers\textsuperscript{m}, and Clifton W. Meyer\textsuperscript{d}

Temperature sensitivity of drought-induced tree mortality portends increased regional die-off under global change-type drought

(PNAS 2009)

Henry D. Adams\textsuperscript{a,b,1}, Maite Guardiola-Claramonte\textsuperscript{a,c}, Greg A. Barron-Gafford\textsuperscript{a,b}, Juan Camilo Villegas\textsuperscript{e,d,e}, David D. Breshears\textsuperscript{a,b,d,f}, Chris B. Zou\textsuperscript{g}, Peter A. Troch\textsuperscript{a,c}, and Travis E. Huxman\textsuperscript{a,b,f}

Photos: C.D. Allen, USGS
Future trends in the Jemez?

“Climate Change Adaptation Planning”
or step 3 in our integrated assessment framework & focus of this workshop

“But wait, there’s more:”
Expansion of this framework to the 4-Corner states.....
Southwest Climate Change Initiative (SWCCI)

I. Regional impacts assessment for each state

II. Determine Conservation Implications w/regional experts

III. Landscape adaptation planning
   *Case study in each state*

IV. Climate Change Learning Network
   I. Refine process
   II. Identify generalities and differences
   III. Make policy recommendations

Source: Hoerling & Eischeid 2007
<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carolyn Enquist</td>
<td>TNC-NM</td>
</tr>
<tr>
<td>Dave Gori</td>
<td>TNC-NM</td>
</tr>
<tr>
<td>Molly Cross</td>
<td>WCS</td>
</tr>
<tr>
<td>Evan Girvetz</td>
<td>U Washington</td>
</tr>
<tr>
<td>Lisa Graumlich</td>
<td>U Arizona</td>
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<td>Gregg Garfin</td>
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<tr>
<td>Anne Bradley</td>
<td>TNC-NM</td>
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<td>Rob Marshall, Marcos Robles, Ed Smith, Gita Bodner</td>
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<td>Tim Sullivan, Betsy Neely</td>
<td>TNC-CO</td>
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<tr>
<td>Joel Tuhy &amp; Staff</td>
<td>TNC-UT</td>
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<tr>
<td>Jack Triepke</td>
<td>USFS-R3</td>
</tr>
<tr>
<td>Deborah Finch, Karen Bagne</td>
<td>USFS-RMRS</td>
</tr>
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</table>

For more information & report downloads: [www.nmconservation.org](http://www.nmconservation.org)
Recent trends in the Jemez Streamflow

Jemez River Discharge, 1972-2007

\[ y = -0.003x + 101.57 \]

\[ r^2 = 0.0061, \ P < 0.05 \]

Data provided by: Bob Parmenter, VCNP
Recent trends in the Jemez Fire Frequency
The West faces a 90% chance of (IPCC 2007):

- declining snowpack
- earlier peak stream flows
- greater ET & evaporation from reservoirs

- Southwest a “Dust Bowl” by mid-21st century?
  (Seager et al. 2007, Science)

... leading to increased competition for already over-allocated water resources.

Source: Hoerling & Eischeid 2007