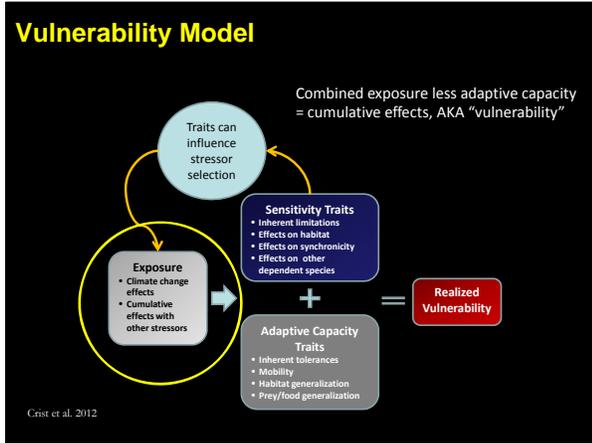


Unit 2: Elements of a Vulnerability Assessment: Exposure



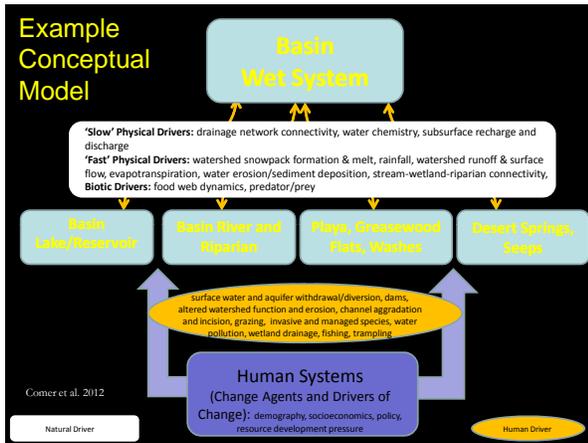
Exposure to What?

- Climate change direct and indirect effects
- Other current, planned, forecast stressors



Where Do I Start?

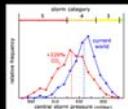
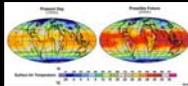
- Useful to have a conceptual model to think through all stressors to be assessed and how they can affect resources
 - Precursor to “response models” covered in the assessment section
- Can also be greatly informed by scenario-based planning approaches to identify potential future stressors



Climate Change Exposure

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

- **Primary factors**
 - Shifts in temperature, precipitation
 - Seasonality and extremes more important than averages
- **Secondary factors, e.g.**
 - Sea-level rise
 - Soil moisture
 - Hydrologic & chemical changes
 - Shifting sea ice dynamics

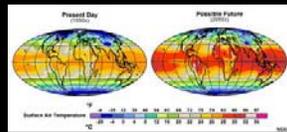


Sources & Differences in Climate Change Data

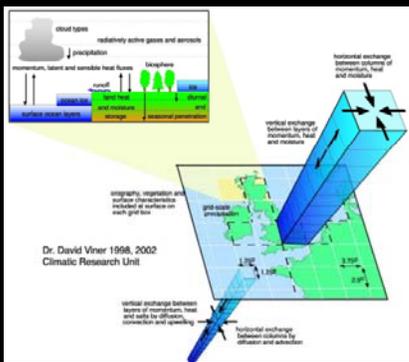
- All climate change data come from Global Climate Models (GCMs)
- Downscaled CC data are now ubiquitous but not standardized, use different methods and produce different variables
- Future forecasts don't come with probabilities but uncertainty can be managed with backcasting results and use of "ensembles" by climate modelers

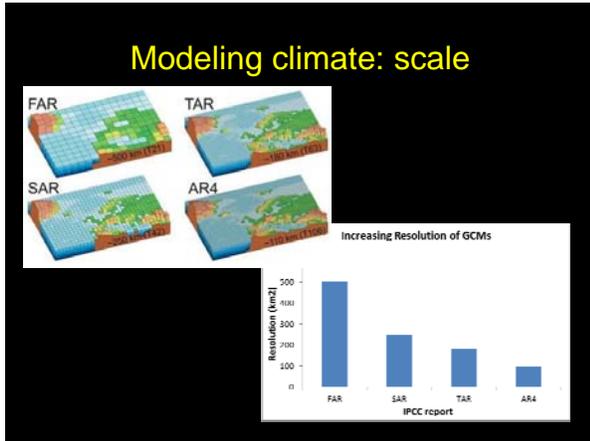
Global Climate Models (GCMs)

- Global climate models
 - Based on principles of thermodynamics and fluid dynamics
 - Describe complex interaction between atmosphere, cryosphere, oceans, land, and biosphere
 - Large-scale (~100 km² but constantly decreasing)



Global Climate Models (GCMs)

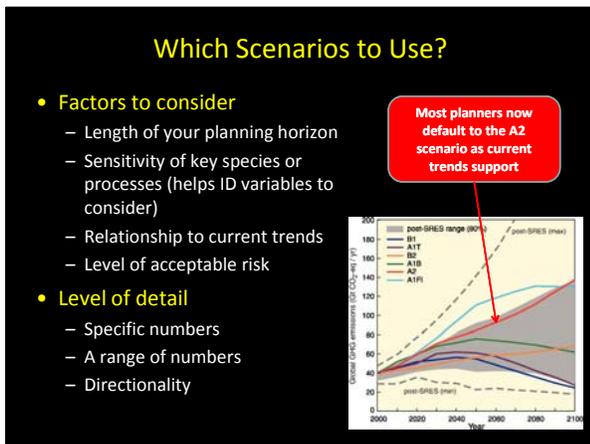




Projecting Global Climate Models

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

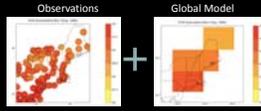
- **Factors to consider in applying GCMs**
 - Uncertainties in scenarios (depend on policy, economics, population, etc.)
 - Variation among output from different modeling teams
 - Confidence in results often higher in nearer term, also higher for temperatures than precipitation



Is Downscaled Information Necessary?

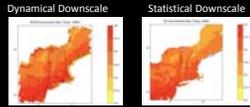
- **Factors to consider**

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



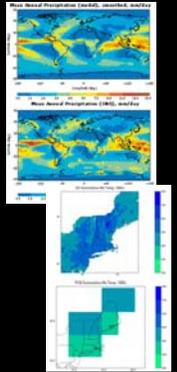
- **Benefits and limitations**

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



Downscaling GCMs

- Using models (and sometimes observations) to convert GCM data to smaller grid sizes (50 – 1 km²)
- Multiple techniques available
 - Dynamic (expensive, less common)
 - Statistical (more common)
 - 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

Questions to Ask About Downscaled Data

- What GCM(s) is it based on, and how well do they perform for this particular region?
- Downscaling method used and suitability for the purpose and region?
- Adequacy (density) of weather stations to calibrate the downscale model
- Is the grid cell size supportive of the relative uncertainty in the inputs? (4km currently fairly standard, any finer is questionable)

Secondary Factors

- All resources will be exposed to direct climate changes
- Not all resources will be exposed to all secondary climate change effects or may be irrelevant for any particular resource
- Conceptual model/expert involvement can assist in determining what effects are necessary to assess, based on e.g.,
 - Location, e.g., proximity to coast, landscape position
 - Dependence on regimes, e.g., hydro, precip, fire
 - Sensitivity to gradients, e.g., soil moisture, water temperature or salinity

CC Exposure: secondary factors

- Examples of secondary factors ^{PCT}
 - Sea level rise
 - Hydrologic regime
 - Soil moisture
 - Fire regime
 - Snow pack vs rainfall
 - Sea ice



Slide 18

PC1 Need to hear presentation to know what was said here
Patrick Crist, 7/20/2012

Secondary factors: sea level rise bathtub model

Skagit Bay - areas at risk for inundation



Secondary factors: sea level rise Complex responses modeled

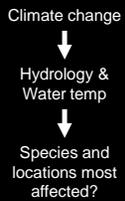
Exposure analysis for assessing vulnerability of coastal wetlands to sea-level rise (wetlands are sensitive to tides/elevation)

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



Secondary factors: hydrology

USGS generating hydrological models for large basins in US Coastal Plain



Mary Freeman et al. (USGS)

Secondary factors: hydrology

- Examined climate and non-climate stressors
- Used downscaled projections to examine the potential hydrological shifts
- Parameterized model with expert opinion
- Expert elicitation methods used to populate & understand influence of climate change vs. non-climate stressors on resources

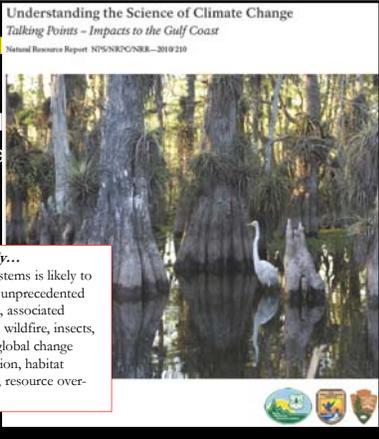
Secondary

- Decreased soil (precip) can lead to

And/or

What scientists think is likely...

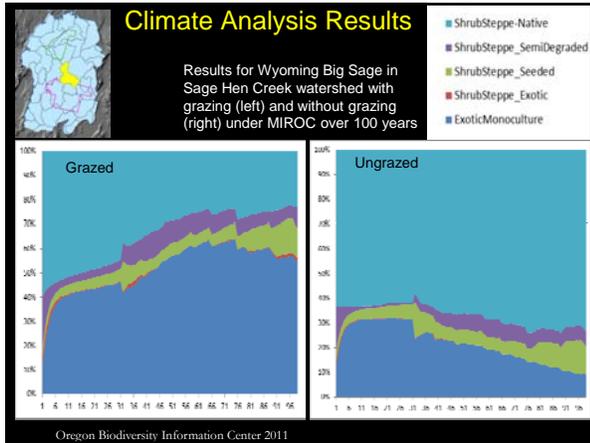
- The resilience of many ecosystems is likely to be exceeded this century by an unprecedented combination of climate change, associated disturbance (flooding, drought, wildfire, insects, ocean acidification) and other global change drivers (land use change, pollution, habitat fragmentation, invasive species, resource over-exploitation) (Figure 6).



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?





Non-climate Stressors Exposure

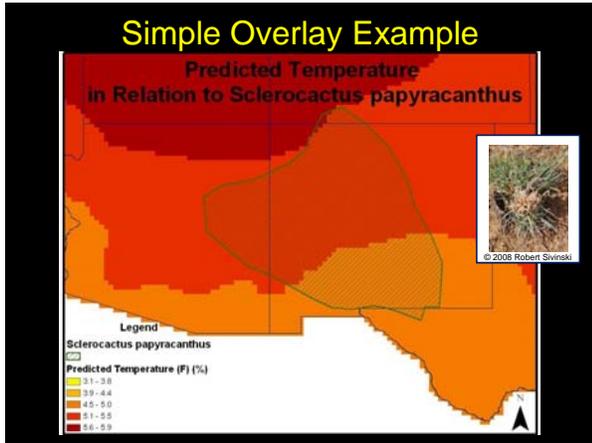
Important because they decrease integrity making resources less resilient to climate change (along with traditional conservation concerns)

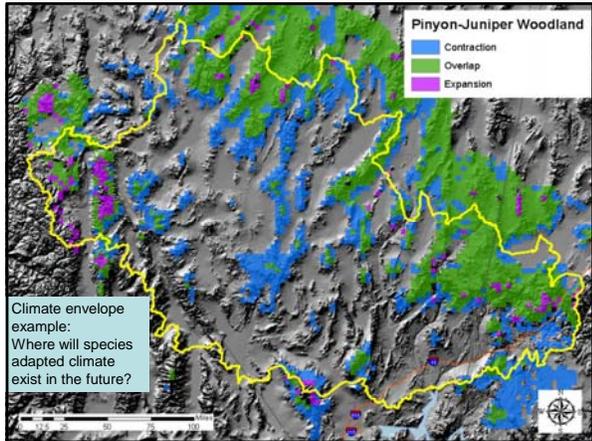
Examples

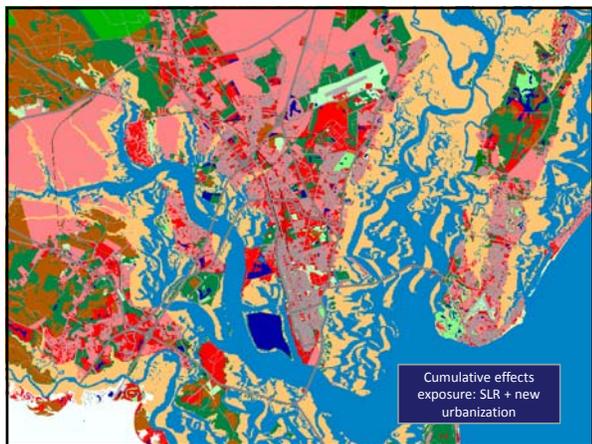
- All types of development (some resource dependent, e.g., power lines)
- Management practices (resource dependent)
- “Tertiary CC effects” e.g., invasive spp spread

Some Options for Determining Exposure

- Simple overlay model (what effects may this resource be subject to) – visual or quantitative
- Bioclimate envelope model (what parts of the resource’s current distribution fall outside its known tolerances—and where might suitable climate exist in the future)
- Cumulative effects assessment (what parts of the resource’s distribution will be subject to what combinations of stressors)





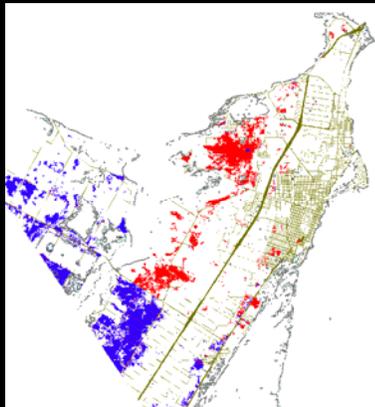


Characterize Degree of Exposure

- Qualitative: Visual examination of overlay— typical when using online “viewers” where you can’t get quantification.
 - Tend to use “degree” or “relative proportion.”
- Quantification through GIS intersect, provides more, but maybe not necessary or true, precision

Map Exposure

Estuarine wetlands exposed to cumulative stressors in Aransas Bay, TX.



Considerations for Ecological Response Models

- **Choice of models**
 - Depends on the species, habitats, ecosystems of concern (including scale)
 - Depends on the types of questions being asked
 - Depends on end-user’s needs
- **Limitations of response models**
 - Overly-simplified (e.g., may ignore factors such as interactions between species; nonlinear, complex responses; other factors)
 - Data availability varies
 - Transferability across regions and scales

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 (view & obtain data)
<http://www.climatewizard.org/>
- Southern Regional Climate Center
<http://www.srcc.lsu.edu/>
- Sea Level Rise Viewer
<http://www.csc.noaa.gov/slr/viewer/#>
- RNCEP: R package to facilitate access and visualization to climate data

Break-out: Assessing Exposure
