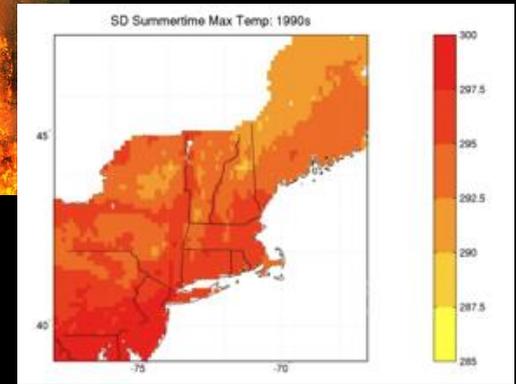


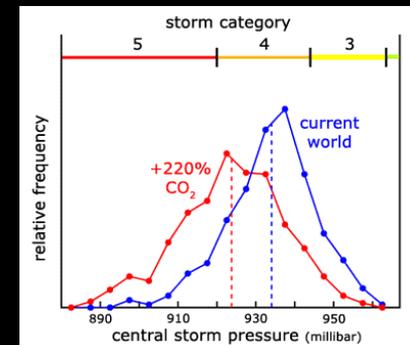
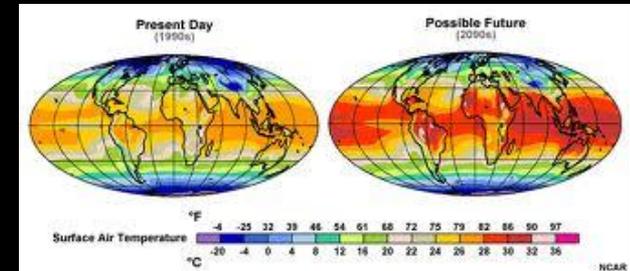
# Unit 2: Elements of a Vulnerability Assessment: Exposure



# Exposure

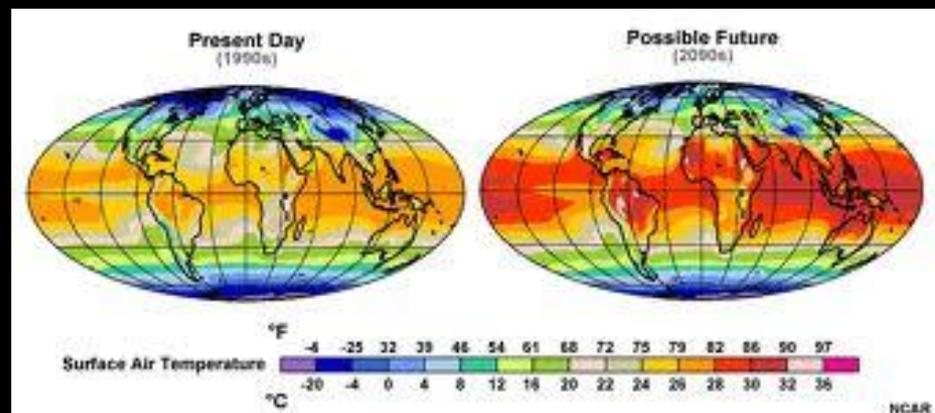
Measure of how much of a change in climate or other environmental factor a species or system is likely to experience

- **Primary factors**
  - Shifts in temperature, precipitation
- **Secondary factors**
  - Sea-level rise
  - Hydrologic changes
  - Shifting sea ice dynamics

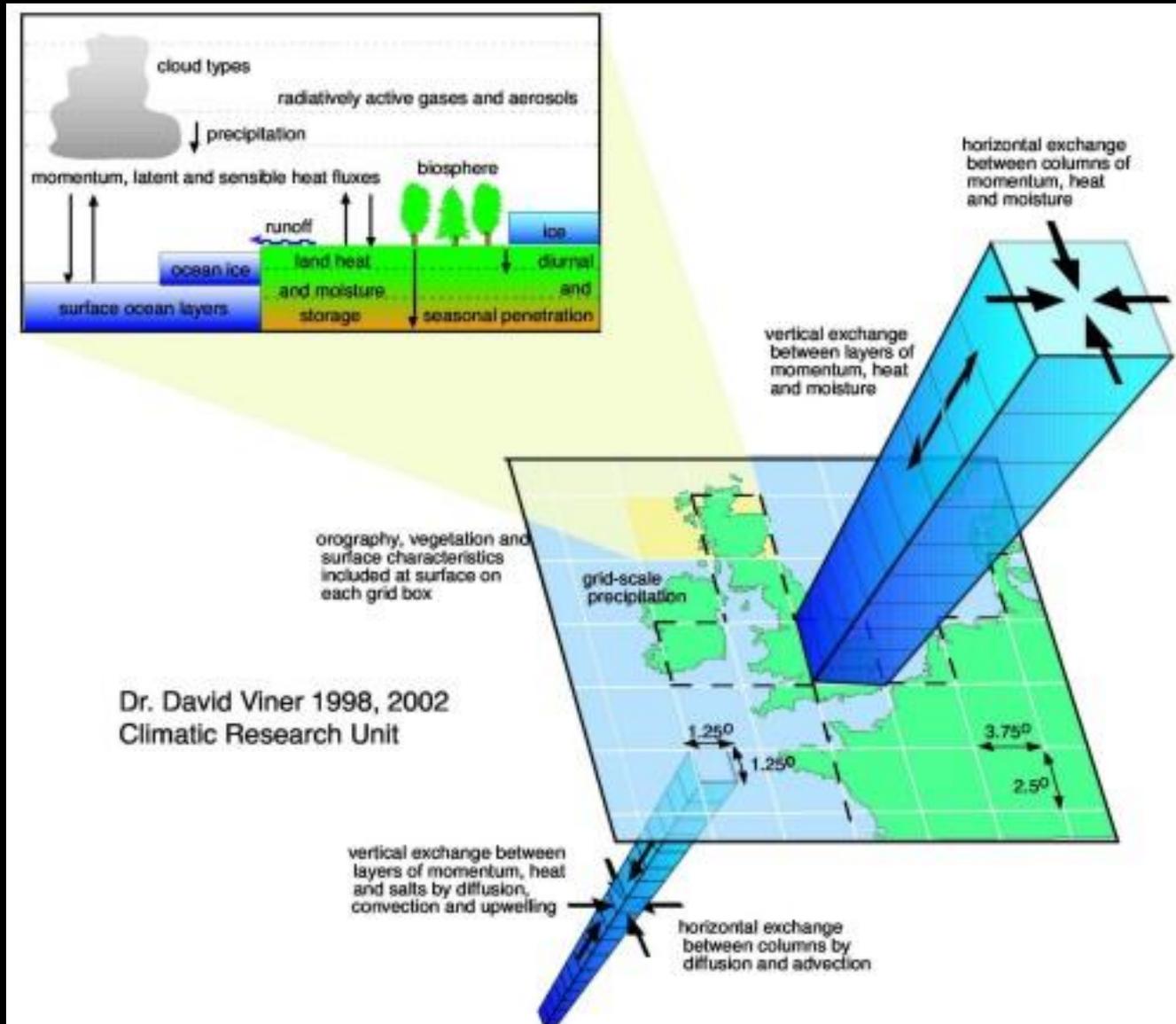


# Global Climate Models (GCMs)

- Based on principles of thermodynamics and fluid dynamics
- Describe complex interaction between atmosphere, cryosphere, oceans, land, and biosphere

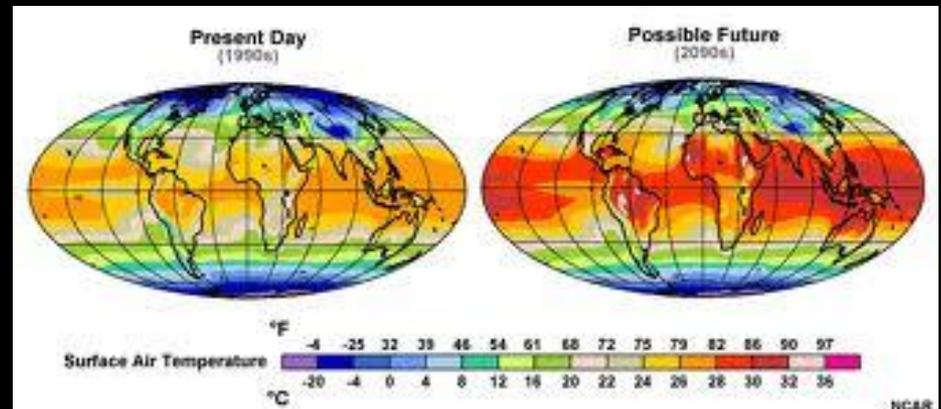


# Global Climate Models (GCMs)

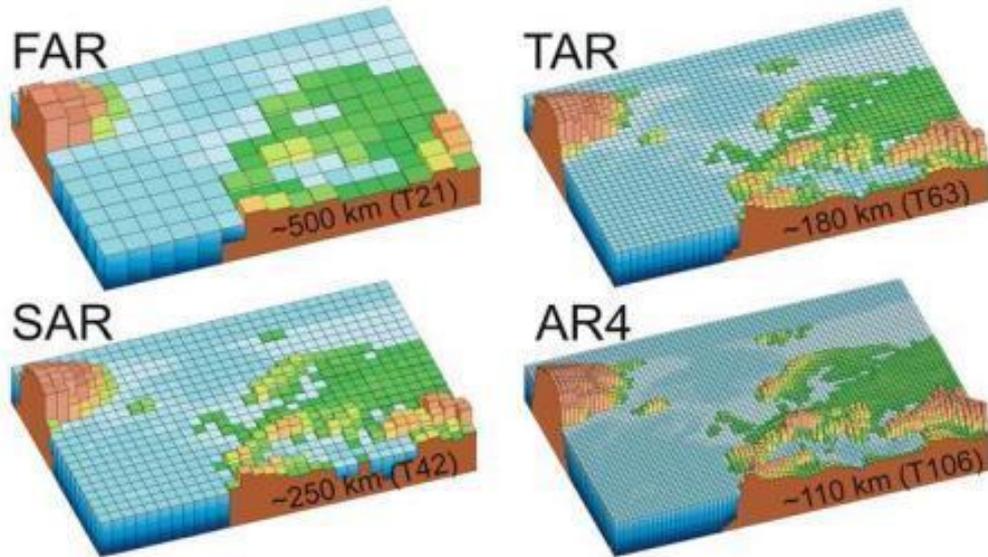


# Global Climate Models (GCMs)

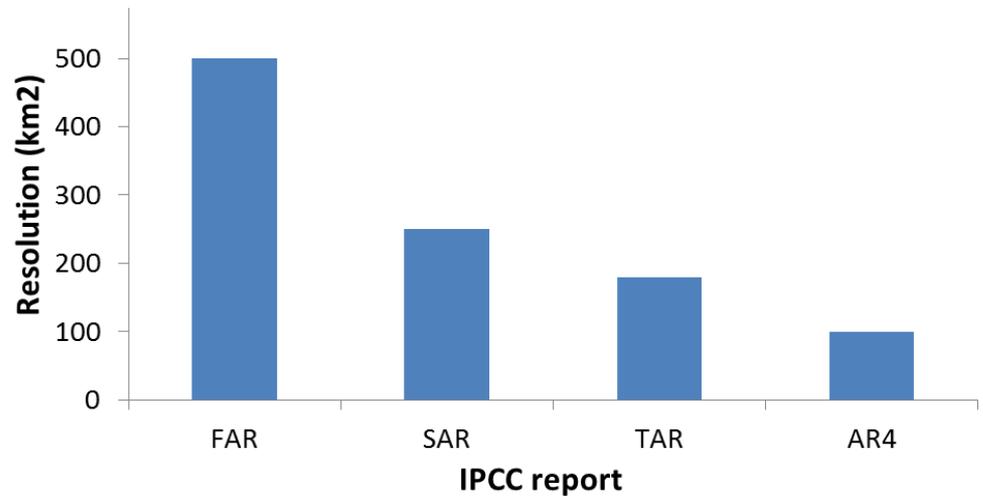
- Global climate models
  - Based on principles of thermodynamics and fluid dynamics
  - Describe complex interaction between atmosphere, cryosphere, oceans, land, and biosphere
  - Large-scale ( $\sim 100 \text{ km}^2$  but constantly decreasing)



# Modeling climate: scale



Increasing Resolution of GCMs



# Projecting Global Climate Models

Projections for changes in climatic variables (e.g., average temperatures, precipitation) based on one or more scenarios for emissions of greenhouse gases, particulates, other factors

- **Factors to consider**

- Uncertainties in scenarios (depend on policy, economics, population, etc.)
- Variation among output from different modeling teams
- Confidence in results often higher in nearer term, also higher for temperatures than precipitation

# Which Scenarios to Use?

- Factors to consider

- Length of your planning horizon

**RCP Database (version 2.0):**

The RCP database aims at documenting the emissions, concentrations, and land-cover change projections of the so-called "Representative scenario development process for the IPCC AR5 can be found in the [IPCC Expert Meeting Report on New Scenarios](#) and [Moss et al. \(2010\)](#). For a draft work plan summarizing the data exchange between the Integrated Assessment and Climate Modeling community see also the "final RCPs have been documented in a Special Issue of Climatic Change that was published in November 2011 ([Climatic Change, Volume 1](#) Special Issue summarizes the main achievements. Further description of the RCP can be found below.

Version 2.0 of the database includes harmonized and consolidated data for three of the four RCPs. This comprises emissions pathways starting from 2005 to 2100 for CO<sub>2</sub> and NH<sub>3</sub>. In addition, harmonized well-mixed GHG emissions of the RCPs have been added for the period 2005 to 2100. Radiative forcing scenarios are provided for the period 2005 to 2100, and are extended for climate modeling experiments to 2300 (ECPs). Wherever available, historical information is provided back to the year 1850. The database also provides information as well as emissions and concentrations data for additional sources: [Click here for CMIP5 recommended data](#).

Initial emissions datasets were made publicly available on May 26, and were extended December 1 to cover harmonized data for all GHGs. For more information about further developments and updates of the database (download is thus only possible after registration).

The data provided for the RCPs is extensive - and has undergone several procedures to assure quality and consistency, to harmonize regional emissions and concentrations projections to 0.5 x 0.5 degree. However, if errors are found or questions remain regarding the data or their use please inform the individual RCP lead authors.

To prevent misuse of the RCPs, we have provided guidance on the limits and uses of the RCPs below (see ["Characteristics and Guidance"](#)).

**Contacts**

We encourage users to send comments on the current database to:

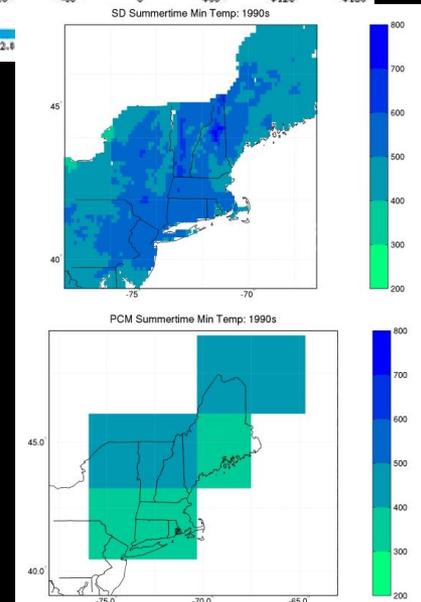
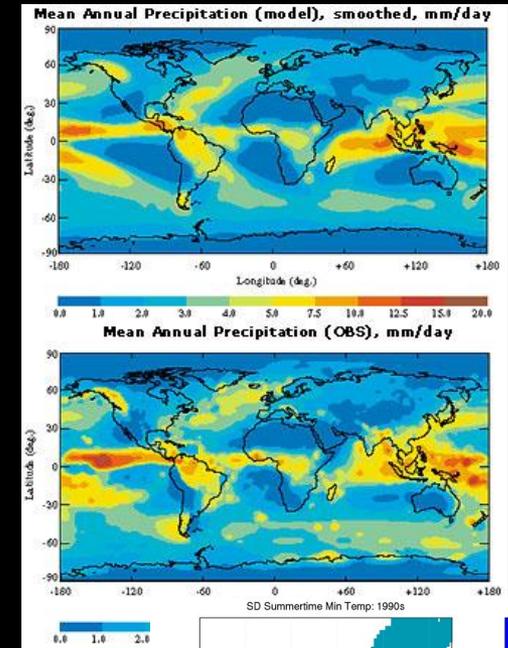
- Length

- A range of numbers

- Directionality

# Downscaling GCMs

- Using models (and sometimes observations) to convert GCM data to smaller grid sizes (50 – 1 km<sup>2</sup>)
- Multiple techniques available
  - Dynamic
  - Statistical
  - Change-factor (Delta method)



# Downscaling Projected GCMs: techniques

- Multiple techniques available
  - **Dynamic:** modeling embeds regional climate model w/in GCM (RCM can account for local surface-rainfall interactions, cloud formation, etc)
  - **Statistical:** statistical relationship identified between GCM and local variables (ex: GCM atmospheric pressure forecasts and local rainfall) – relationships used to downscale GCM for specific areas
  - **Change-factor (Delta method):** historical values from observations subtracted from GCM values – differences are used to correct modeled values at smaller scale

# Is Downscaled Information Necessary?

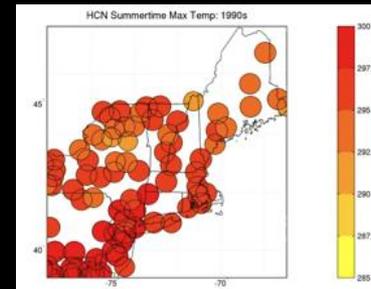
- **Factors to consider**

- Scale of area being managed
- Complexity of area being managed

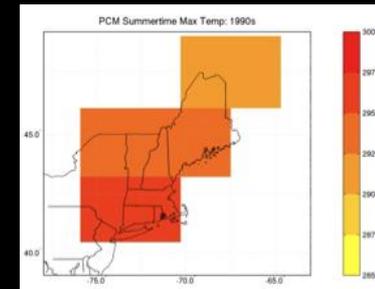
- **Benefits and limitations**

- Data often more relevant for management scale
- Not necessarily more “accurate”
- Allows for modeling of secondary factors

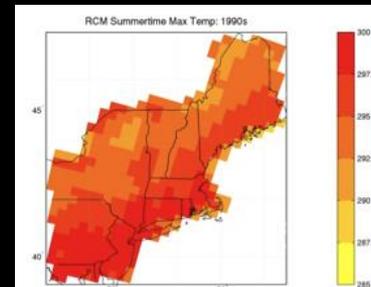
Observations



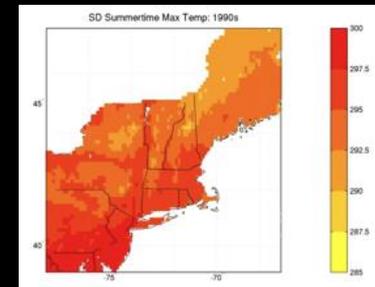
Global Model



Dynamical Downscale



Statistical Downscale



# Exposure: secondary factors

- **Response Models**
  - Conceptual (qualitative)
  - Quantitative (wide range of complexity)
- **Examples of secondary factors**
  - Sea level rise
  - Hydrology
  - Fire regime
  - Vegetation changes
  - Topography
  - Snow pack
  - Sea ice



# Secondary factors: sea level rise bathtub model

Skagit Bay - areas at risk for inundation

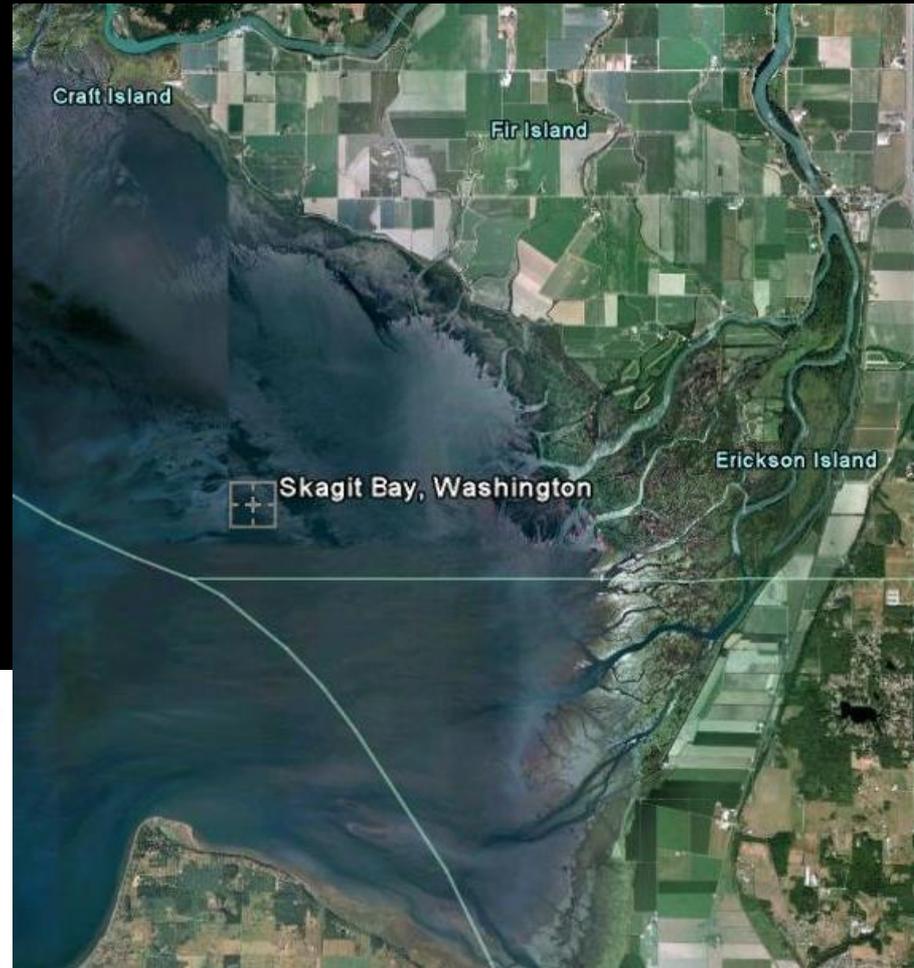


# Secondary factors: sea level rise

## Complex responses modeled

Exposure analysis for assessing vulnerability of coastal wetlands to sea-level rise (wetlands are sensitive to tides/elevation)

- Initial Condition
- 11.2-inch SLR
- 27.3-inch SLR
- Diked areas



# Secondary factors: hydrology

USGS generating hydrological models for large basin in US Coastal Plain

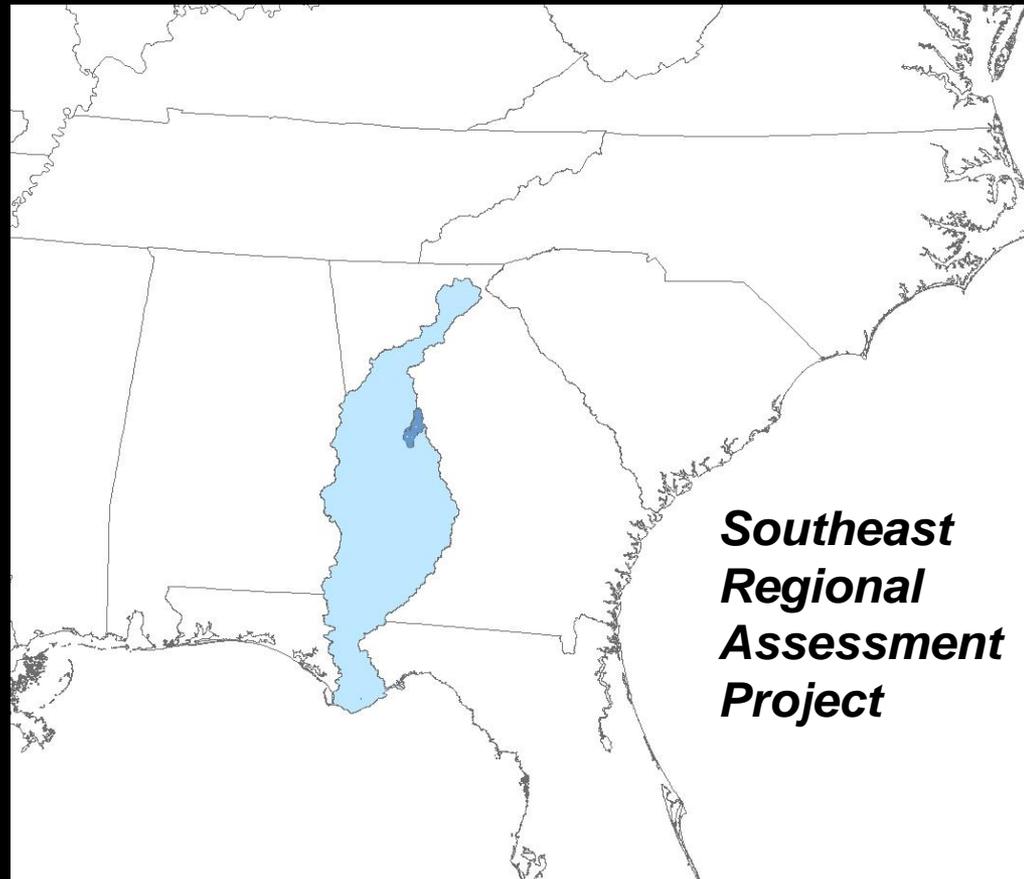
Climate change



Hydrology &  
Water temp



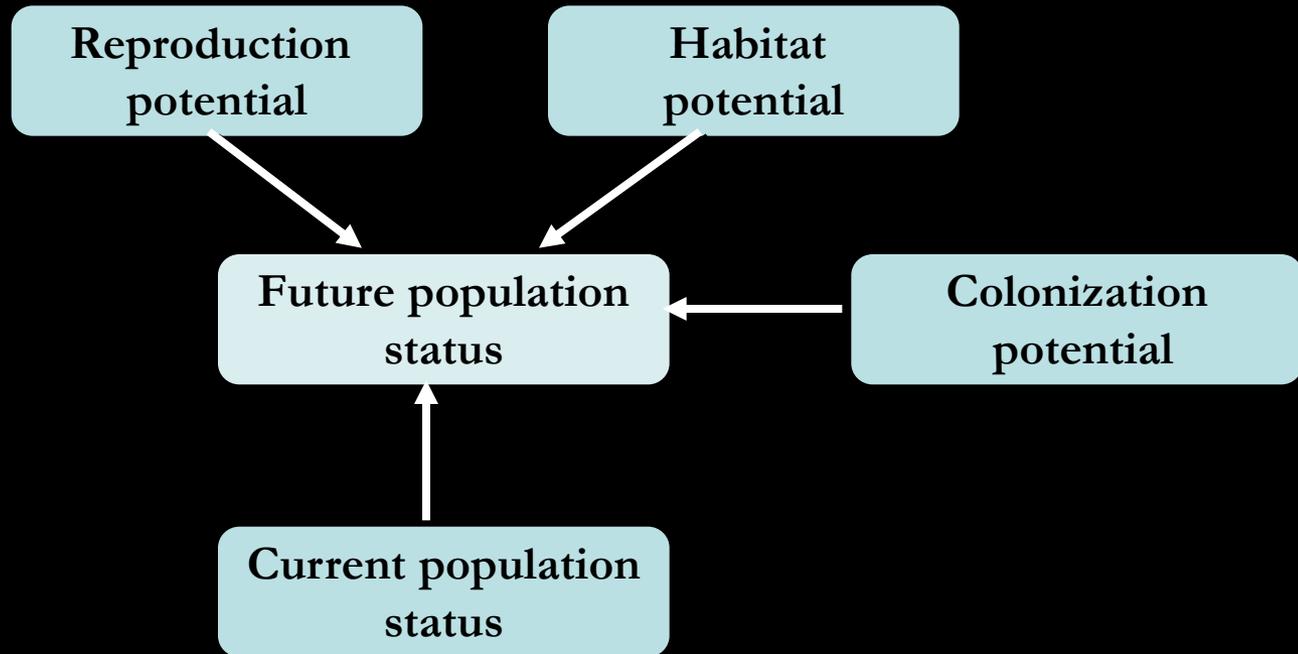
Species and  
locations most  
affected?



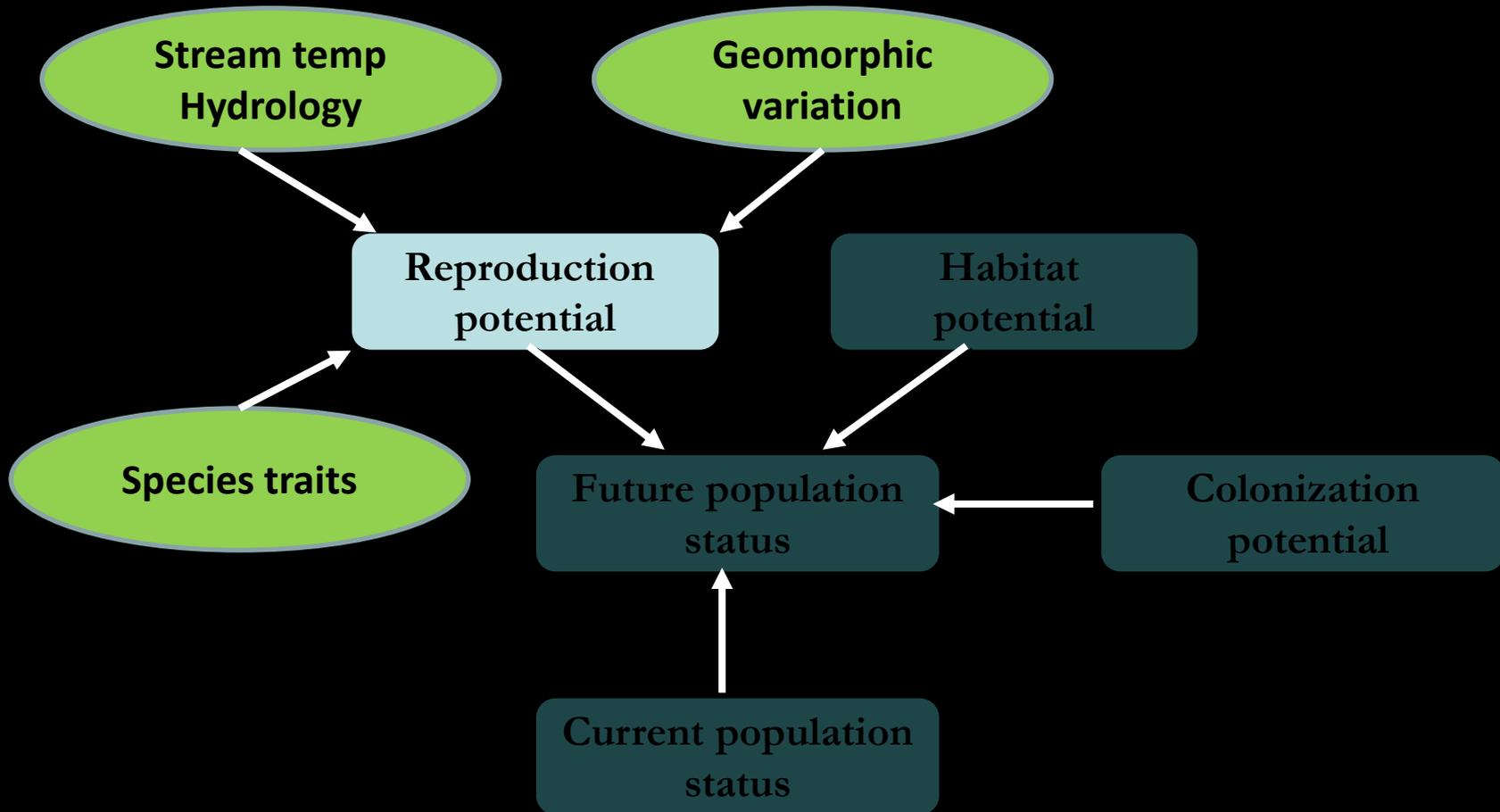
# Secondary factors: hydrology

- Examined climate and non-climate stressor
- Used downscaled projections to examine the potential hydrological shifts
- Parameterized model with expert opinion
- Bayesian belief networks populated to understand influence of climate change vs. non-climate stressors

# Secondary factors: hydrology



# Secondary factors: hydrology



# Secondary factors: fire regime

- Reduced snow pack and earlier snow melt can produce bigger, more frequent fires

And/or

- Fuel production may decline and drive down fire frequency

CSIRO PUBLISHING

[www.publish.csiro.au/journals/ijwf](http://www.publish.csiro.au/journals/ijwf)

*International Journal of Wildland Fire* 2010, 19, 903–913

**Future climate affects management strategies for  
maintaining forest restoration treatments**

*Corinne Diggins<sup>A</sup>, Peter Z. Fulé<sup>A,C</sup>, Jason P. Kaye<sup>B</sup> and W. Wallace Covington<sup>A</sup>*

# Secondary: dynamic veg models

- Niche-based modeling to understand vegetation response to changing climate
  - Uses empirical physiological characteristics to model
  - Can link to GCMs (but with caution)
  - Excludes some ecosystem types (e.g., wetlands)
- Exposure or sensitivity?



# Tools/Resources for Relevant Information

- DOI Climate Science Centers (CSCs) and Landscape Conservation Cooperatives (LCCs)
  - CSCs will deliver basic climate impact science to LCCs
  - LCCs will link science with conservation delivery
- ClimateWizard
- SLAMM
- NE climate scenarios

# Break-out: Assessing Exposure