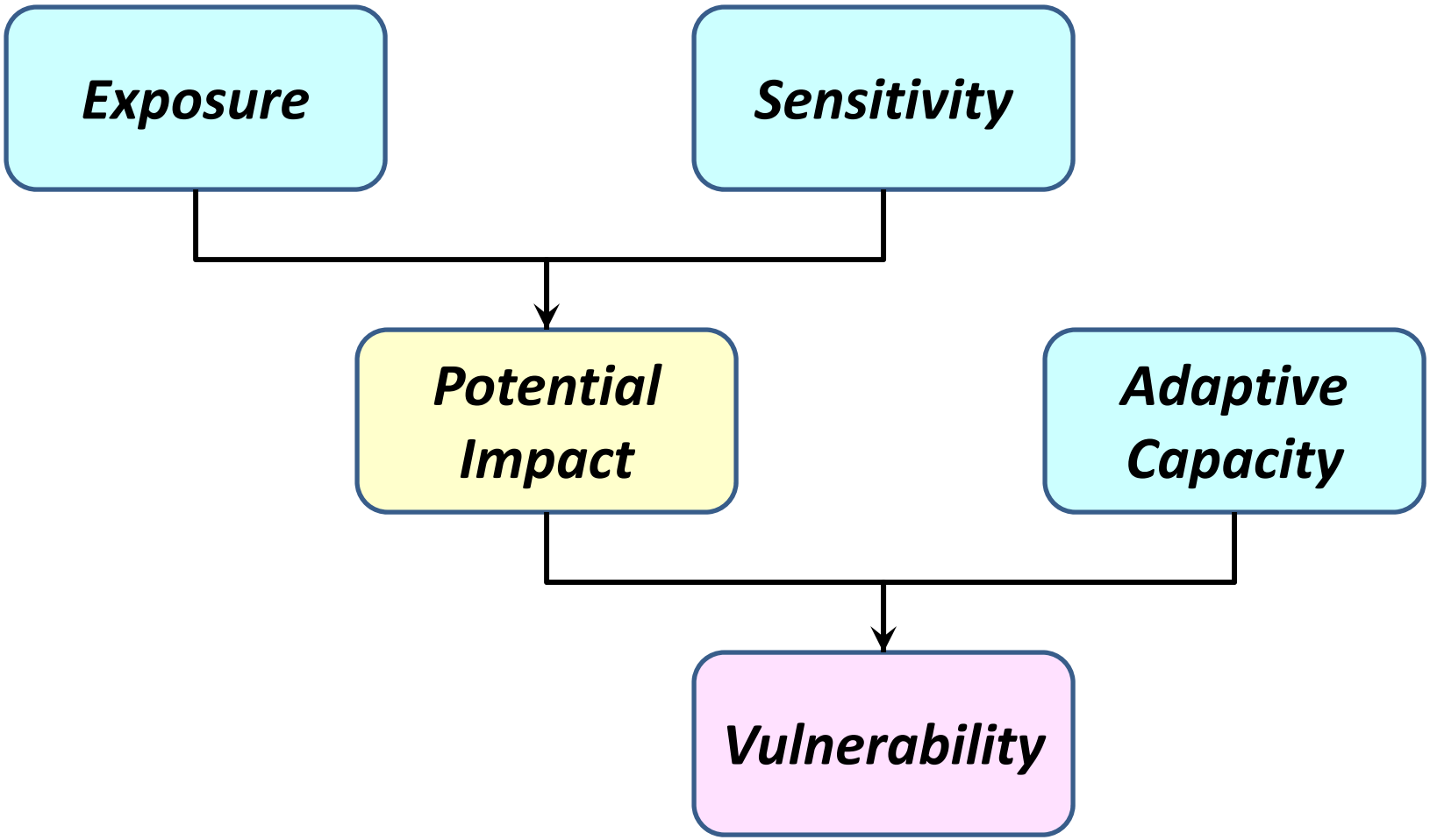
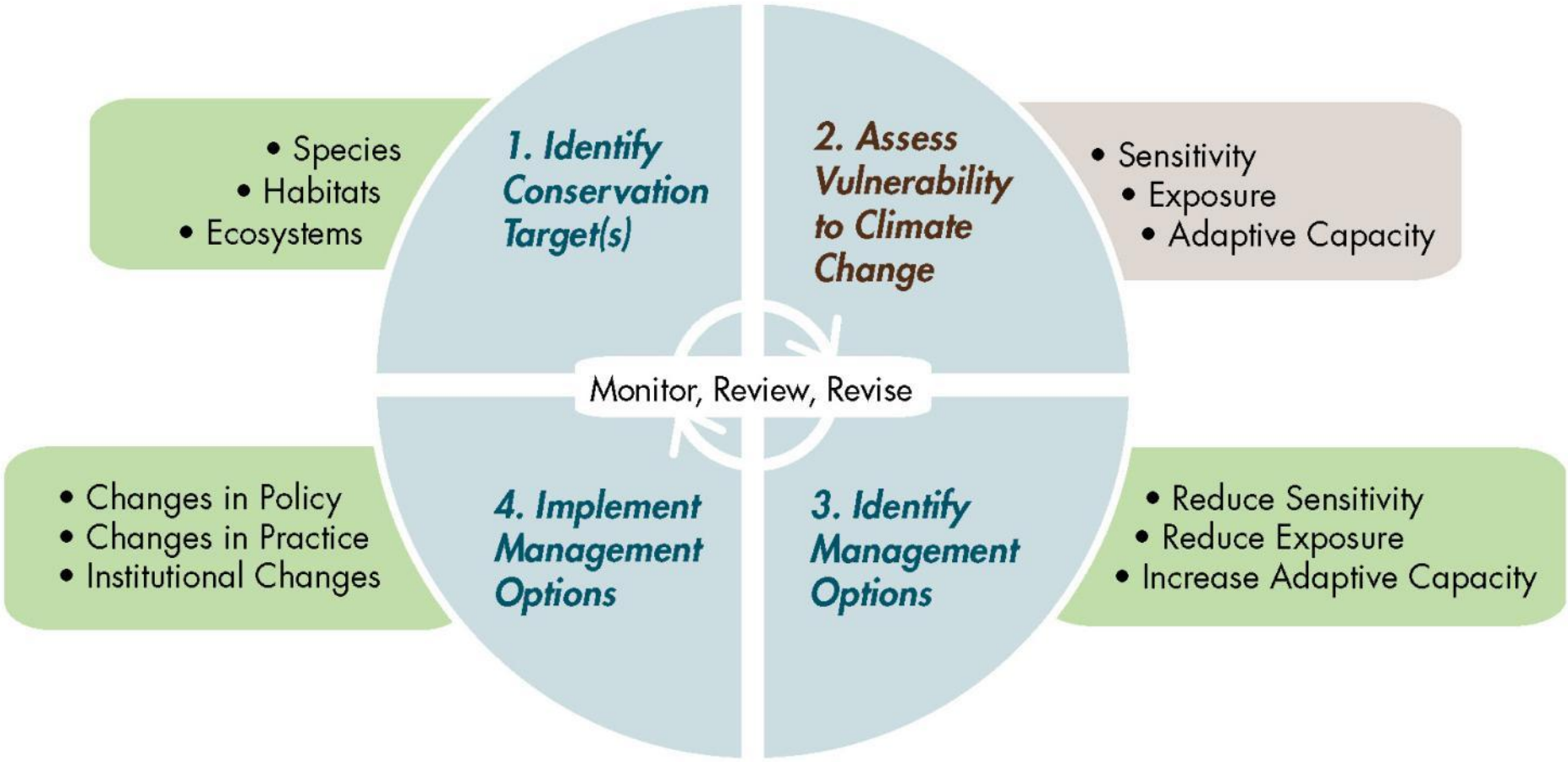
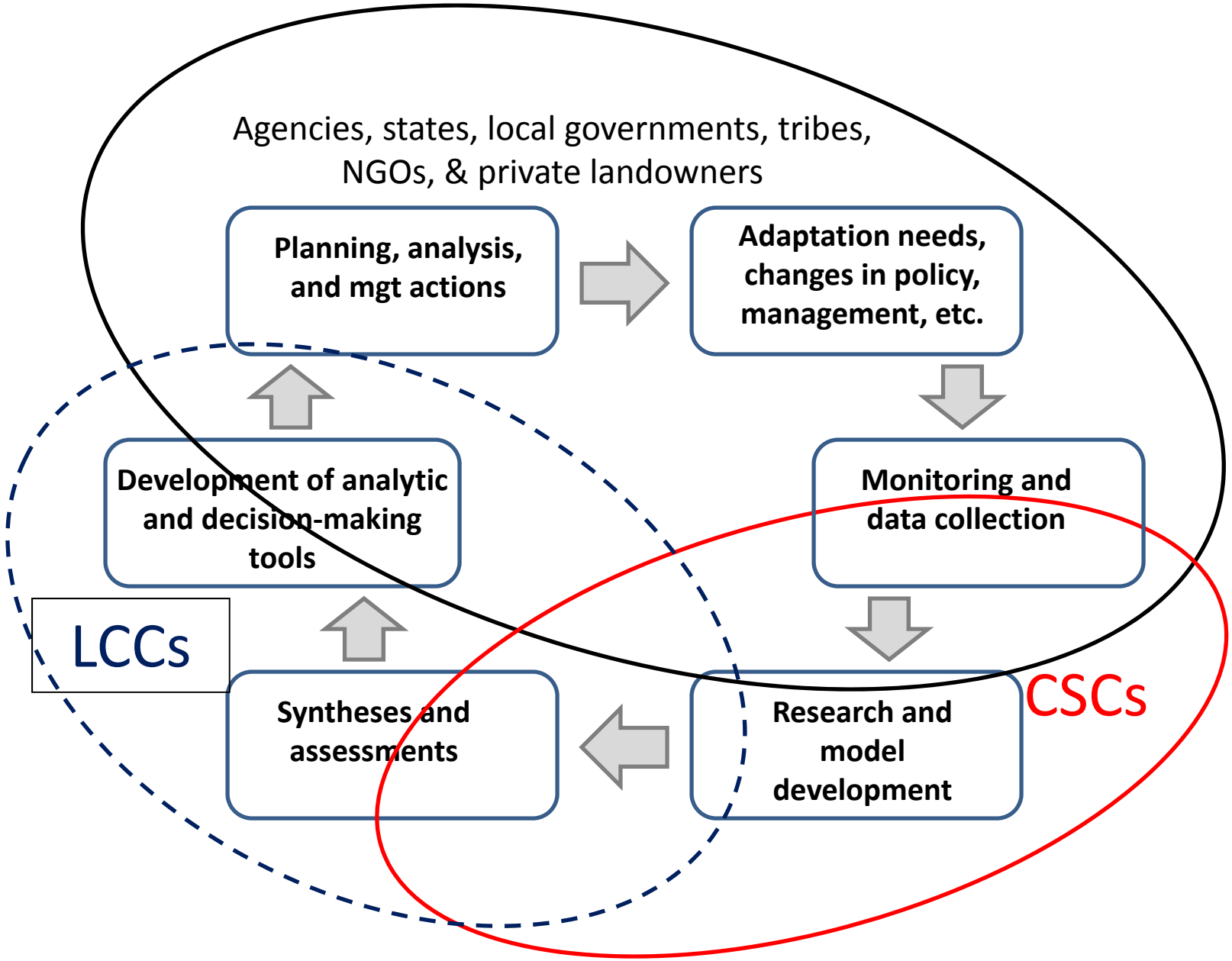
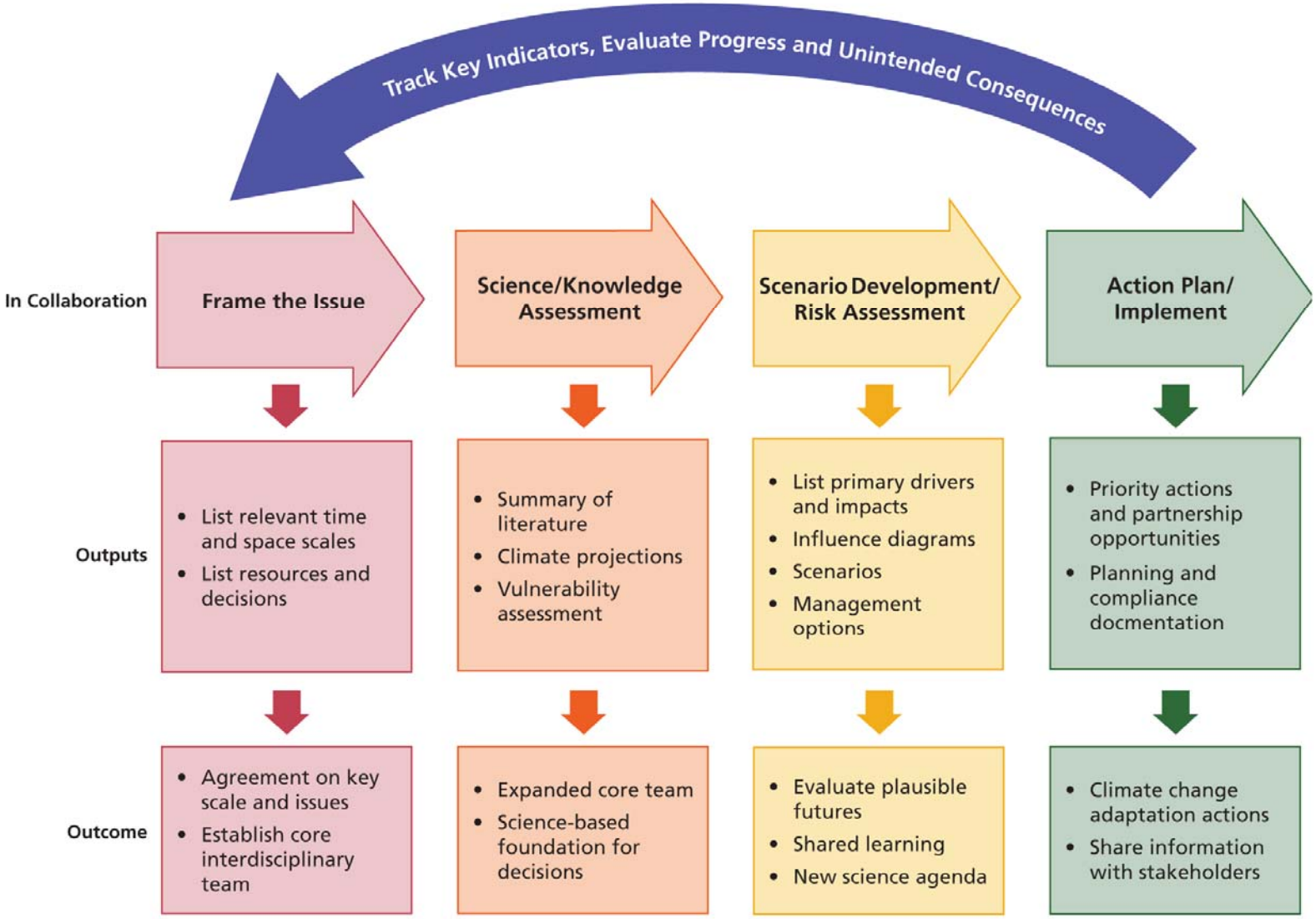
Vulnerability Assessments for LCC-VP
6 March 2012



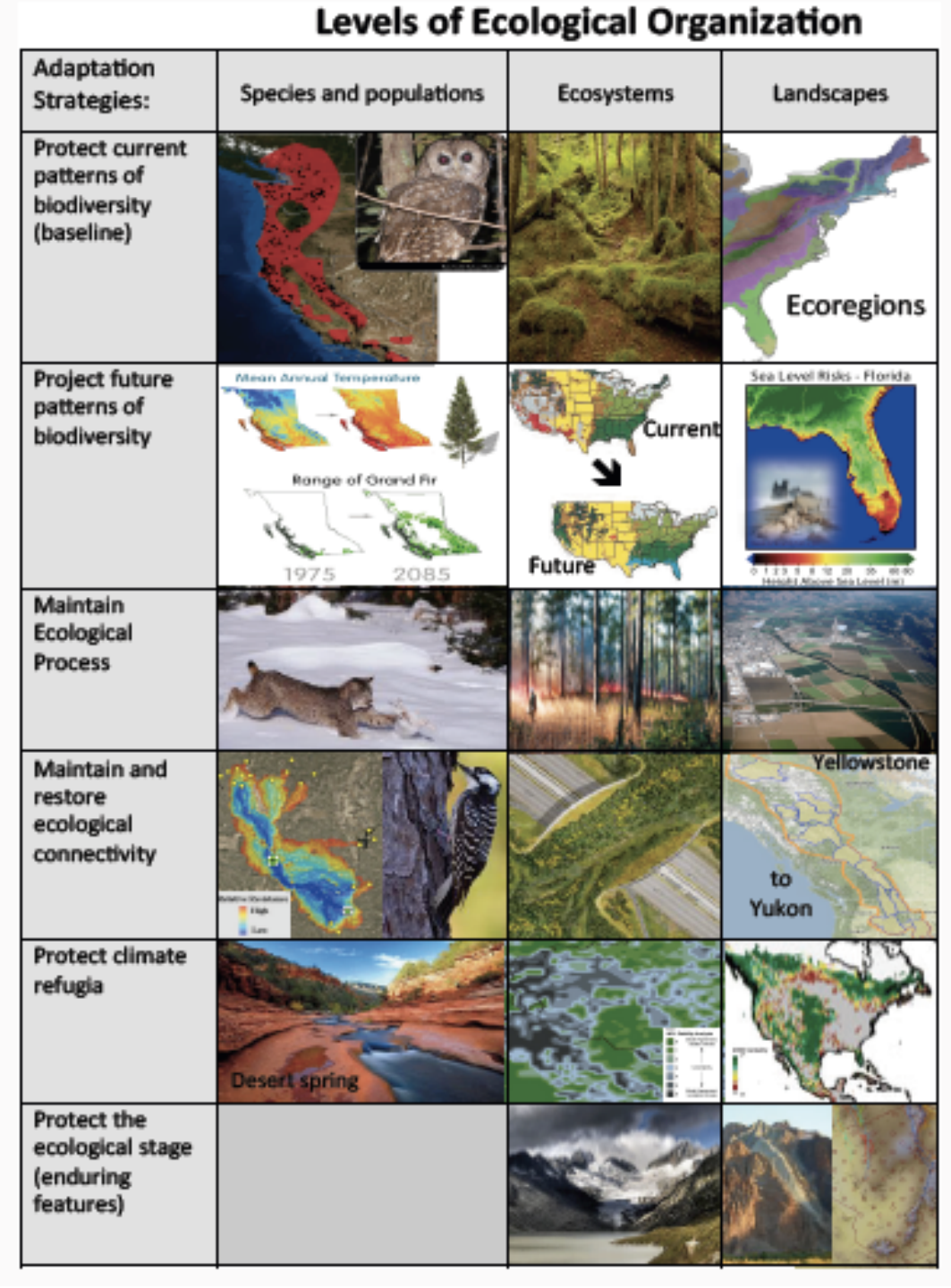

• Species
• Habitats
• Ecosystems
1. Identify Conservation Target(s)
2. Assess Vulnerability to Climate Change
• Sensitivity
• Exposure
• Adaptive Capacity
Monitor, Review, Revise
• Changes in Policy
• Changes in Practice
• Institutional Changes
4. Implement Management Options
3. Identify Management Options
• Reduce Sensitivity
• Reduce Exposure
• Increase Adaptive Capacity

Adaptive Management Roles and Functions



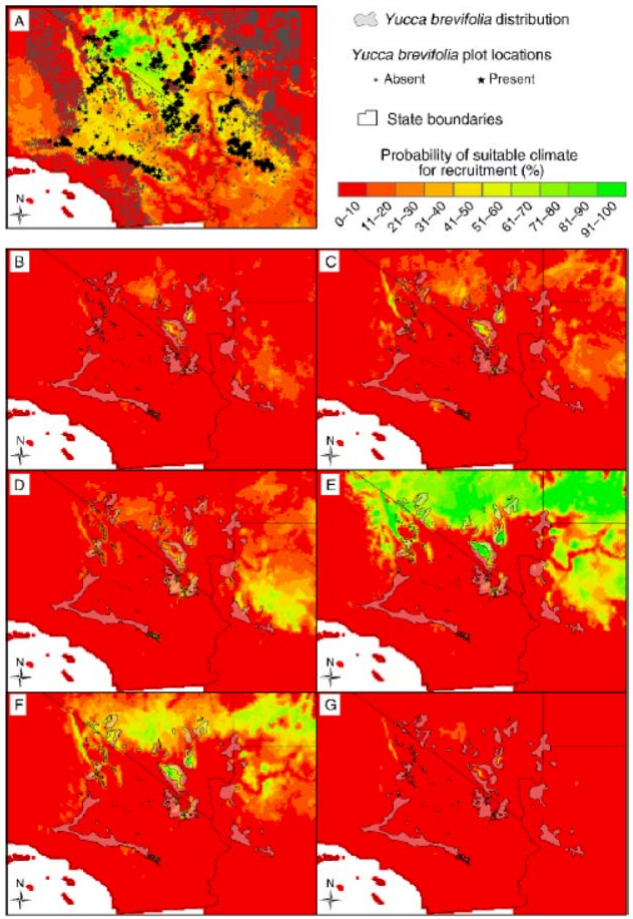

Track Key Indicators, Evaluate Progress and Unintended Consequences
In Collaboration
Frame the Issue
Science/Knowledge Assessment
Scenario Development/ Risk Assessment
Action Plan/ Implement
Outputs
List relevant time and space scales
List resources and decisions
Summary of literature
Climate projections
Vulnerability assessment
List primary drivers and impacts
Influence diagrams
Scenarios
Management options
Priority actions and partnership opportunities
Planning and compliance docmentation
Outcome
Agreement on key scale and issues
Establish core interdisciplinary team
Expanded core team
Science-based foundation for decisions
Evaluate plausible futures
Shared learning
New science agenda
Climate change adaptation actions
Share information with stakeholders

Yale framework



	Levels of Ecological Analysis		
Adaptation Objectives:	A. Landscapes	B. Ecosystems	C. Species and populations
1) Protect current patterns of biodiversity (baseline)	• Map genetic patterns across the landscape • Map **beta and gamma diversity** • Map **biodiversity hotspots**	• Map terrestrial and aquatic ecosystems and their associated services	• Assess population sizes and dynamics and phenological trends, or use existing status assessments (e.g., conservation status ranks) • Map occurrences of rare species and plant communities • Map distributions of more common species
2) Project future patterns of biodiversity	• Forecast land-use change • Project sea-level rise • Analyze climate-change projections • Map projected future biodiversity hotspots	• Forecast vulnerability of ecosystems to climate change • Map areas that would support shifts in vegetation types and/or biomes	• Forecast vulnerability of species and rare communities to climate change based on their capacity to adapt to environmental change • Map areas that would support shifts in species distributions of vulnerable and/or indicator species or community types
3) Maintain ecological processes	• Analyze projected precipitation and temperature trends • Analyze projected extreme weather events	• Map potential future patterns of fire, hydrology, carbon sequestration, and ecological integrity • Map where ecosystem services	• Forecast how climate change factors may impact the viability of particular species populations or function of rare plant communities

How do we conduct VAs to inform decisions at species, ecosystem, and broader scales?



(Cole et al. 2011)

Exposure

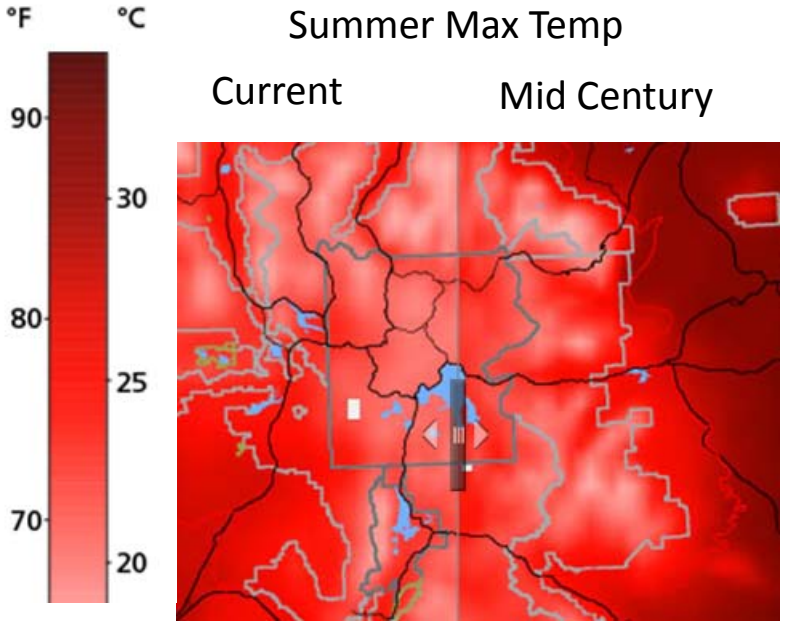
The nature and degree to which a system is exposed to significant climate variations (IPCC 2001).

- Mobility, habitat use, life history
- Interactions with other stressors

Assessing Exposure – focus on extrinsic factors

- Climate – temp & precip
- Drought & hydrology
- pH, salinity, storms

Climate & response models used extensively to estimate exposure



Sensitivity

Degree to which something is or is likely to be affected by or responsive to climate changes.

- Physiology, behavior, habitat specificity
- Affected by other stressors

Assessing Sensitivity – focus on *intrinsic factors*

- Phenology and environmental cues
- Interactions and community structure
- Temperature-sensitive species or ecosystem processes

Adaptive capacity refers to the ability of a system to accommodate or cope with climate change impacts with minimal disruption.

- Ability to move
- Adapt evolutionary
- Modify behavior

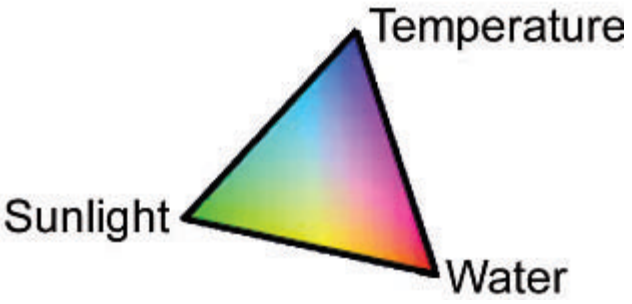
Assessing adaptive capacity – can be intrinsic or extrinsic

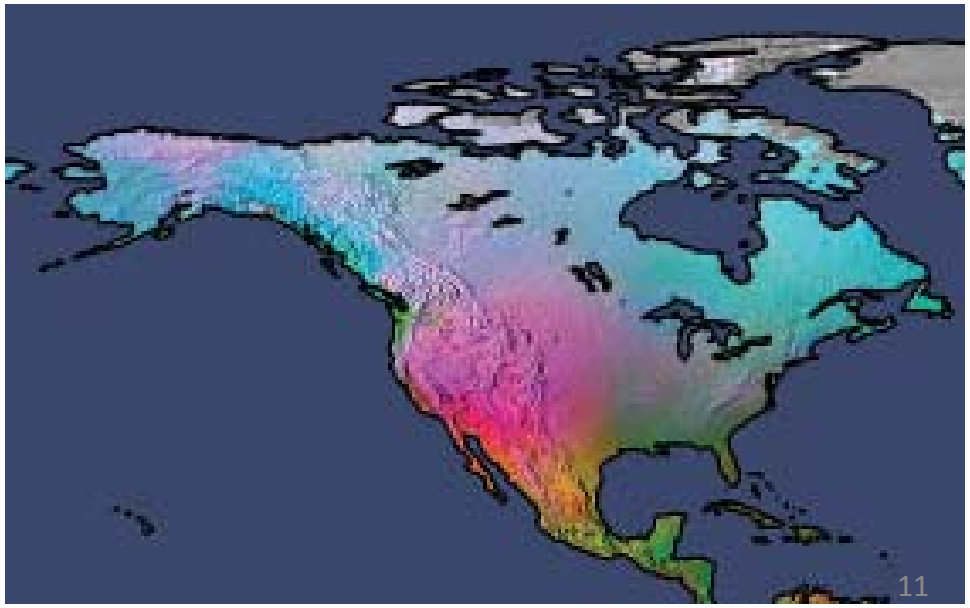
- Behavioral or phenotypic plasticity
- Genetic diversity
- Ecosystem processes
- Redundancy

Photo: Chrístoslílu

What we want to accomplish in this project:

	Species	**Ecological System (ES)**	**LCC-Scale**
Exposure	CC Projections	CC Projections	CC Projections
Sensitivity	Bioclimate modelling(?)	TBD (ecologically relevant)	Biome BGC responses; NPP controls
Adaptive Capacity	Species & habitat traits (Patrick?)	TBD	ES diversity; Envir. heterogeneity





How do we address VA at larger spatial scales?

Magness, D. R., J. M. Morton, F. Huettmann, F. S. Chapin, and A. D. McGuire. 2011. A climate-change adaptation framework to reduce continental-scale vulnerability across conservation reserves. Ecosphere **2**:art112.

Exposure, Sensitivity, and Adaptive Capacity

Definition	Variables
extent of climate change experienced by a species or locale.	(1) annual temperature change rate (°C/yr)
degree to which species survival, persistence, fitness or regeneration may be affected by climate change.	(2) critical habitat for threatened or endangered species in refuge (yes/no); (3) refuge boundary contains biome boundary (yes/no)
capacity of a species to cope with climate change, including adaptation responses such as shifting to more suitable local microhabitat or migrating to more suitable regions	(4) latitude range within refuge boundary (decimal degrees); (5) elevation range within refuge boundary (m); (6) road density of watershed(s) in which refuge is embedded (m/ha); (7) percentage of watershed(s) with permanent conservation protection (%)

Estimating Vulnerability for 501 refuges (Magness et al. 2011)

Variable	Source	Criteria
Exposure: 1950-2006 temperature change	PRISM 4 km or CRU 50-km data by pixel averaged over refuge area.	> 2.4°C/100 yrs = high exp.
		< 0.005 °C = low
Sensitivity: Critical habitat for T&E species	USFWS critical habitat database	Unit has identified critical habitat
Sensitivity: Near edge of biome	Olson et al. (2001) biome map with 14 global units	Biome edge within refuge
Adapt Cap: Latitudinal range	USFS boundaries	> 0.28° threshold (h,m,l)
Adapt Cap: Elevation range (adaptive capacity)	USGS DEM	> 31m threshold (h,m,l)
Adapt Cap: Road density (connectivity)	US Census	0.3 km/km^2 in watersheds (HUC level not provided)
Adapt Cap: Protection	Cons. Biol. Inst.	25% in watersheds

Combined

Estimating Vulnerabilty of Ecological Systems

	Variable	LCC-VP	Magness et al.
Exp	Temp & Precip change; Historical & projected	PRISM; 1 km downscaled data	PRISM 4 km or CRU 50-km data by pixel averaged over refuge area.
Sen	Ecological responses to climate changes	Projections of water stress, NPP (TOPS)	USFWS critical habitat database
	Area of ES within current climate-defined space projected to be lost (i.e. shifted to new area)	Based on distribution of ecological systems or CEC Level 3 types	Edge of biome: Olson et al. (2001) biome map with 14 global units
Adpt Cap	Facets – redundancy and weighted proportion of facets lost due to climate shifts (weighting TBD)	Facet variables – soil/lithography, aspect, water balance (aridity index?) (TBD)	Latitudinal range - USFS boundaries
	Facets – Range of variation	Variables used to define facets (TBD)	(NA)
	Extent of ecosystem modification	- Developed area (SERGoM) - Naturalness - Human footprint	Elevation range - USGS DEM
	Connectivity	Method might (will likely) differ based on biome.	Connectivity – Roads from US Census
	Conservation context: Proportion protected – current & projected	PAD-US	Protected status - Cons. Biol. Inst.

Issues and consideration:

- Focus of analysis – CEC3, ecological systems, parks/refuges, “units of concern” (e.g. GYC)
- Could include species or biodiversity – e.g. # of species of special concern (avoid T&E)
- How to define facets. Many potential variables and methods
- Approach might be better suited to management units than ecosystem types (could use PACE to define)
- Some ‘fuzziness’ between sensitivity and adaptive capacity (semantics)

CEC Level 3