Impacts of Climate Change on Aquatic and Riparian Landscapes

…and Use of Downscaling to Guide Integrated Preparation Planning

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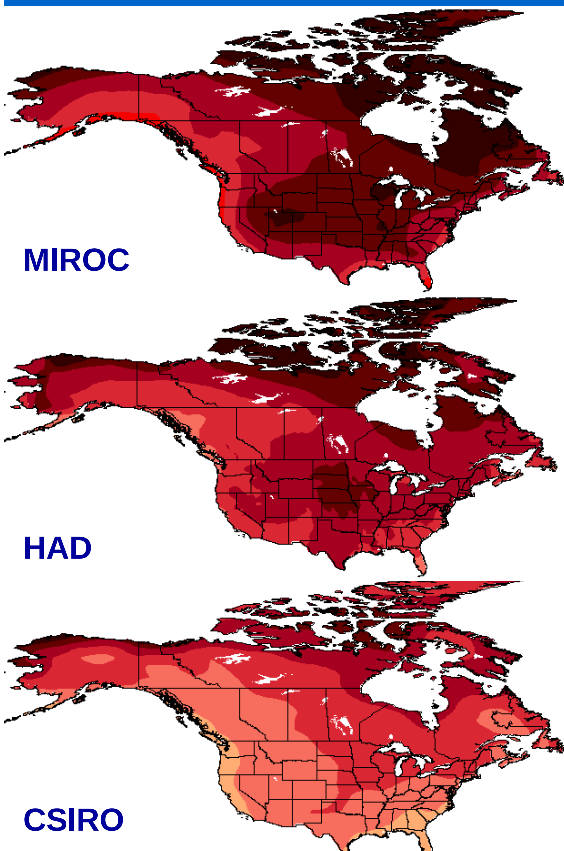
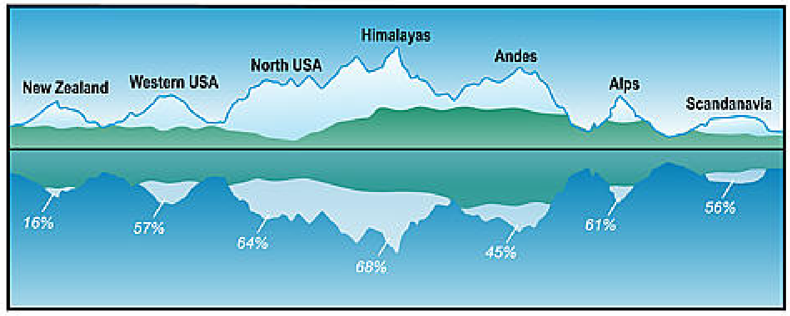
WHAT DOES CLIMATE CHANGE MEAN?

Change in Temperature
2070-2099 vs. 1961-1990

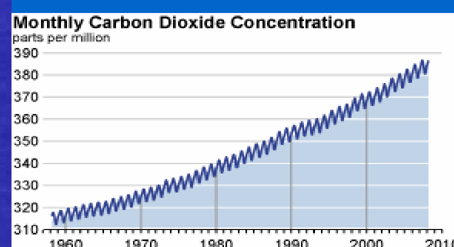


	0-1
	1-2
	2-3
	3-4
	4-5
	5-6
	6-7
	> 7

Change in Mountain Snowpack
1900 vs. 2000

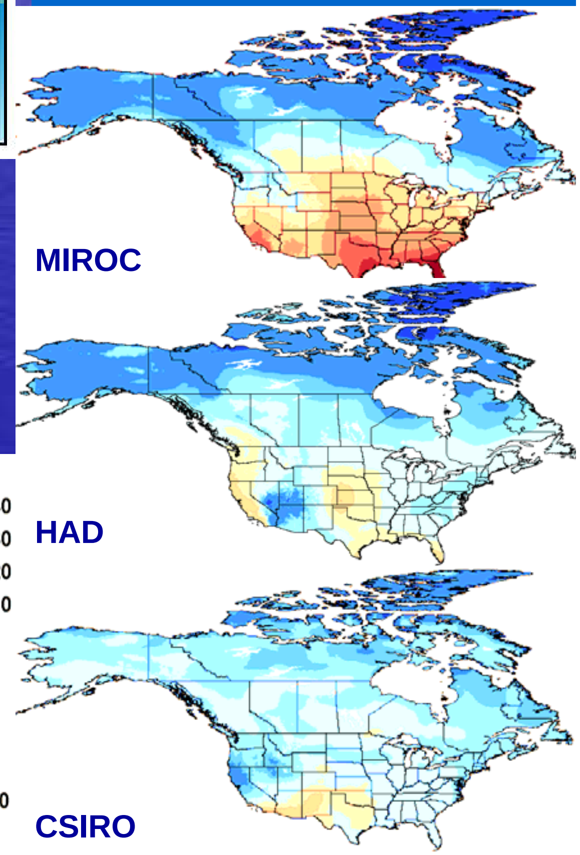


- **Pre-industrial ~ 275 ppm**
- **1958 = 315 ppm**
- **2000 = 367 ppm**
- **3% increase/year**



Change in Precipitation
2070-2099 vs. 1961-1990

	< -50
	-50 - -40
	-40 - -30
	-30 - -20
	-20 - -10
	-10 - 0
	0 - 11
	11 - 25
	25 - 43
	43 - 67
	67 - 100
	> 100



WHAT DOES CLIMATE CHANGE MEAN FOR AQUATIC ECOSYSTEMS?

ALTERED FLOW PATTERNS

- Higher peak flows – “flashier” runoff
- Peak flows occur earlier in season
- Longer duration of summer low flows

COMPROMISED WATER QUALITY

- Higher summer water temperatures
- Lower dissolved oxygen
- Increased bacteria, sediment, disease
- Higher toxic concentrations and mobilization

WHAT DOES CLIMATE CHANGE MEAN FOR AQUATIC ECOSYSTEMS?

REDUCED SUITABLE HABITAT

- Changes in flow – scour to bedrock and contraction of water network
- Loss of riparian shade, deep pools and undercut banks
- Reduced reproductive potential (Fish scale their size and therefore fecundity to habitat volume)

"Goldfish never outgrow their fish bowl"

INCREASED DISTURBANCE

- Increased flood, drought, and fire
- Wet cycles wetter; dry cycles drier
- Longer wet and dry cycles

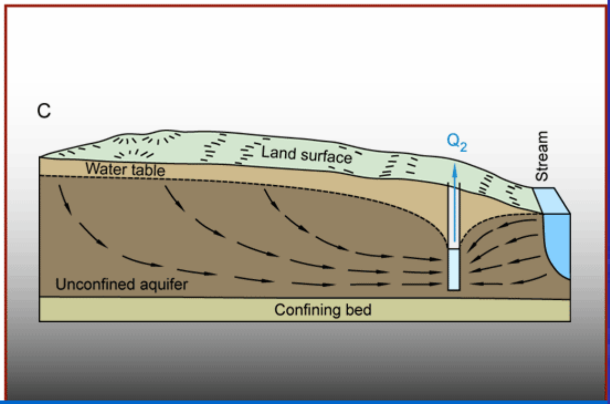
EXISTING STRESSORS WILL MAGNIFY *AND* BE MAGNIFIED BY CLIMATE CHANGE

WATER DIVERSIONS

PESTICIDES/HERBICIDES & OTHER "EMERGING CONTAMINANTS"

PASSAGE BARRIERS

EXOTIC SPECIES

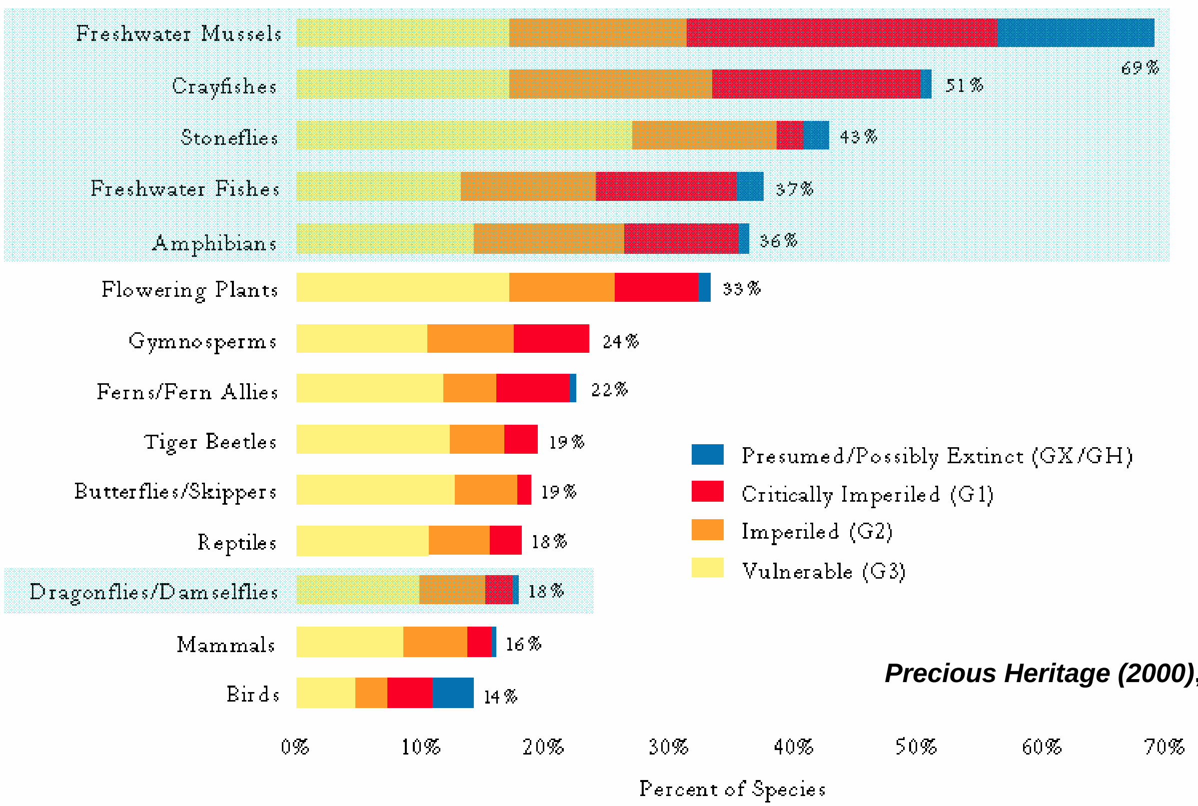


GROUNDWATER PUMPING

RIPARIAN/FLOODPLAIN DEVELOPMENT

WHY IS CLIMATE CHANGE CRITICAL FOR AQUATIC CONSERVATION?

Proportion of species at risk by plant and animal group



***Precious Heritage (2000)*, ©TNC, ABI**

WHAT SHOULD BE DONE?

BUILDING RESISTANCE

Pushing back against the effects of climate change

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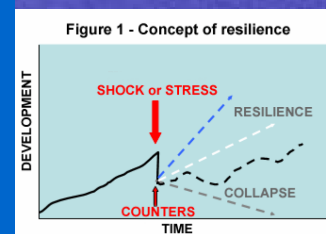
BUILDING RESILIENCE

Bouncing back and recovering from climate change impacts



PREPARATION

Getting ready for climate changes

Ecologically Sound Approaches to building resistance…

…Increase the "sponge" ***(floodplain restoration)***

Ecologically Sound Approaches to building resilience…

…Increase functional diversity
…Increase connectivity

WHY DOWNSCALE CLIMATE PROJECTIONS?

- Highlights the problems at a meaningful scale
  - Generational – mid and end century
  - Seasonal and annual averages
  - Spatial – our own backyard vs. global

- Helps identify local info gaps

- Fosters proactive governance

- Engages local experts, stakeholders, and decision makers

ELEMENTS OF CHANGE

I. TENSION

II. EFFICACY

III. BENEFIT

CLIMATE FUTURES FORUMS - PILOT BASINS

National Center for Conservation Science & Policy

University of Oregon Climate Leadership Initiative

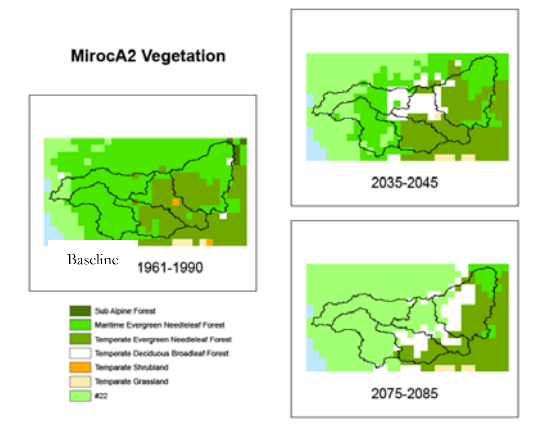
A FRAMEWORK FOR CLIMATE CHANGE PREPARATION STRATEGIES

ROGUE FUTURES FORUM

MODEL OUTPUTS AT BASIN-SCALE

Spatial Maps

- **Temperature**
  - **Spring, Summer, Fall, Winter Mean**
- **Precipitation**
  - **Spring, Summer, Fall, Winter Mean**
- **Vegetation**
- **Fire**
  - **Proportion Burned**
  - **Biomass Consumed**

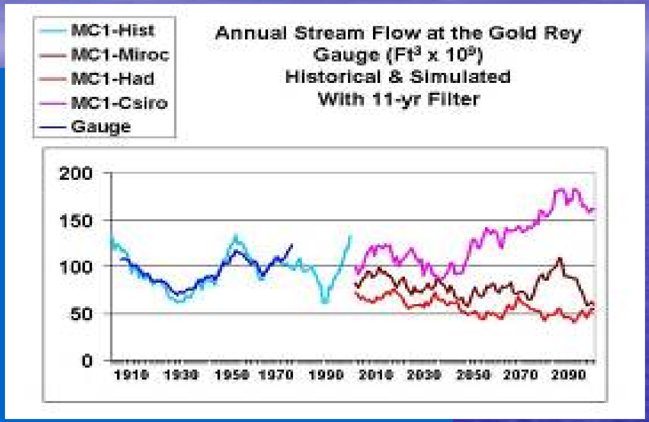


PNW Research Station
USDA Forest Service

ROGUE FUTURES FORUM

MODEL OUTPUTS AT BASIN-SCALE

Time Series Graphs



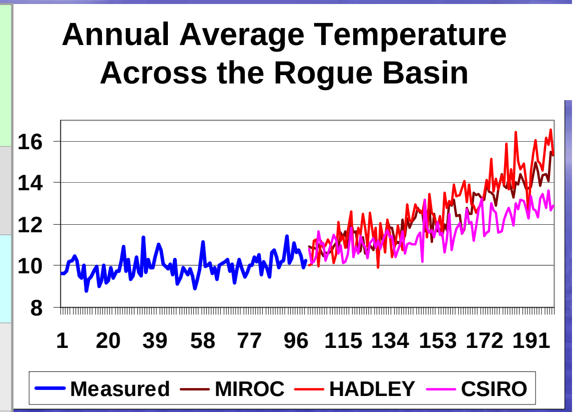
- **Temperature**
  - **Ave Annual**
  - **Ave Monthly**
- **Precipitation**
  - **Annual Sum**
  - **Ave Monthly Sum**
  - **Ave Monthly Snow Accumulation**
  - **Average Monthly Snow Melt**
- **Annual Stream Flow**
- **Fire**
  - **Annual Sum Vegetation Carbon**
  - **Annual Sum Biomass Consumed by Fire**
- **Area within Rogue in Specific Vegetation Type**

ROGUE FUTURES FORUM

TEMPERATURE

Temperature predictions for the Rogue River Basin

Timeframe	CSIRO	MIROC	Hadley
***Annual Average Temperature*: Baseline (1910-2000) = 49.5°F-51°F**			
2035/45	**+1°F**	**+3°F**	**+3°F**
2075/85	**+4°F**	**+6°F**	**+8°F**
***Average July Temperature*: Baseline (1910-2000) = 66°F**			
2035/2045	**+4°F**	**+4°F**	**+6°F**
2075/85	**+7°F**	**+8°F**	**+15°F**
***Average December Temperature*: Baseline (1910-2000) = 36°F**			
2035/45	**Little change**		**+3°F**
2075/85	**+3°F**		**+6°F**



Annual Average
2040: + 1°F to 3°F

2080: + 4°F to 8°F

Summer Average
2040: + 4°F to 6°F

2080: + 7°F to 15°F

Winter Average

2080: + 3°F to 6°F

The Rogue River Basin is likely to see regional increases slightly above the global average

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PRECIPITATION AND STREAM FLOW

Precipitation predictions for the Rogue River Basin

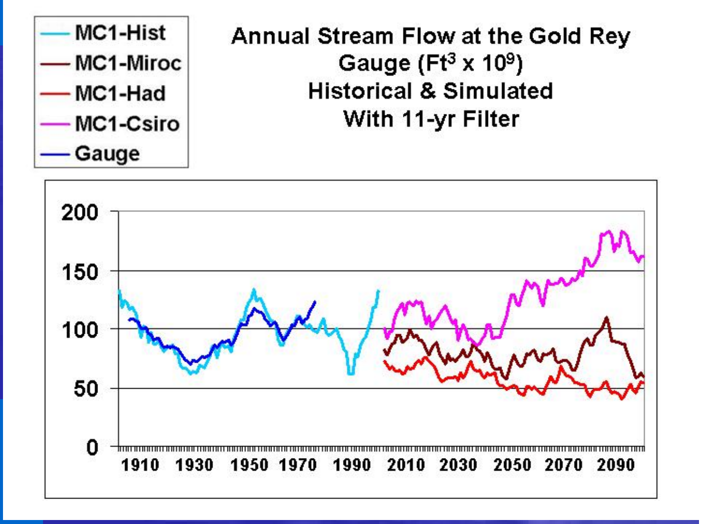
Timeframe	CSIRO	MIROC	Hadley
Annual Sum Precipitation: Baseline (1910-2000) ≈ 47-63 in			
2035/45	↔	↔	↔
2075/85	↑	↔	↔
Average July Precipitation: Baseline (1910-2000) ≈ 0.5 in			
2035/2045	↔	↔	↔
2075/85	↔	↔	↔
Average Dec Precipitation: Baseline (1910-2000) ≈ 7.5 in			
2035/45	↑	↑	↔
2075/85	↑	↑	↔

CSIRO

- **25% less snow accumulation and melt by 2040**
- **Another 25% decline by 2080**

MIROC

- **75% less snow accumulation by 2040**
- **50% less snow melt by 2040**



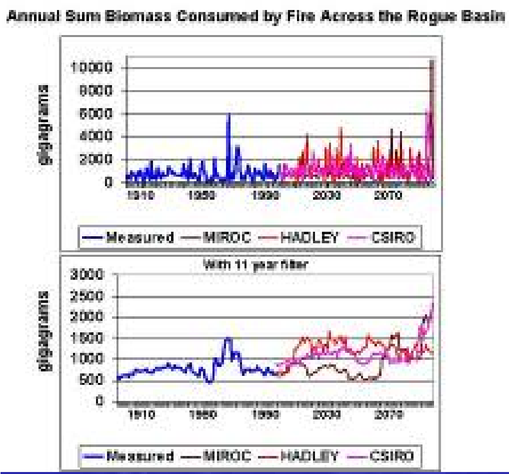
HADLEY

- **75% less snow accumulation & melt by 2040**
- **Another 75% decline by 2080**

ROGUE FUTURES FORUM

VEGETATION CARBON AND BIOMASS CONSUMED BY FIRE

Carbon and Fire predictions for the Rogue River Basin			
Timeframe	CSIRO	MIROC	HADLEY
Annual Sum Vegetation Carbon			
2035/45	↓	↑	↓
2075/85	↑	→	→
Annual Sum Biomass Consumed by Fire			
2035/45	↑	↓	↑
2075/85	↓	↑	↓



CSIRO & HADLEY: Increased fires 1st half of century

MIROC: Increased fires 1st and last thirds of century

ROGUE FUTURES FORUM

CHANGES TO VEGETATION PATTERNS

Vegetation pattern predictions for the Rogue River Basin			
Time Frame	**CSIRO**	**MIROC**	**Hadley**
***Vegetation - Warm Maritime Evergreen Needleleaf*: Baseline 5%**			
2035/45		↑	↑
2075/85		50%	50%
***Vegetation - Maritime Evergreen Needleleaf*: Baseline 60%**			
2035/45	50%		↓
2075/85	none	5%	none
***Vegetation - Temperate Evergreen Needleleaf*: Baseline 30%**			
2035/45	60%	↓	50%
2075/85	30%	15%	30%
***Vegetation - Temperate Deciduous Broadleaf*: Baseline negligible**			
2035/45		20%	30%
2075/85		25%	50%

ROGUE FUTURES FORUM

RECOMMENDATIONS from the Natural Systems Workshop

AQUATIC SCIENTISTS

- Restore and maintain
  - Floodplains
  - Tributary junctions
  - Cool water hyporheic inflow areas
  - Reaches with gravels and high topographic complexity
  - Channel complexity and remove passage barriers
  - High elevation riparian areas
- Manage urban, septic, road runoff
- Manage fisheries to maintain genetic and life history diversity
- Protect groundwater sources and recharge areas

EASY CHOICES – HARD CHOICES

HABITAT

- Protect
- Reconnect
- Restore

- Rehabilitate

SPECIES

- Conserve
- Recover

- Document Extirpation/Extinction
- Maintain "Zoo" Population
- Translocate

PREPARATION STRATEGIES

What Will Society Do to Prepare for Inevitable Climate Impacts?

The Fears: Flood Drought Fire

MALADAPTIVE RESPONSES/OPPORTUNITIES

- **Build Dams**
  (flood control, power, storage)
- **Build Levees**
  (flood protection)
- **Withdraw Groundwater**
  (droughts)
- **Clear Cut Forests**
  (increase water in streams)

ADAPTIVE RESPONSES/OPPORTUNITIES

- **Get development out of floodplain**
  (no new development, relocate existing)
- **Restore floodplain function**
- **Promote water conservation**
- **Minimize impermeable surfaces**
- **Establish and promote "green development" incentives**
  (bioswales, xeric landscaping, location)





PREPARE THE LAND TO HELP

Functional Floodplains Serve As a Sponge
(Floodplains soak up "flood waters" *and* release them slowly)

Constrained Floodplains Exacerbate the Effects of Floods *and* Droughts