

Assessing and Adapting to Climate Change Intermountain Region – Focus on Infrastructure

Association of Conservation Engineers
9/27/16



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Forest Service, Ogden, Utah

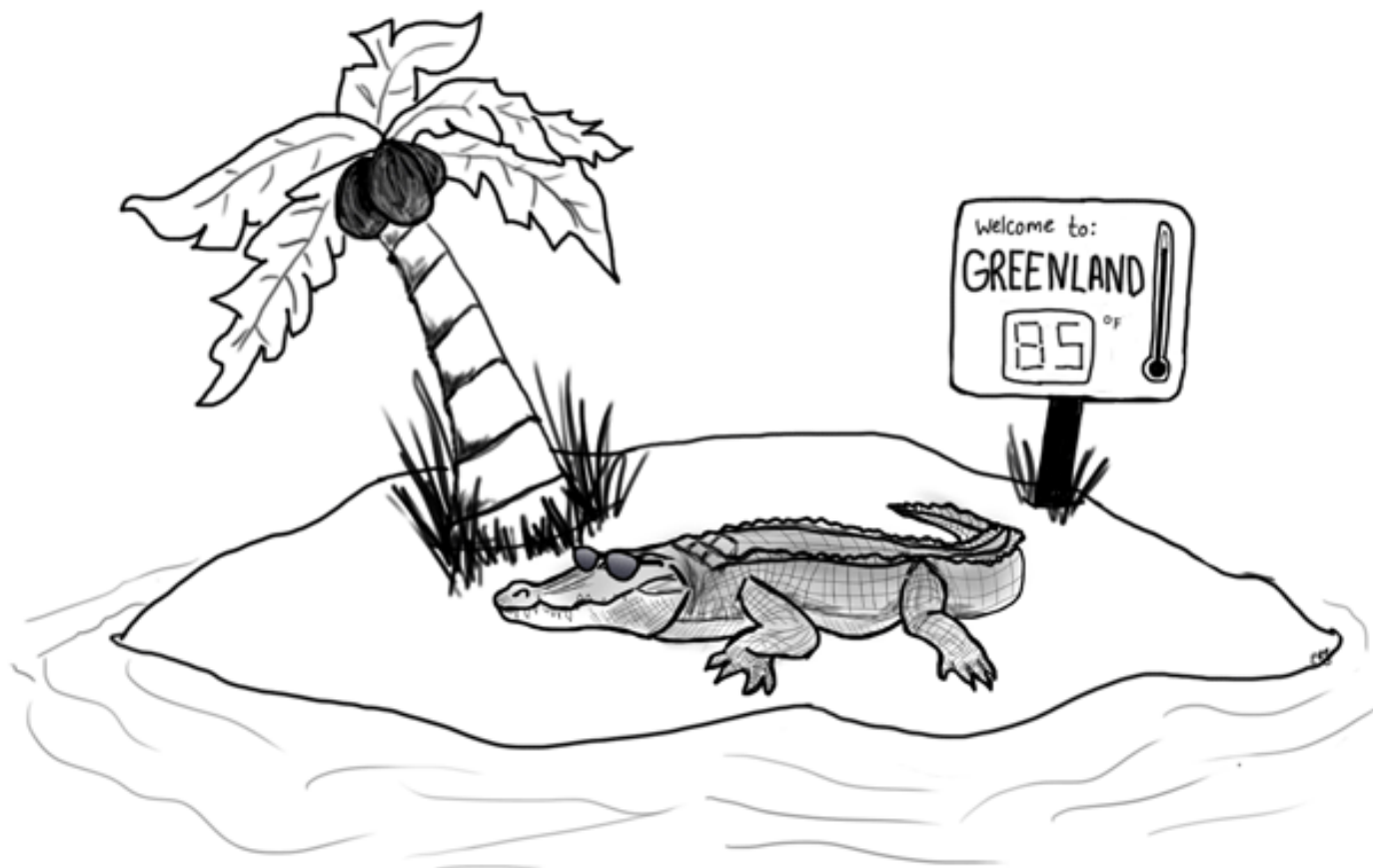
**We have lots of information!
What is important? What isn't?**



Climate Change Scorecard = accountability

Organizational Capacity	
1	Employee Education
2	Designated Climate Change Coordinators
3	Program Guidance
Engagement	
4	Science and Management Partnerships
5	Other Partnerships
Adaptation	
6	Assessing Vulnerability
7	Adaptation Actions
8	Monitoring
Mitigation and Sustainable Consumption	
9	Carbon Assessment & Stewardship
10	Sustainable Operations

USFS information & tools

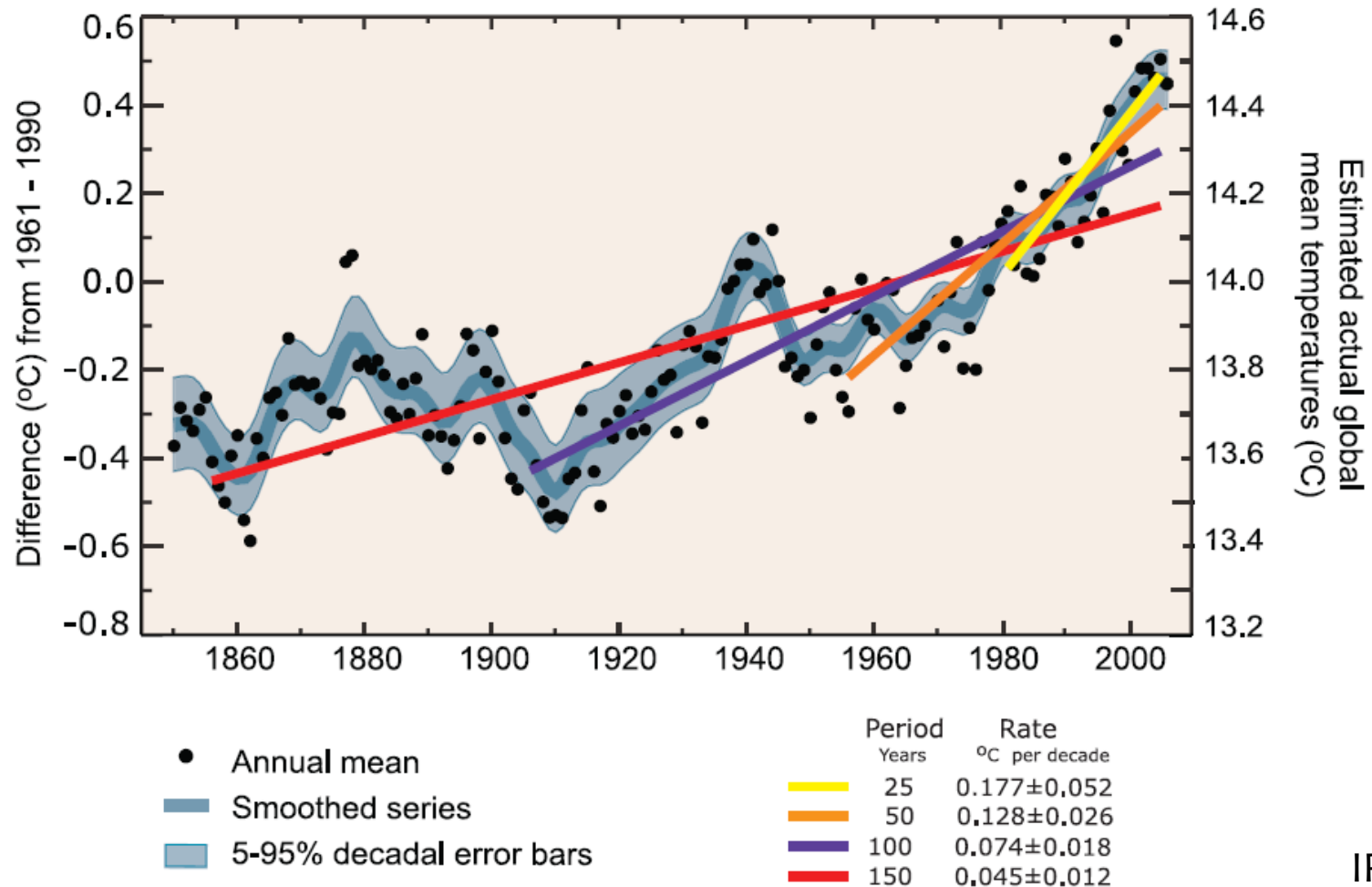


56 million years ago

Cartoon by Emily Greenhalgh, NOAA Climate.gov.

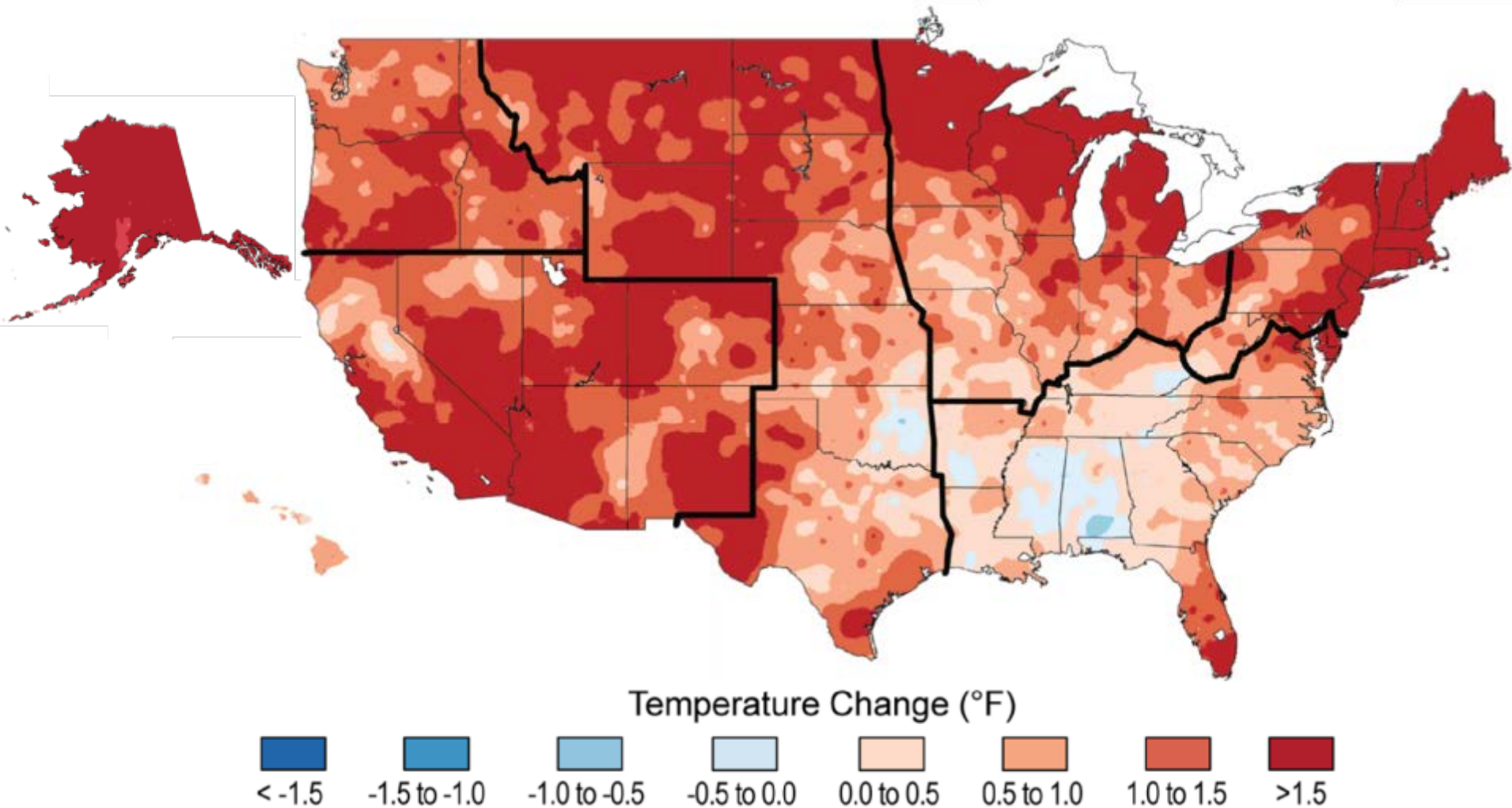
Rate of Climate change

The average global surface temperature has risen 1.53°F over the past 100 years



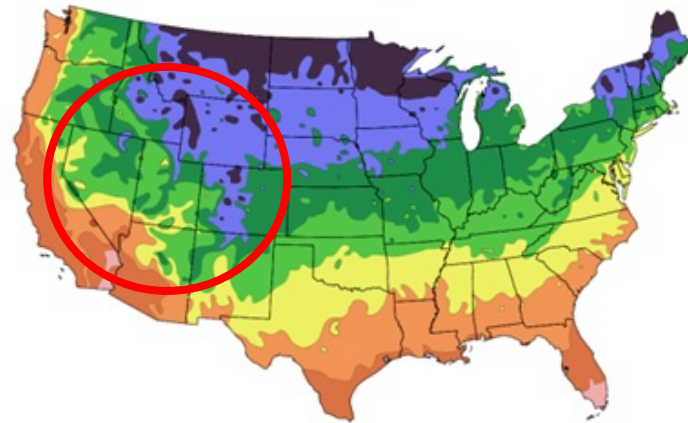
Climate change or global warming?

Contiguous US: 1991-2012 departure from 1901-1960 average



USDA plant hardiness zones

1990 Map



After USDA Plant Hardiness Zone Map, USDA Miscellaneous Publication No. 1475, Issued January 1990

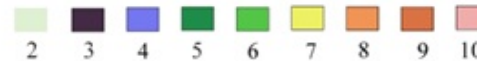
© 2006 by The National Arbor Day Foundation®

2012 Map



Re-colored version of the 2012 USDA Plant Hardiness Zone Map
(available at: <http://planthardiness.ars.usda.gov/PHZMWeb/>)

Zone



Climate Change Trends

- About 1.5F warming, with regional variability.
- General increases in annual precipitation, except in the southwest.
- More big rain events, more of annual precip within those events.

The earth has warmed and the climate is changing as a result, with regional variations.

To say or not to say ... “climate change” ...
that is the question ...

Temperature

Precipitation

Science

Drought

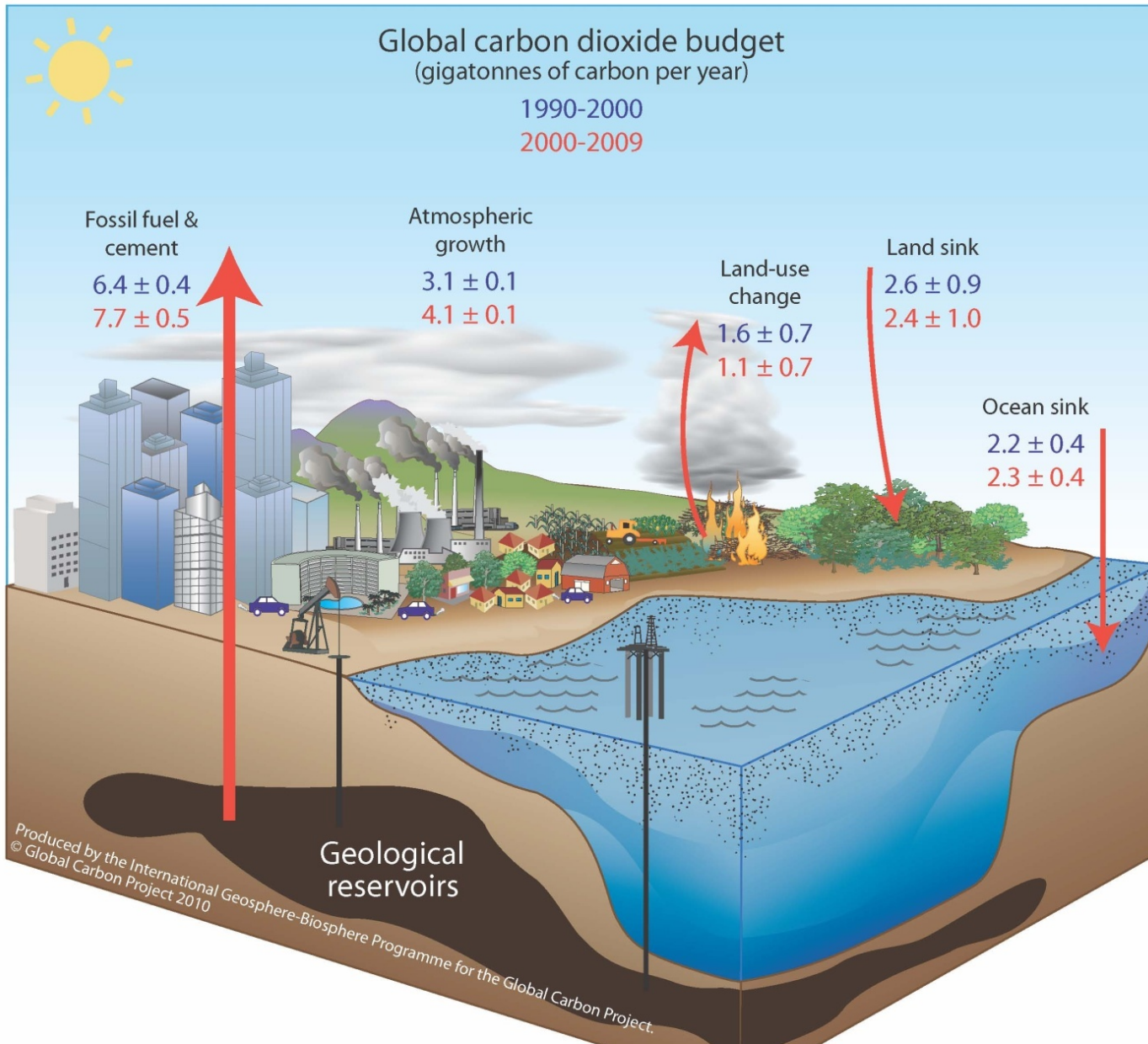
Changing conditions

Ecological transitions

Greenhouse gases

Future resource conditions

Anthropogenic change?



Net sources
and sinks

The atmosphere is massive, how can we change it?

- Fossil carbon is an addition – it has been isolated from the carbon cycle for millions of years.
- Greenhouse gases have different atmospheric lifetimes – Water vapor lasts hours to days – CO₂ may last decades to centuries – Methane lasts about 12 years
- Land cover change transfers carbon to the atmosphere.

The measurement record clearly shows our additions to the atmosphere.

Isn't future climate change uncertain?

- Models have acknowledged shortcomings.
- They do well globally with air temps, and less well with precipitation.
- Great at multi-decadal trends, more uncertainty at multi-year.
- Emissions uncertainties are inherent.

All models are uncertainty, some are useful – best to use multiple models, think long term, and consider a range of futures.

What will all this mean for forests?

Some benefits, but more widespread increases in stress.

- Precipitation
- Temperature
- CO₂ fertilization
- Extreme weather events
- Longer growing seasons
- Species range shifts
- Expanded pest and disease ranges
- Decreased snow pack and early thaw
- Increased frequency and intensity of fire

Consider local species, trends, and landscape!

***Where can I find help and
tools?***

Climate Change Resource Center

www.fs.usda.gov/ccrc/

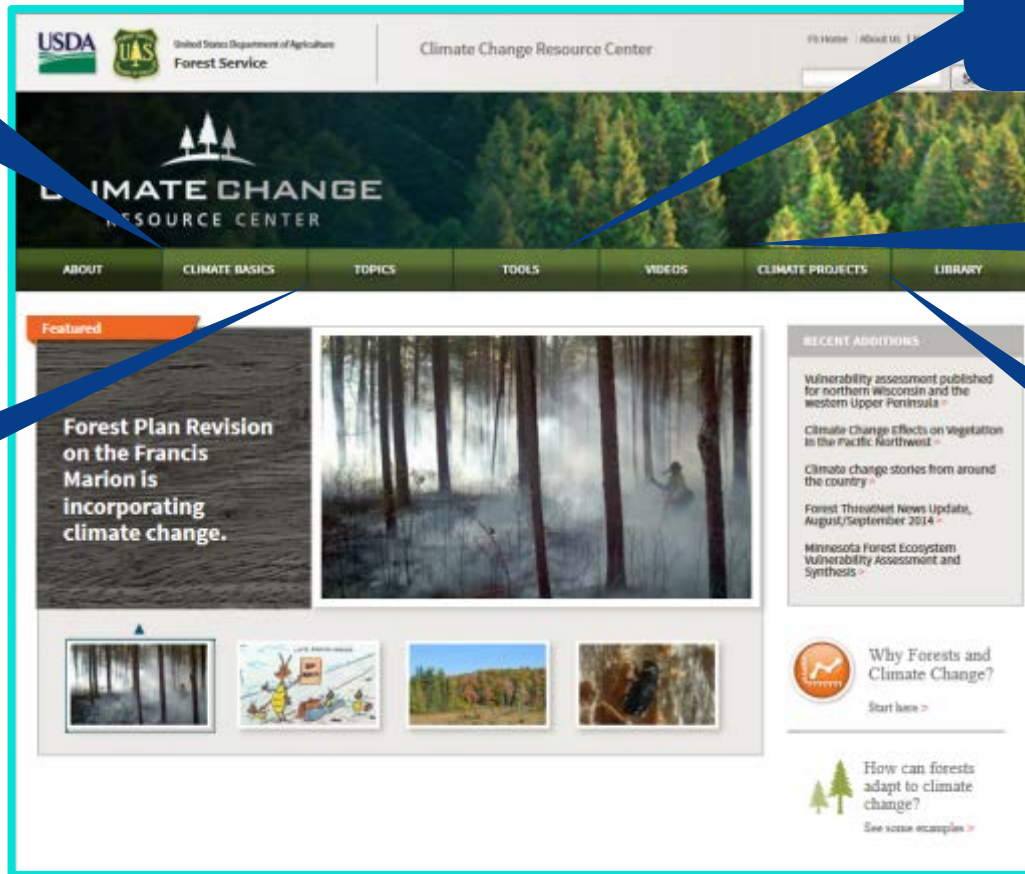
climate basics

climate/carbon tools

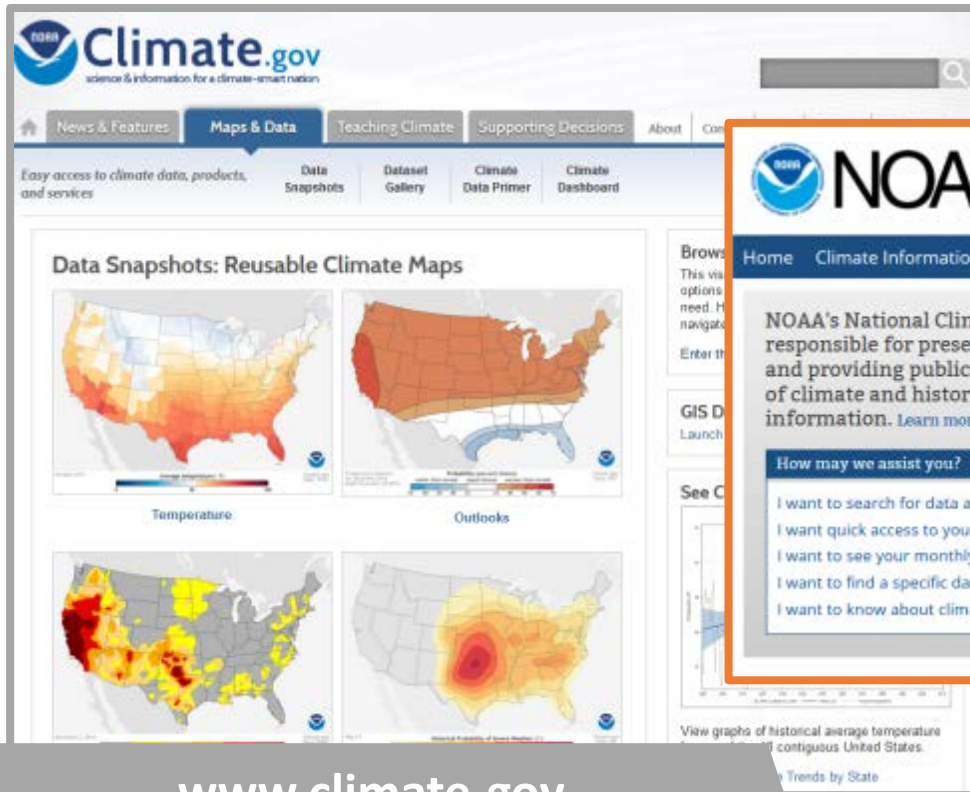
videos

topic pages

extras!

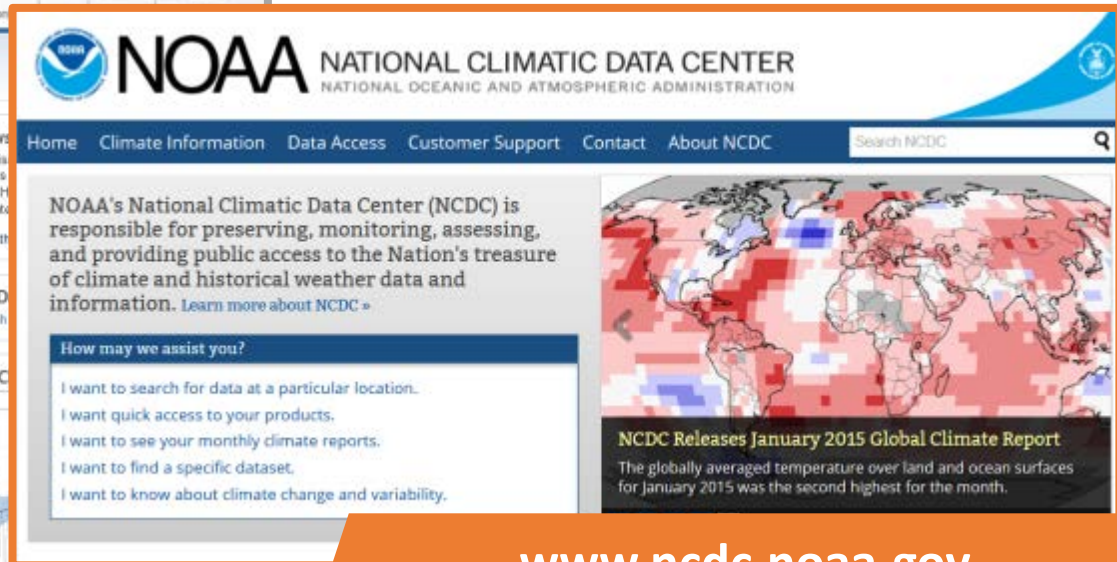


Datasets and maps



The screenshot shows the Climate.gov website. The main navigation bar includes 'News & Features', 'Maps & Data', 'Teaching Climate', and 'Supporting Decisions'. Below this, there are links for 'Data Snapshots', 'Dataset Gallery', 'Climate Data Primer', and 'Climate Dashboard'. The 'Data Snapshots: Reusable Climate Maps' section features four maps of the United States: 'Temperature', 'Outlooks', and two others. The 'Temperature' map shows a color scale from blue to red. The 'Outlooks' map shows a color scale from blue to red. The other two maps show different climate data visualizations.

www.climate.gov



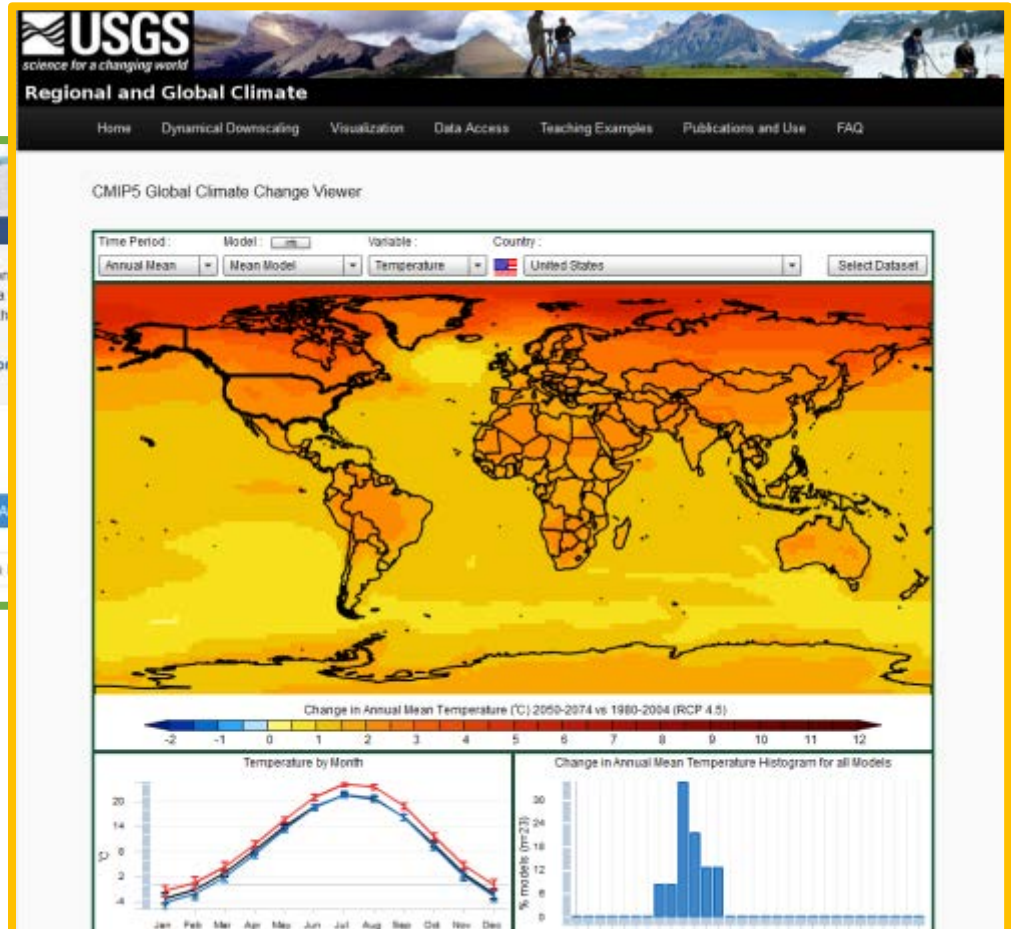
The screenshot shows the NOAA National Climatic Data Center (NCDC) website. The main navigation bar includes 'Home', 'Climate Information', 'Data Access', 'Customer Support', 'Contact', and 'About NCDC'. Below this, there is a search bar and a list of links: 'Browse', 'GIS Data', and 'See C'. The main content area features a large text block: 'NOAA's National Climatic Data Center (NCDC) is responsible for preserving, monitoring, assessing, and providing public access to the Nation's treasure of climate and historical weather data and information. Learn more about NCDC >'. Below this is a section titled 'How may we assist you?' with four options: 'I want to search for data at a particular location.', 'I want quick access to your products.', 'I want to see your monthly climate reports.', 'I want to find a specific dataset.', and 'I want to know about climate change and variability.'. To the right of this text is a world map showing global temperature anomalies. Below the map is a section titled 'NCDC Releases January 2015 Global Climate Report' with the text: 'The globally averaged temperature over land and ocean surfaces for January 2015 was the second highest for the month.'

www.ncdc.noaa.gov

Datasets and maps



cida.usgs.gov/gdp/



CMIP5 Global Climate Change Viewer

Datasets and maps

The screenshot shows the Climate.Data.Gov website. At the top, there is a search bar with the text "Search Data.gov" and a magnifying glass icon. Below the search bar is the "DATA.GOV" logo with the American flag, and a navigation menu with links for "DATA", "TOPICS", "IMPACT", "APPLICATIONS", "DEVELOPERS", and "CONTACT". The "CLIMATE" section is highlighted in blue, with a sub-menu containing "Themes", "Data", "Resources", "Challenges", "FAQ", and "Contact Climate". The main content area features a paragraph about finding climate change data and a "HIGHLIGHTS" section. The highlighted article is titled "Launch of Ecosystem-Vulnerability theme of Climate.Data.Gov" and includes a list of five bullet points describing the data's uses. A blue banner at the bottom of the page contains the URL "www.data.gov/climate/".

Search Data.gov

DATA.GOV DATA TOPICS IMPACT APPLICATIONS DEVELOPERS CONTACT

CLIMATE

Themes - Data Resources Challenges FAQ Contact Climate

Here you can find data related to climate change that can help inform and prepare America's communities, businesses, and citizens. Initially, in this pilot phase, you can find data and resources related to [coastal flooding](#), [food resilience](#), [water](#) and [ecosystem vulnerability](#). Over time, you will be able to find additional data and tools relevant to other important climate-related impacts, including risks to human health, and energy infrastructure. Please share your [feedback](#).

HIGHLIGHTS

Launch of Ecosystem-Vulnerability theme of Climate.Data.Gov

The U.S. government has released a collection of data and tools that will advance planning capabilities for the impacts of climate change on our nation's ecosystems. The data and tools will provide information and will help to stimulate innovation in preparing for climate impacts on fire regimes, water availability, carbon sequestration, biodiversity conservation, ocean health, and the spread of invasive species. Here are some examples of how the data and tools could be used:

- Help communities and natural resource managers determine if they are currently at risk from wildfires and if they will be impacted in the future due to wildfires becoming more prevalent and severe;
- Provide information to the public on their sources of water and their sensitivities to climate change;
- Aid in the public understanding of the role that ecosystems play in mitigating rising carbon dioxide levels due to their absorbing and storing of carbon, as well as how land management activities may influence storage capabilities;
- Identify the potential impacts of climate change on rare and endangered species, iconic species, and ecosystems;
- Identify which invasive species may threaten specific locations and their impacts on local communities and their economies. This effort will contribute to early detection, rapid response activities.

Highlights

www.data.gov/climate/



United States
Department of
Agriculture

Forest Service

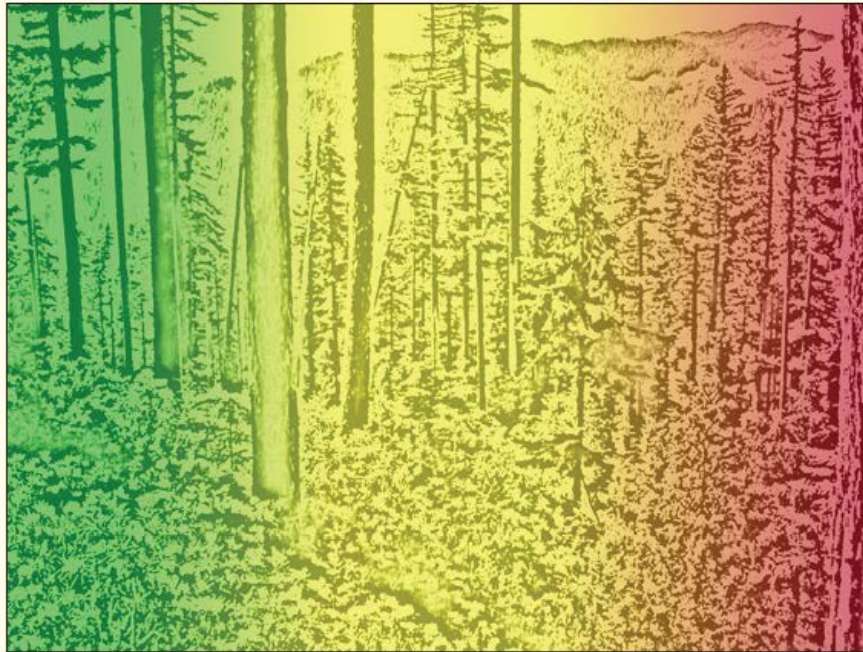
Pacific Northwest
Research Station

General Technical
Report
PNW-GTR-870

December 2012



Effects of Climatic Variability and Change on Forest Ecosystems: A Comprehensive Science Synthesis for the U.S. Forest Sector



National Climate
Assessment for forests

Copyrighted Material
Advances in Global Change Research 57

David L. Peterson
James M. Vose
Toral Patel-Weynand *Editors*

Climate Change and United States Forests

 Springer

Copyrighted Material

High-profile book in
international literature



United States
Department of
Agriculture

Forest Service

Pacific Northwest
Research Station

General Technical Report
PNW-GTR-855

November 2011



Responding to Climate Change in National Forests: A Guidebook for Developing Adaptation Options

David L. Peterson, Constance I. Millar, Linda A. Joyce,
Michael J. Furniss, Jessica E. Halofsky, Ronald P. Neilson,
and Toni Lyn Morelli



Adaptation guidebook
for National Forests

Climate Change Adaptation Library

HOME WHAT WE DO WHO WE ARE ADAPTATION LIBRARY PROJECTS

ADAPTATION PARTNERS

SCIENCE-MANAGEMENT PARTNERSHIPS FOCUSED
ON CLIMATE CHANGE ADAPTATION IN THE
WESTERN UNITED STATES

<http://adaptationpartners.org/library.php>

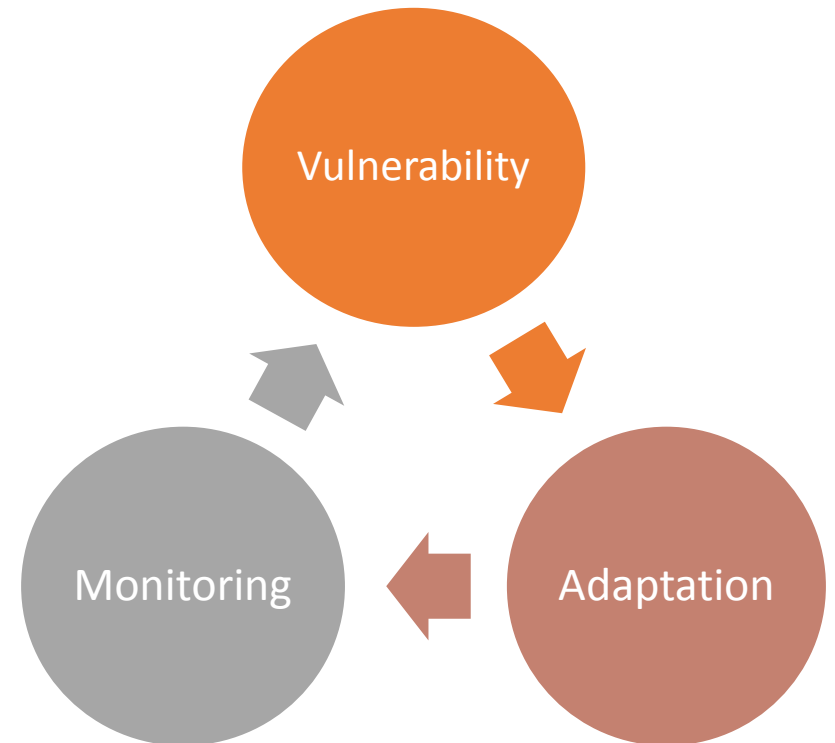
Assessing and adapting to climate change

Vulnerability Assessment

Evaluation of the degree to which organisms and systems are susceptible to the effects of climate change

Adaptation

Adjustment in natural or human systems to reduce harm, facilitate transitions, or exploit benefits of climate change



The adaptation process

*Start with a science-
management partnership*

1. Education

Hold workshops and webinars to increase climate change knowledge.

2. Vulnerability Assessment

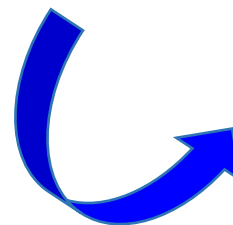
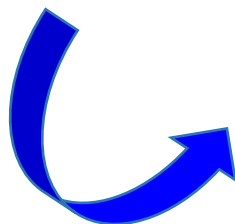
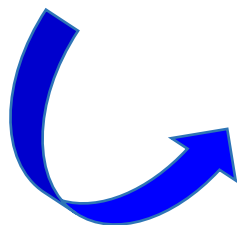
Review climate projections and identify resource sensitivities.

3. Adaptation Planning

Develop science-based adaptation options.

4. Implementation

Incorporate adaptation strategies into existing management plans.



Typical assessment topics

- Vegetation (ecological disturbance)
- Wildlife
- Water
- Fish

New assessment topics

- Recreation
- Infrastructure
- Ecosystem services
- Cultural resources

We're making progress



Assessments completed or in process

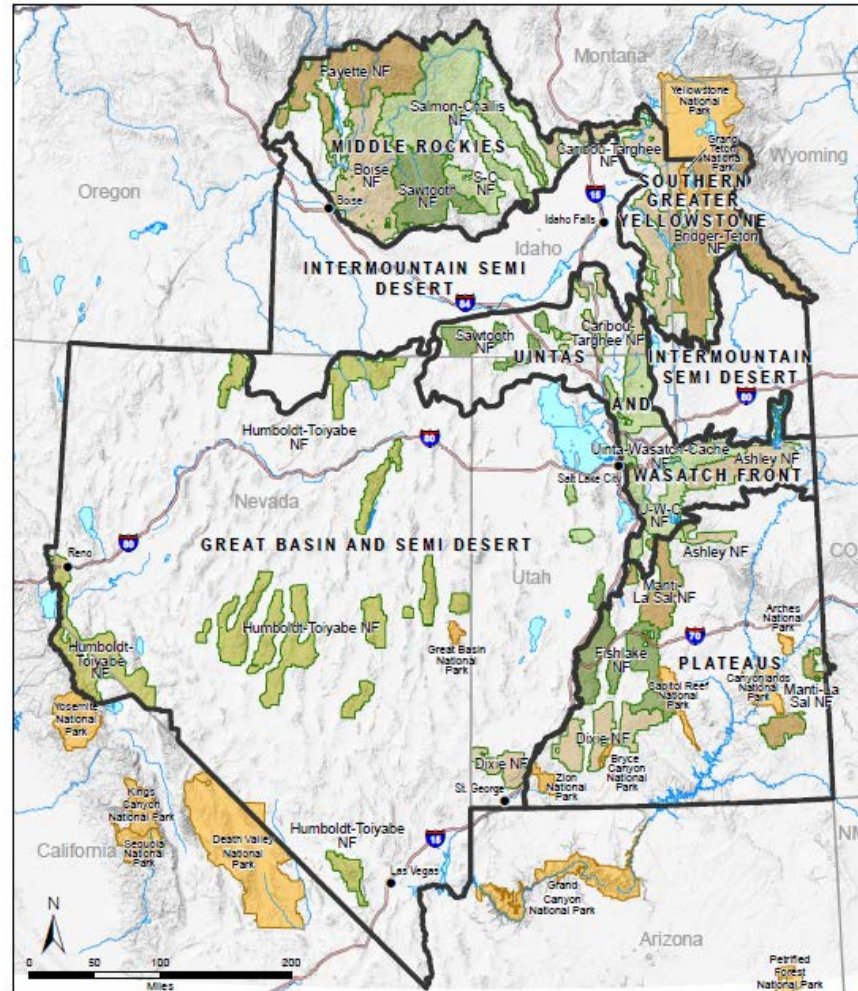
Products and outcomes

- Climate change thinking and awareness
- Climate change partnerships
- Data gathering and information sharing
- Website (<http://adaptationpartners.org>)
- USFS General Technical Report and other scientific publications
- Follow-up projects in the region

Products and outcomes

The most important outcome is building organizational capacity to address the effects of climate change on natural resources.

What does a climate change assessment look like?



RD4 IM GIS - 20160414

Progress report for Region 4

The Intermountain Adaptation Partnership (IAP)

Goals for the science-management partnership:

- Increase climate change awareness
- Assess vulnerability of natural resources
- Develop adaptation strategies and tactics

<http://adaptationpartners.org/iap>



IAP Vision and Strategy

- Identify key resources critical to ongoing resource management and planning
- Provide specialist training to apply climate change knowledge in land management
- Guide national forest planning and NEPA analysis
- Create partnerships with other agencies and stakeholders
- Publish a peer-reviewed assessment

Leaders and Partners

USFS: Region 4, S&PF, RMRS, PNW

National Park Service

Bureau of Land Management

USFWS Landscape Conservation Cooperatives

USGS Climate Science Centers

Tribes

States

NGOs

Universities

Conservation groups

Two-Day Workshops

<u>Dates</u>	<u>Location</u>	<u>Total Attendees</u>	<u>Forest Service</u>	<u>Partners</u>
May 4-5	Ogden, Utah	50	41	9
May 11-12	Boise, Idaho	53	32	21
May 18-19	Salt Lake City, Utah	54	37	17
May 25-26	Reno, Nevada	43	28	15
June 1-2	Idaho Falls, Idaho	51	37	14



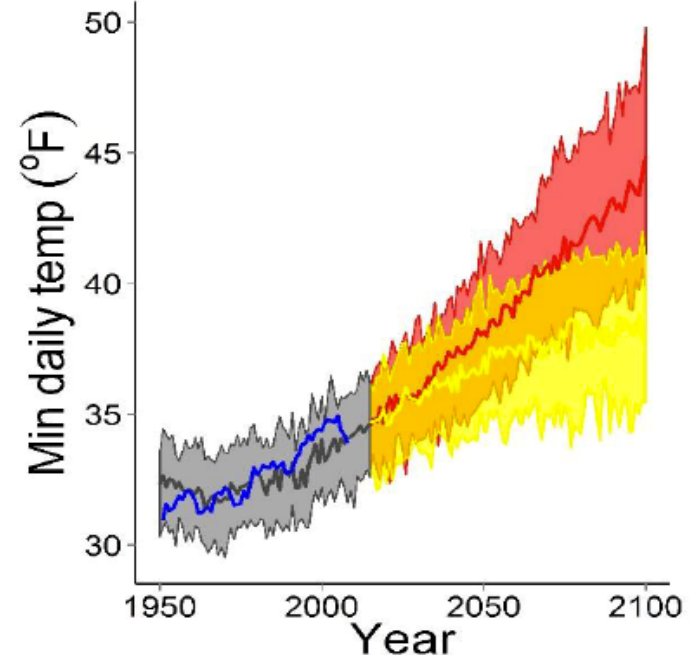
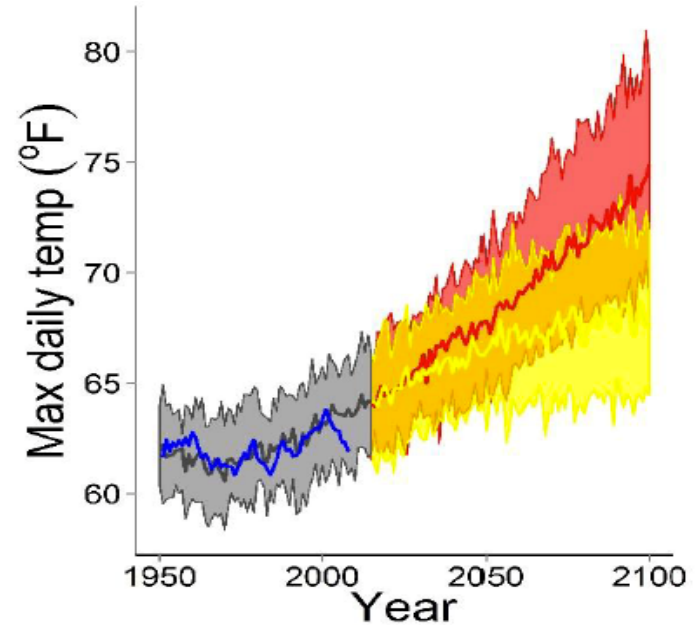
IAP Focus Areas

- Climate
- Hydrology, Soil, and Water
- Aquatic Species
- Vegetation
- Disturbance
- Terrestrial Animals
- Recreation
- Infrastructure
- Cultural Heritage
- Ecosystem Services



Climate

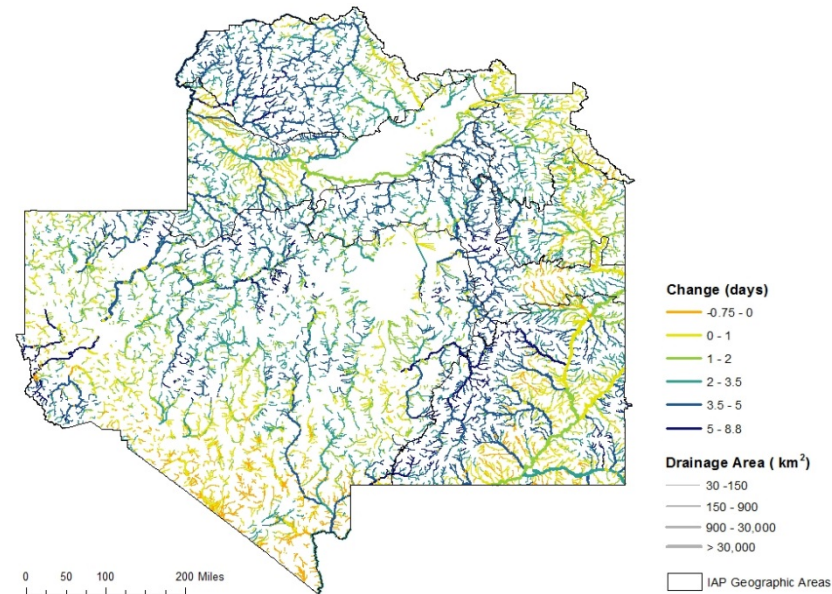
- Average temperature has increased 1.5F in the past 50 years.
- Average temperature will increase 3-4F by 2050, 7-10F by 2100.
- Precipitation may increase slightly in winter (uncertain)



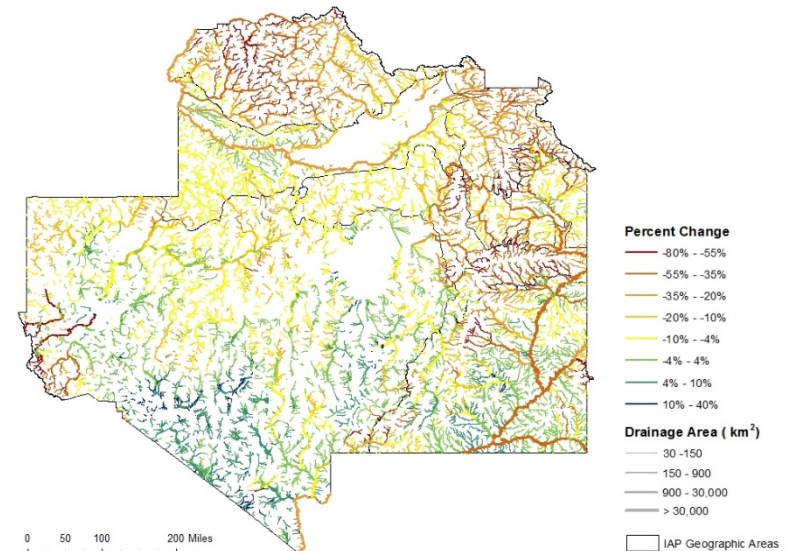
Hydrology, soil, water

- Snowpack will become intermittent at low-mid elevations
- Reduced snowpack will cause (1) higher winter peak flows, (2) lower streamflows and higher stream temp. in summer
- Groundwater and water supplies will decrease

Change in Number of Winter Floods (historic-2040s)



Percent Change in Mean Summer Flow (historic-2040s)



Aquatic species

- Higher stream temps. will reduce habitat for cold-water fish, especially bull trout, cutthroat trout
- Less water & higher temp will stress amphibians, mussels, & springsnails
- Habitat for most species will be retained at higher elevations



Vegetation

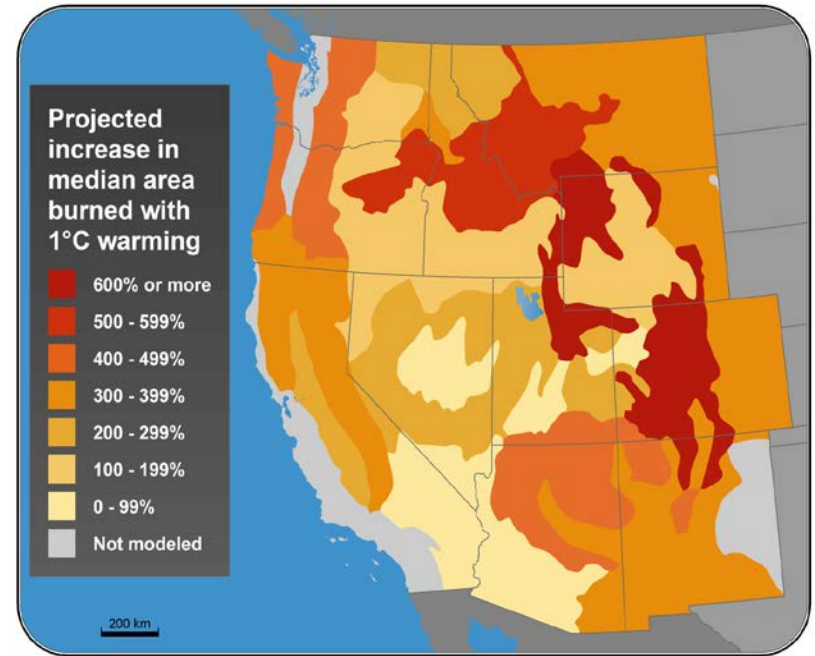
- Most low-mid elevation forests will grow slower; some high-elevation forests will grow faster
- Distribution & abundance of species will shift
- Increasing fire & insects will reduce dominance of susceptible species



Disturbance

- Area burned by wildfire will increase 200-300% by mid-21st century
- Bark beetle outbreaks will be more common in lodgepole pine & ponderosa pine
- Mass wasting & flooding will be more common in some areas

Wildfire area burned, 2050



Terrestrial animals

- Snow-dependent mammals (wolverine, lynx) will be especially vulnerable
- Amphibian species will be vulnerable to changes in ponds & riparian areas
- Animal species that require specific vegetation (e.g., sage-grouse) may be vulnerable



Recreation

- Warm-weather activities will expand (esp. shoulder seasons)
- Winter activities will decrease, especially at low-mid elevations
- Water-based activities will probably increase, as recreationists avoid heat



Cultural heritage

- Increased fire & flooding will threaten the integrity of artifacts
- Increased aridity & erosion will make artifacts more vulnerable to illegal collecting
- Altered vegetation may affect some cultural sites & landscapes



Ecosystem services

- Less productive range & altered land use will reduce grazing values
- Less snow, more drought, & more fire will reduce water supplies & quality
- Ranges of native pollinators may decrease
- Increased disturbance will reduce carbon storage



Infrastructure

- Increased flooding will damage roads, culverts, & bridges
- Increased flooding & avalanche hazard will reduce visitor safety
- Increased road damage will reduce visitor access, especially in floodplains

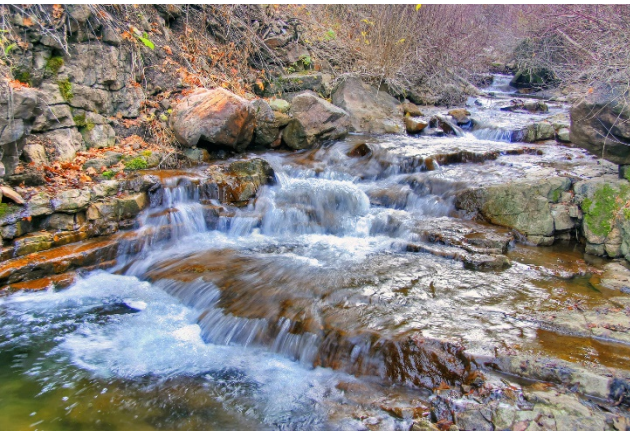


How do we manage for resilient systems in a warmer climate?



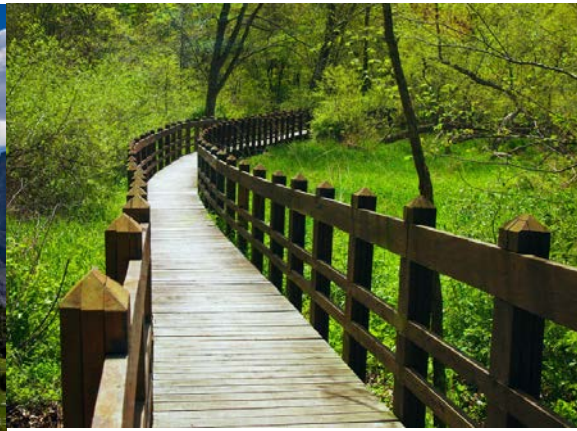
Infrastructure Risk

- Climate change is expected to increase risk
 - Extreme rainfall
 - Snowmelt changes
 - Flooding
- Increased risk to:
 - Infrastructure
 - People
 - Ecosystems
- Type of risks include
 - Washouts
 - Landslides
 - Culvert failure
 - Streamside road avulsion



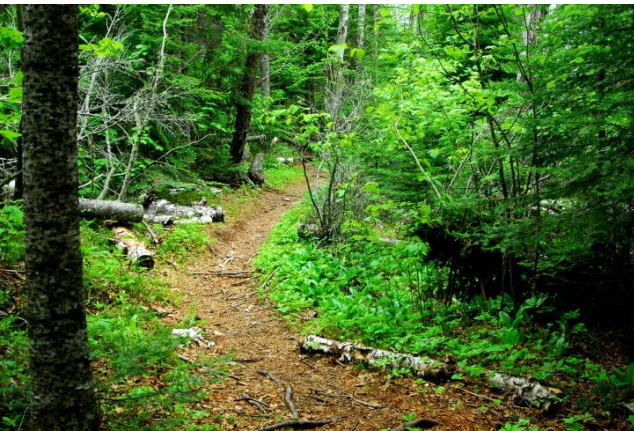
Assessment Approach – Three Levels

- Assessment Level 1 – Infrastructure presence
 - Know what infrastructure exists – how much of each type and where
- Assessment Level 2 – Regional scales of analyses
 - National Forests
 - Proximity to streams
 - For roads and streams in particular, road-stream intersections
 - Slope steepness
 - Soil type
- Assessment Level 3 – Smaller scales of analysis
 - Watersheds
 - Past ERFO sites
 - Areas of high human presence
 - High infrastructure values



Types of Infrastructure

- Road transportation system: roads, bridges, culverts
- Trails, trail bridges
- Buildings
- Developed Recreation Sites
- Dams



Higher Risk Infrastructure

- Communities that rely on road access
- Steep terrain and erosive soil types
- Stream channels with high avulsion
- Sensitive ecosystems
- Areas that have failed before
- Aging and deteriorating infrastructure
- High risk of wildfire, landslides, flooding



Road Transportation System – Level 1

Table 10.1-Road mileage for different maintenance levels in national forests in the U.S. Forest Service Intermountain Region

Region 4 Roads Operation Maintenance Level Mileage

Forest	Maintenance Level					Total
	1	2	3	4	5	
Ashley National Forest	23.28	973.96	339.35	156.64	87.57	1,580.80
Boise National Forest	1,527.18	2,503.12	541.88	14.34	-	4,586.52
Bridger-Teton National Forest	571.96	983.47	385.01	213.95	-	2,154.39
Dixie National Forest	992.18	2,075.37	460.37	48.89	14.77	3,591.58
Fishlake National Forest	42.72	1,710.40	168.38	12.41	7.26	1,941.17
Manti-LaSal National Forest	302.28	1,615.55	290.09	9.02	-	2,216.94
Payette National Forest	841.77	1,649.46	428.4	35.78	3.96	2,959.37
Salmon-Challis National Forest	1,198.25	2,344.79	341.61	41.39	1.51	3,927.55
Sawtooth National Forest	268.14	1,340.80	269.61	16.8	20.93	1,916.28
Caribou-Targhee National Forest	460.62	1,528.89	577.44	177.05	23.44	2,767.44
Humboldt-Toiyable National Forest	493.14	4,351.46	626.12	68.6	16.8	5,556.12
Uinta-Wasatch-Cache National Forest	181.66	1,689.05	434.25	140.78	124.52	2,570.26
Grand Total	6,904.18	22,768.32	4,865.51	939.65	300.76	35,778.42

OPER MAINT LEVEL

Description

1 - BASIC CUSTODIAL CARE (CLOSED)

Assigned to roads that have been placed in storage (>one year) between intermittent uses. Basic custodial maintenance is performed. Road is closed to vehicular traffic.

2 – HIGH CLEARANCE VEHICLES

Assigned to roads open for use by high clearance vehicles.

3 – SUITABLE FOR PASSENGER CARS

Assigned to roads open for and maintained for travel by a prudent driver in a standard passenger car.

4 – MODERATE DEGREE OF USER COMFORT

Assigned to roads that provide a moderate degree of user comfort and convenience at moderate travel speeds.

5 – HIGH DEGREE OF USER COMFORT

Assigned to roads that provide a high degree of user comfort and convenience.

Bridge System – Level 1

Intermountain Region Forests	Adequate	Structurally Deficient	Total
Ashley	28	7	35
Boise	114	6	120
Bridger Teton	96	20	116
Dixie	37	8	45
Fishlake	13	1	14
Manti La Sal	26	3	29
Payette	59	9	68
Salmon-Challis	115	6	121
Sawtooth	95	6	101
Caribou-Targhee	53	18	71
Humbolt-Toyabee	29	5	34
Uinta-Wasatch-Cache	94	2	96
Total	759	91	850

Trail System – Level 1

Intermountain Region Forests	Miles	Trail Bridges
Ashley	1,108	41
Boise	1,970	67
Bridger Teton	3,436	47
Dixie	1,912	23
Fishlake	2,351	3
Manti La Sal	953	5
Payette	1,841	103
Salmon-Challis	3,452	53
Sawtooth	2,491	84
Caribou-Targhee	3,950	52
Humbolt-Toyabee	3,578	8
Uinta-Wasatch-Cache	2,579	51
Total	29,622	537

Buildings – Level 1

Intermountain Region Forests	# FS Buildings	Total DM	Total CRV
Regional	5	\$389,006	\$1,636,835
Ashley	116	\$3,028,836	\$26,390,537
Boise	303	\$7,972,863	\$70,230,404
Bridger-Teton	212	\$1,755,813	\$38,380,272
Dixie	88	\$3,265,997	\$21,176,792
Fishlake	71	\$218,288	\$8,625,186
Manti-LaSal	66	\$684,676	\$9,297,776
Payette	238	\$13,935,458	\$54,305,579
Salmon-Challis	274	\$18,560,269	\$46,087,048
Sawtooth	144	\$7,874,535	\$25,735,418
Caribou-Targhee	149	\$855,023	\$36,137,504
Humboldt-Toiyabe	238	\$6,717,168	\$64,322,268
Uinta-Wasatch-Cache	229	\$7,290,860	\$43,624,253
Total	2,133	\$72,548,793	\$445,949,869
DM = Deferred Maintenance			
CRV = Current Replacement Value			

Dams System – Higher Risk

- Communities that rely on resources – may see agricultural resources change into drinking water resources
- Communities that are downstream
- Areas that have failed before
- Inadequate safety provisions
- Inadequate spillways for extreme storms
- New hydrologic regimes where snowfall and snowpack is declining



Dams System – Level 1

Intermountain Region Forests	Active	Inactive/disposed	Total
Ashley	29	0	29
Boise	5	3	8
Bridger Teton	16	5	21
Dixie	40	6	46
Fishlake	36	13	49
Manti La Sal	36	9	45
Payette	13	0	13
Salmon-Challis	9	0	9
Sawtooth	6	1	7
Caribou-Targhee	14	0	14
Humbolt-Toyabee	32	6	38
Uinta-Wasach-Cache	48	20	68
Total	284	63	347

Extreme weather + increased disturbance: Our primary challenge



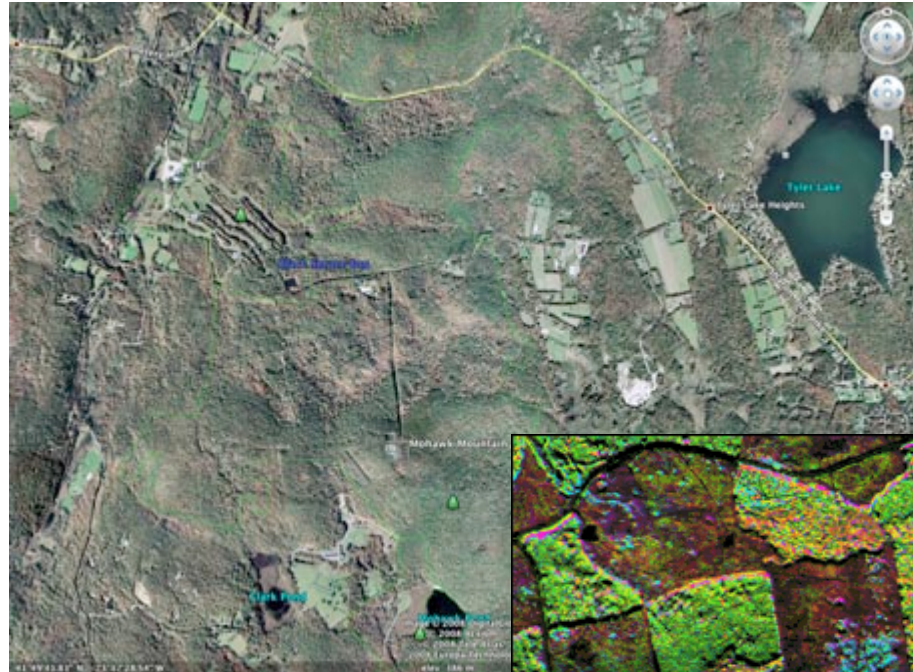
Adaptation strategy

Increase landscape diversity

Diversify spatial distribution of forest age and structure

Implement thinning and fuel treatments across large landscapes.

Orient the location of treatments in large blocks to modify fire severity and spread.



Adaptation strategy

Treat large disturbances as an opportunity

Develop management strategies and on-the-ground actions for implementation following wildfire and insect outbreaks.

Include long-term experimentation.

Get the plans approved.

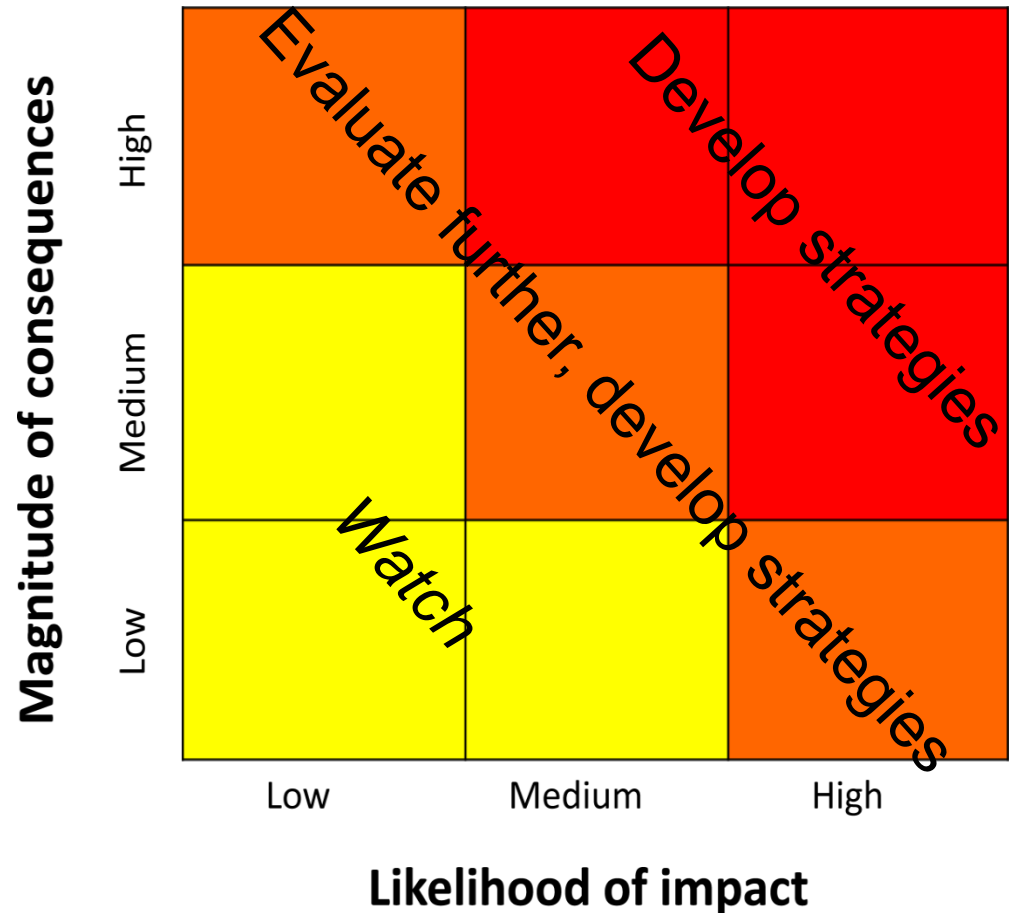


Adaptation strategy

Incorporate risk assessment

Quantify or at least estimate the risk of climate change effects on natural resources.

Use risk assessment to guide adaptation responses.



Breakout Group/Resource Area:

Group Members:

1	Sensitivity to climatic variability and change:			
2	Adaption Strategy / Approach:			
		Specific Tactic – A	Specific Tactic – B	Specific Tactic – C
3	Tactics			
4	Where can tactics be applied?			
5	Opportunities for implementation			
6	Comments			

ADAPTATION SYNTHESIS: WATER RESOURCES

Sensitivity to Climate Change	Adaptation Strategy	Adaptation Tactic
Higher peak flows will lead to increased road damage at stream crossings	Increase resilience of stream crossings, culverts, and bridges to higher peak flows	<ul style="list-style-type: none"> • Continue to replace culverts with higher capacity culverts • Complete unit-wide inventory of culverts and bridges, including GPS locations of structures and accurate culvert data • Consider a process for replacing culverts based on projected future, rather than historical, peak flows • Consider prioritizing structure replacement in high-risk (mixed-rain-and-snow) watersheds • Reroute roads out of flood plains
	Increase resistance of road surfaces to higher peak flows at stream crossings	<ul style="list-style-type: none"> • Install hardened stream crossings • Perform a basin-wide assessment of current hydrological interactions with roads • Continue to use grade control structures, humps, and water bars to reduce velocity and redirect flow

Vulnerability assessment & adaptation strategies will inform:

- Forest plan revisions
- NEPA documents
- Local management projects
- Restoration efforts
- Monitoring programs

For information on webinars and workshops,
and to subscribe to the listserv, see:

<http://adaptationpartners.org/iap>

Intermountain Adaptation Partners

Preparing for climate change through science-management collaboration

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Intermountain Adaptation Partners (IAP)

IAP is a Forest Service science-management collaboration with the following goals:

1. Increase climate change awareness;
2. Assess the vulnerability of natural resources and ecosystem services to climate change; and
3. Develop science-based adaptation strategies that can be used by national forests to understand and mitigate the effects of climate change.

IAP is an Adaptation Partners Project.

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Adaptation is a marathon, not a sprint

