IUCN SSC Guidelines for
Assessing Species' Vulnerability to Climate Change

Climate Change Specialist Group
IUCN-Species Survival Commission

IUCN

SSC
Species Survival Commission

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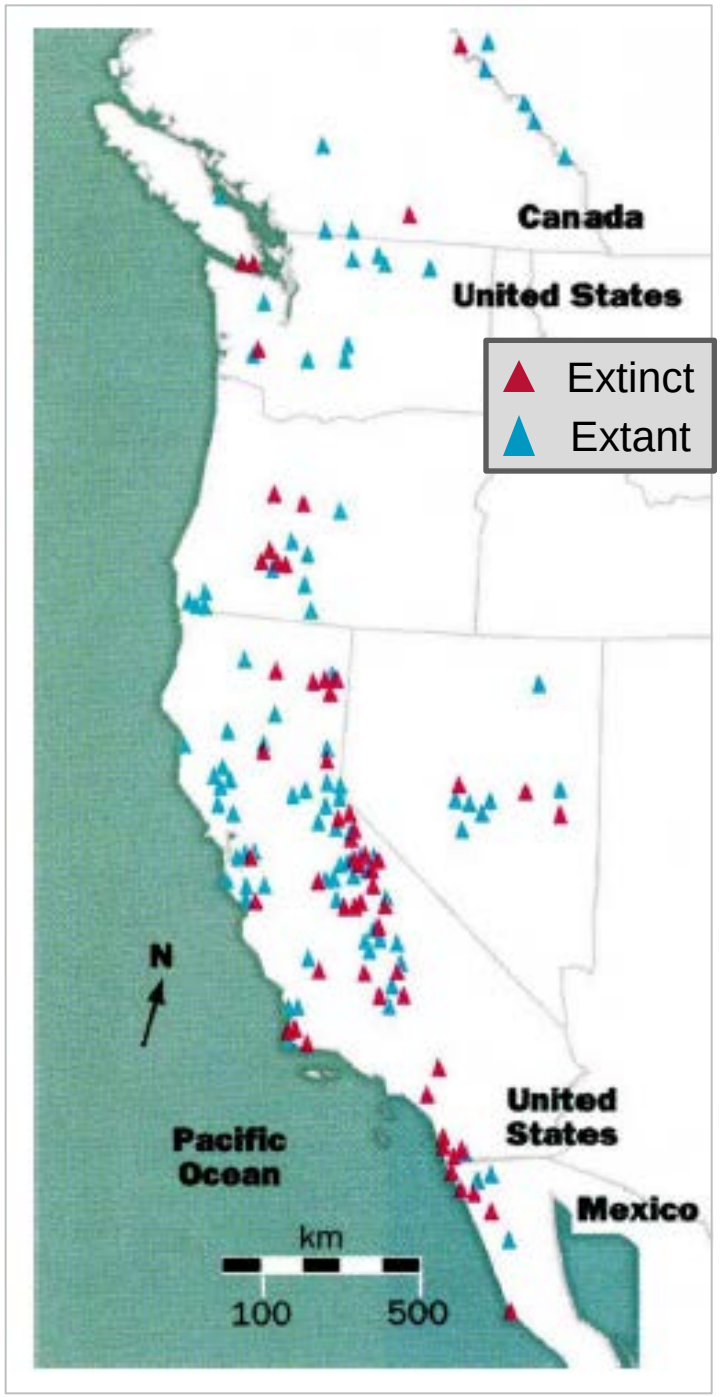
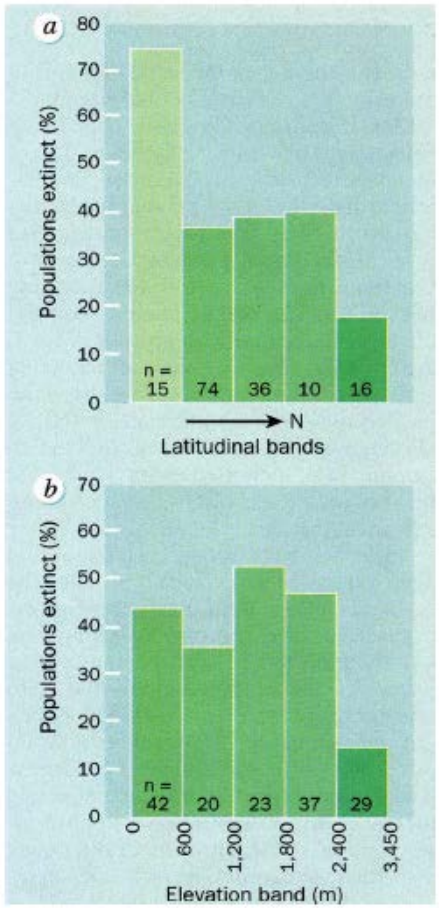
JOHANNESBURG

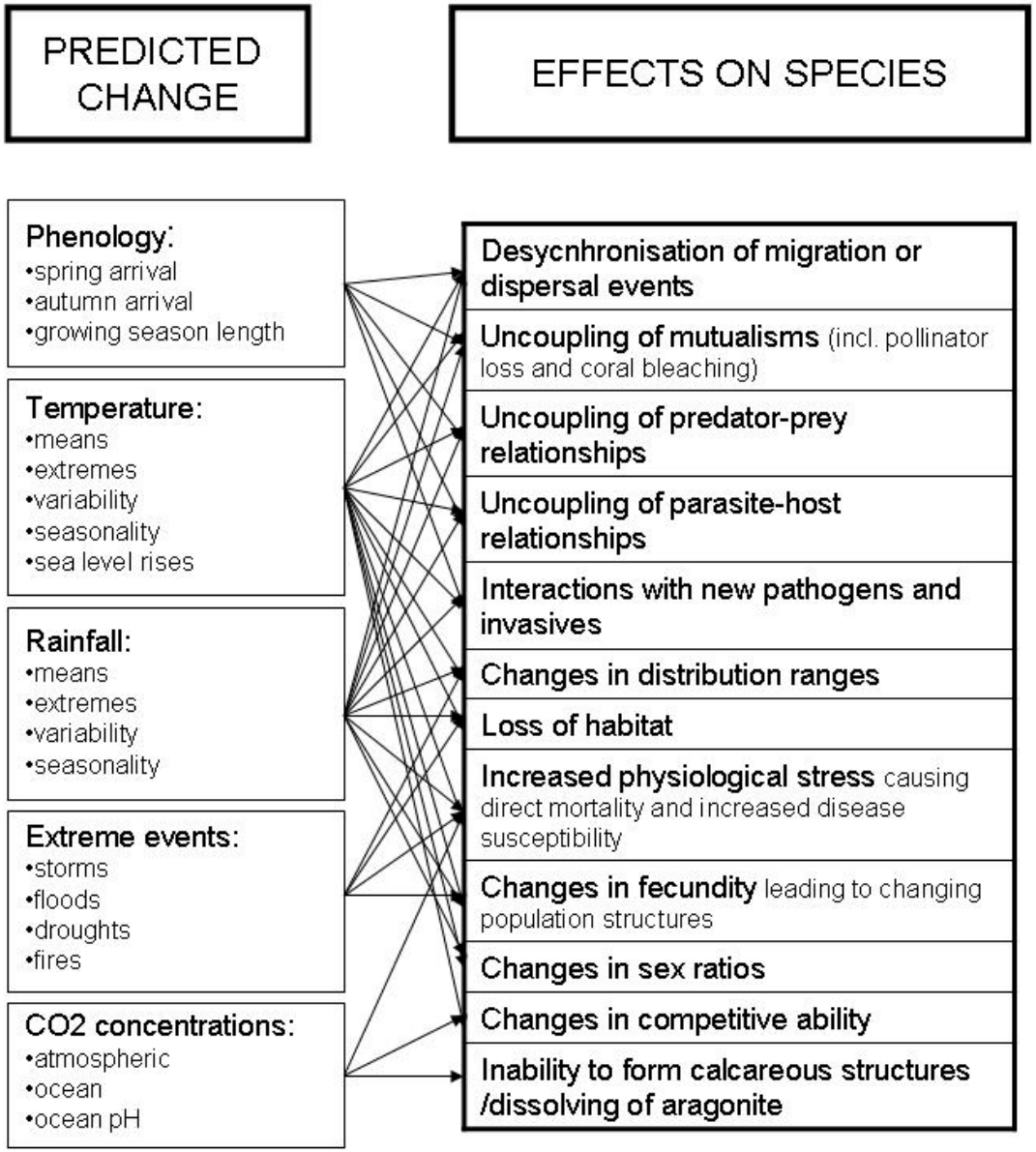
First evidence of climate change impacts on species:
Edith's Checkerspot Butterfly





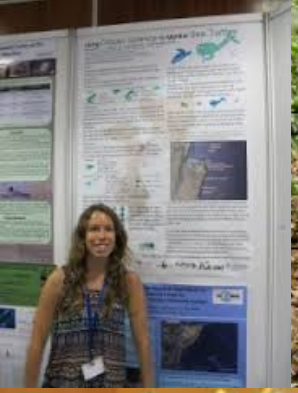
Parmesan, 1996, Nature

"Fingerprints of climate change"



Foden et al, 2008

The unfolding impacts of climate change impacts on species are many, complex and interacting



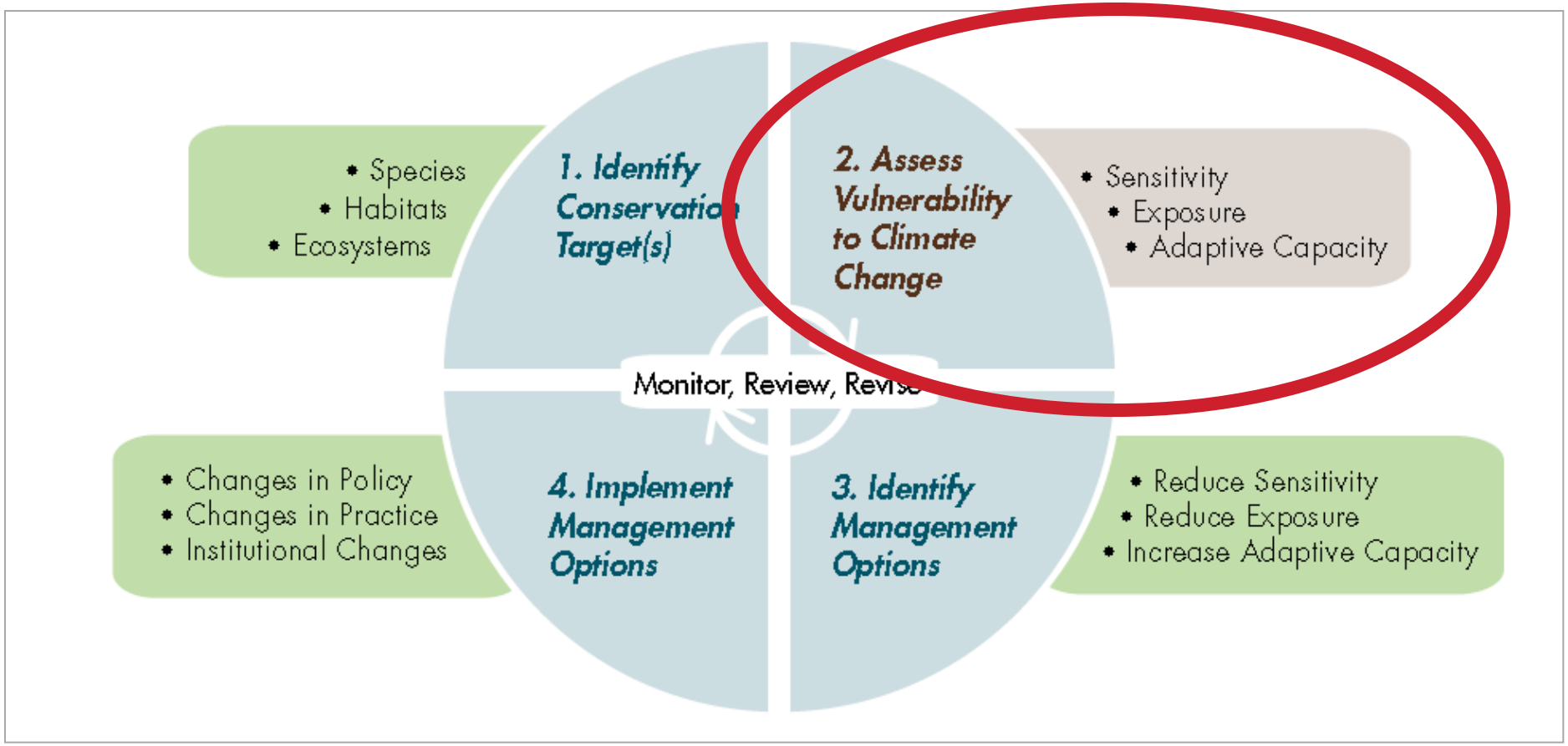








Steps for developing climate change adaptation strategies for biodiversity



Glick, Stein & Edelson, 2011, Scanning the Conservation Horizon

IUCN SSC Guidelines for Assessing Species' Vulnerability to Climate Change

Aimed at assisting conservation practitioners to:

- Understand the key concepts and terminology
- Set clear and realistic objectives
- Select approaches and methods
- Work responsibly with uncertainty
- Find and select relevant species, climate and ecological datasets
- Find and use user-friendly assessment tools

Climate Change
Specialist Group
IUCN-Species Survival Commission

Climate Change Vulnerability Assessment of Species

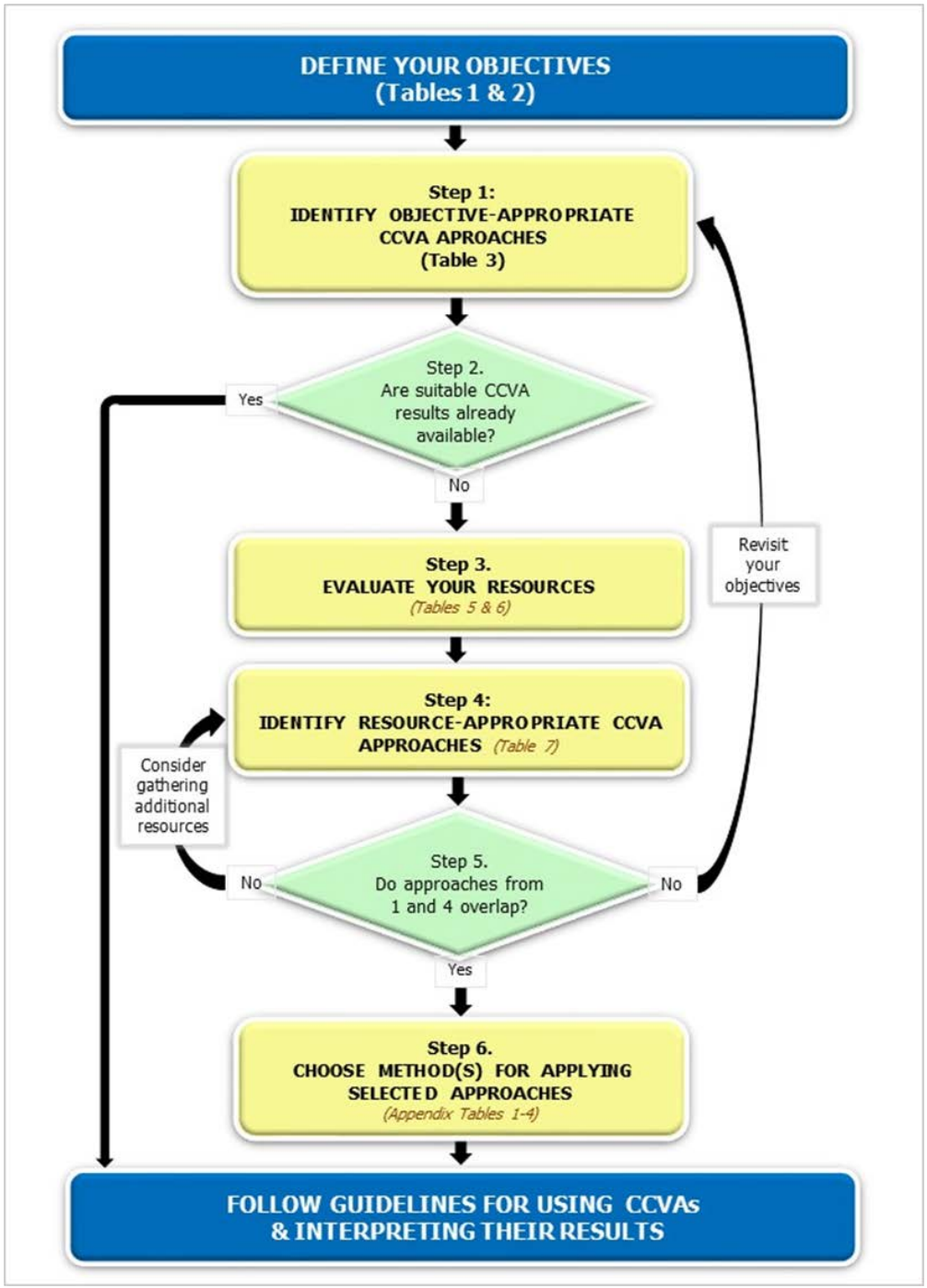
Task Force:

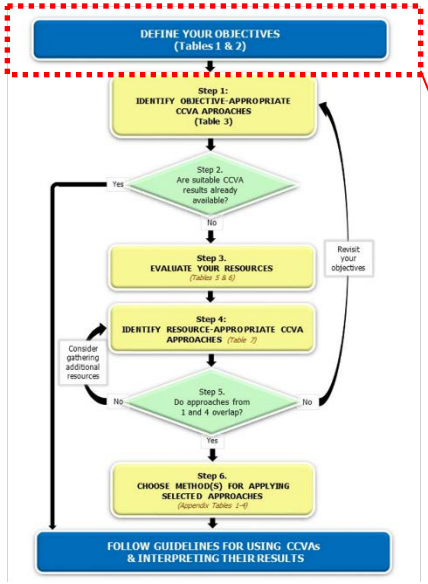
Foden, W.B., Young, B.E., Huntley, B., Williams, S.E., Carr, J.A., Hoffmann, A.A., Hole, D.G., Martin, T.G., Pacifici, M., Scheffers, B.R., Akçakaya, H.R., Bickford, D., Butchart, S.H.M., Corlett, R.T., Kovacs, K.M., Midgley, G.F., Pearce-Kelly, P., Pearson, R.G., Rondinini, C., Stanley-Price, M., Visconti, P. and Watson, J.E.M.

Work in progress:
we're looking for additional input

IUCN Guidelines:

conceptual steps for assessing climate change vulnerability of species



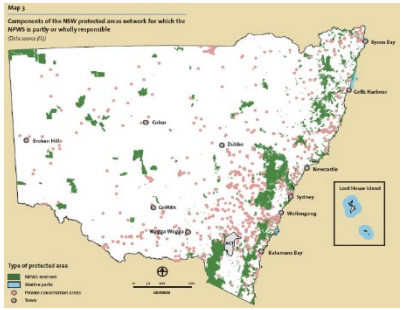

DEFINE YOUR OBJECTIVES
(Tables 1 & 2)
Step 1:
IDENTIFY OBJECTIVE-APPROPRIATE
CCVA APROACHES
(Table 3)
Step 2.
Are suitable CCVA
results already
available?
Yes
No
Step 3.
EVALUATE YOUR RESOURCES
(Tables 3 & 6)
Revisit
your
objectives
Step 4:
IDENTIFY RESOURCE-APPROPRIATE CCVA
APPROACHES (Table 7)
Consider
gathering
additional
resources
Step 5.
Do approaches from
1 and 4 overlap?
No
No
Yes
Step 6.
CHOOSE METHOD(S) FOR APPLYING
SELECTED APPROACHES
(Appendix Tables 1-4)
FOLLOW GUIDELINES FOR USING CCVAs
& INTERPRETING THEIR RESULTS

Stage I


DEFINE YOUR OBJECTIVES
(Tables 1 & 2)

DEFINING CLEAR OBJECTIVES & SCOPE

Site



Network of sites
e.g. region, state or country

Taxon
e.g. Subpopulation
Species
Species group (e.g. birds; vertebrates)

Which?	How much?	Why?	Where?	When?	What's missing?
2100 (85 years)	2065 (50 years)		2040 (25 years)		2025 (10 years)

For example:

Which sites in the network contain greatest concentrations of CC vulnerable species in 2050?

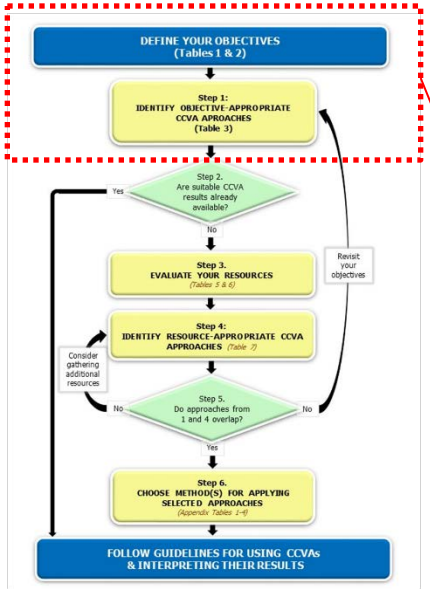
Where will suitable climate conditions for my focal species be found in 2040?

Are the sites with greatest potential as climatic refugia currently protected?

When will my protected area become unsuitable for its target species?

Which new species should I be preparing for in my region? By when?

What are the main reasons that my species is vulnerable to climate change?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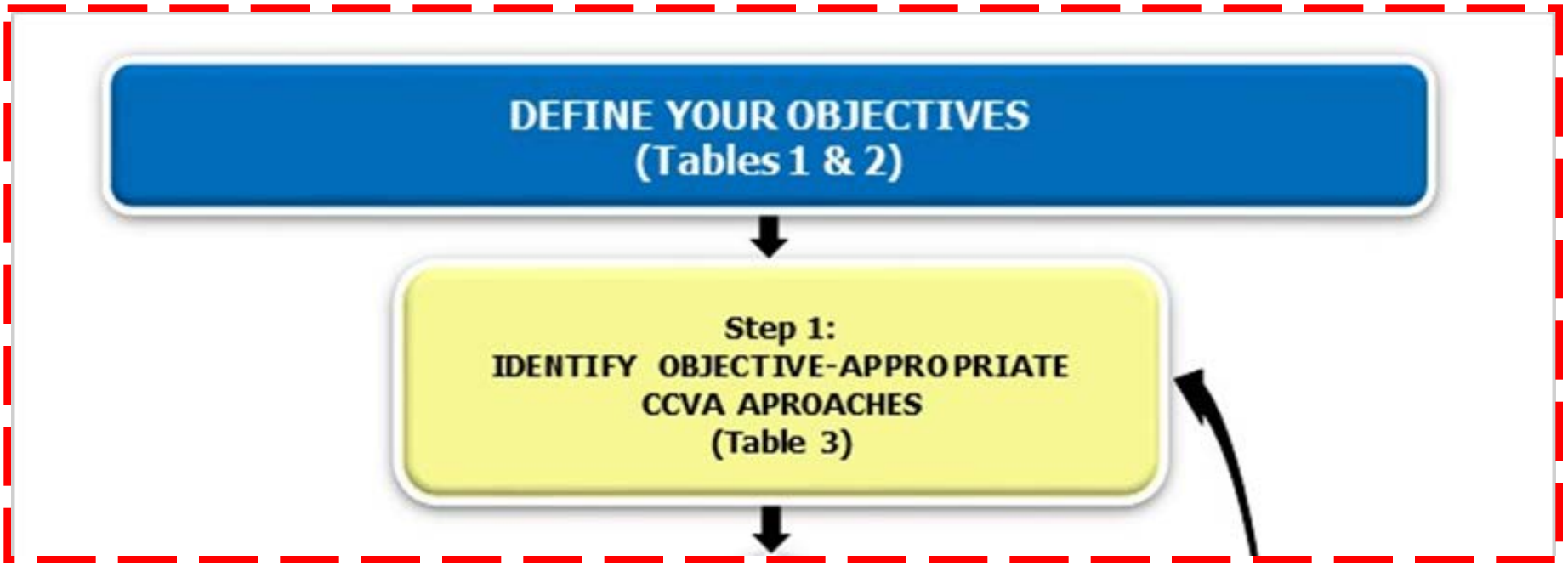
Step 1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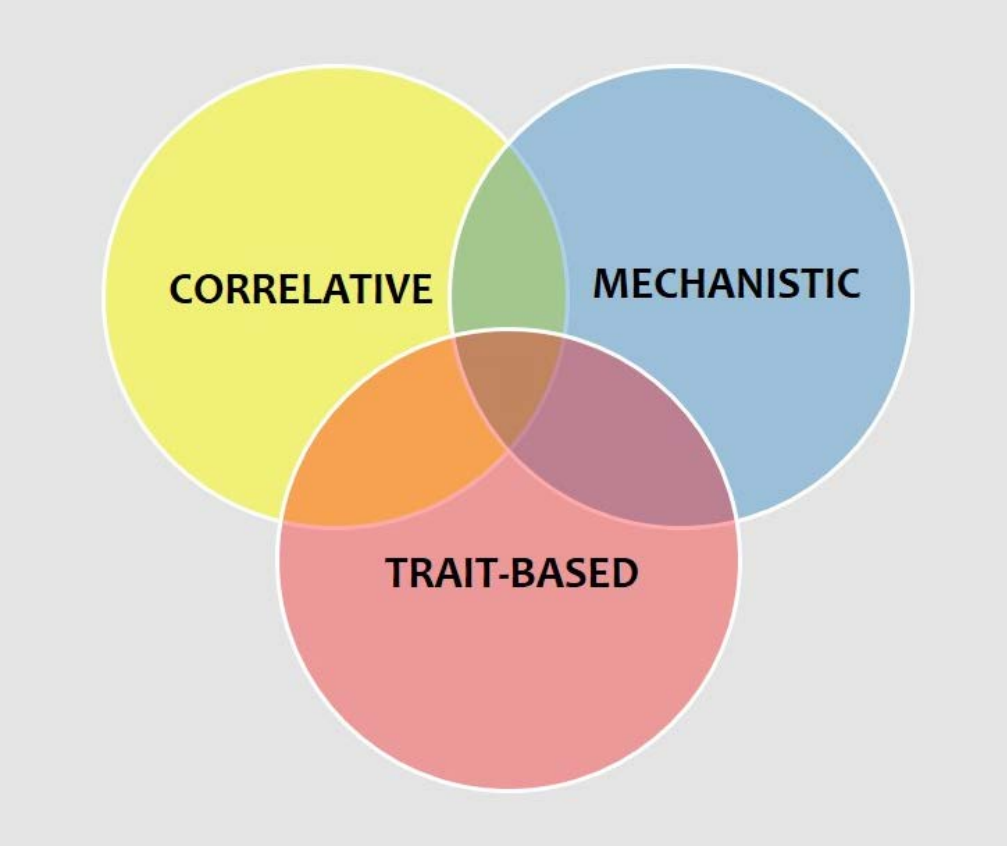
Approaches for assessing species' vulnerability to climate change



Pacifici et al., in press, Nature Climate Change

CORRELATIVE APPROACH

1. Use species' current range to characterise its relationship with key bioclimatic variables (e.g. temperature, precipitation)

Observed distribution

Modelled distribution - historical

Bocage's Weaver
Ploceus temporalis

Willis et al. 2010

CORRELATIVE APPROACH

1. Use species' current range to characterise its relationship with key bioclimatic variables (e.g. temperature, precipitation)

2. Extrapolate that relationship to project location of suitable climate space in the future

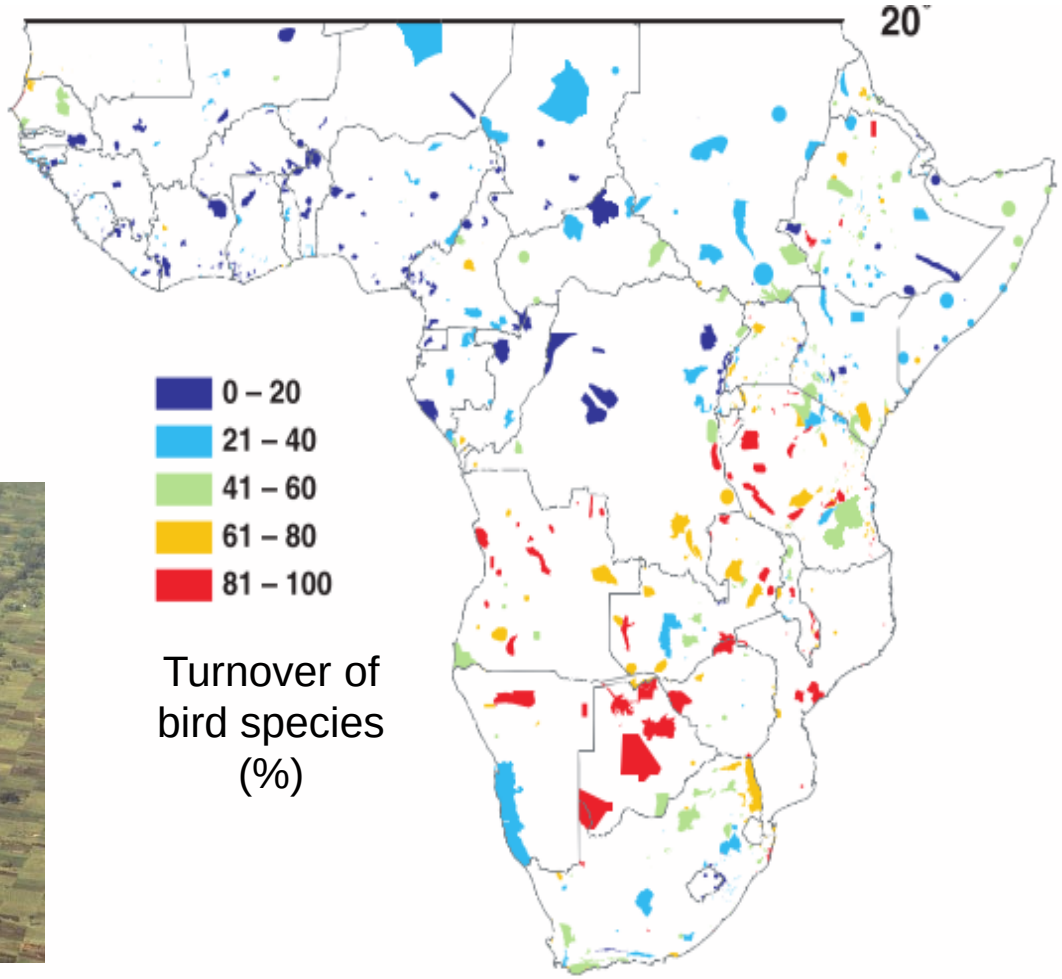
Bocage's Weaver
Ploceus temporalis

Willis et al. 2010

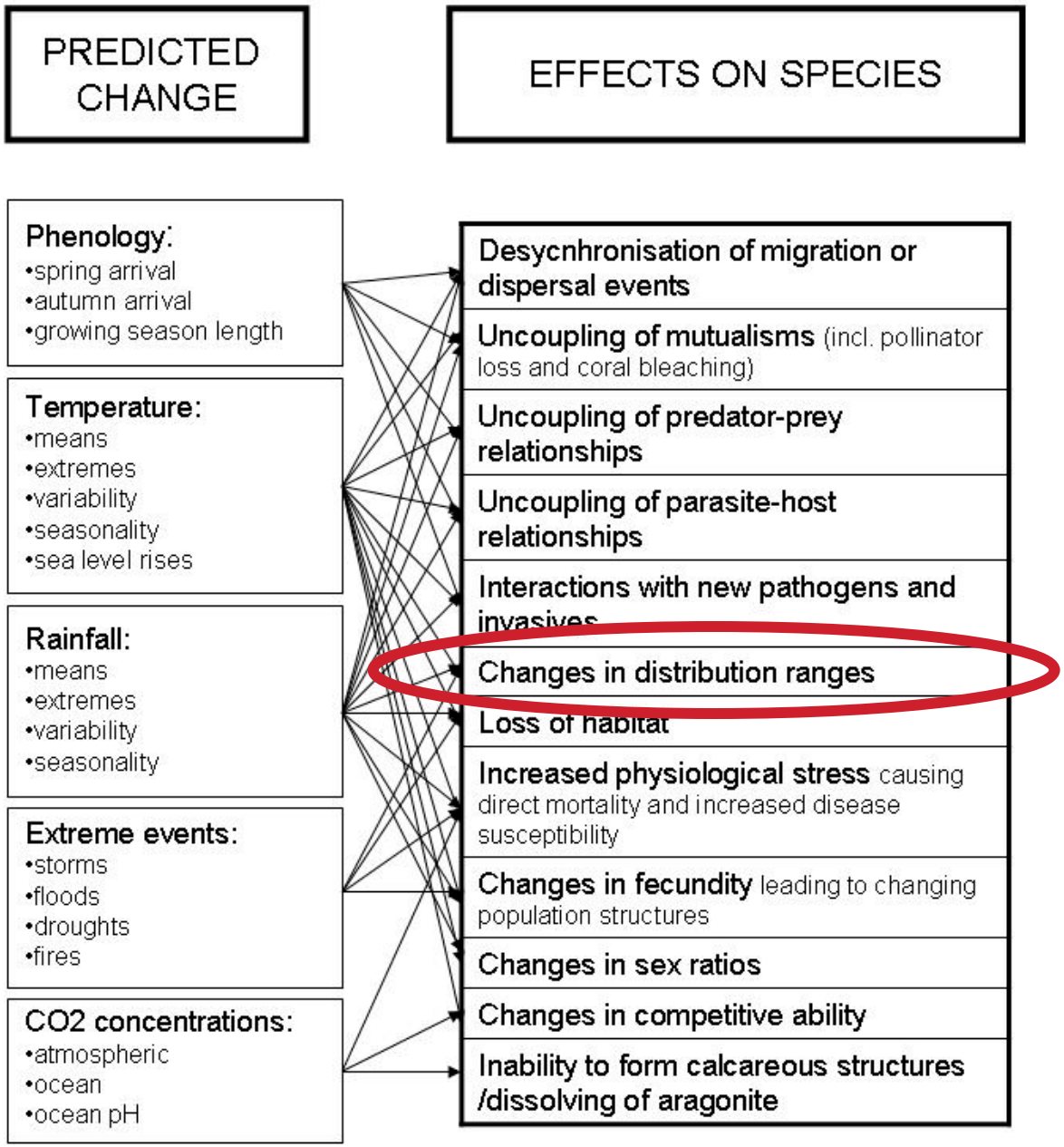
Types of Correlational Approaches

Method type	Methods
Climate Envelope/Profile methods	Multilevel rectilinear envelope
	Binary convex hull envelope
	Continuous point-to-point similarity metric
	Ecological niche factor analysis (ENFA)
Regression-based	Generalized linear models (GLM)
	Generalized additive models (GAM)
	Multivariate adaptive regression splines (MARS)
	Boosted regression trees (BRT)
Machine- learning	Artificial neural networks (ANN)
	Random forests (RF)
	Maximum Entropy (MaxEnt)
	Genetic algorithms
Classification methods	Flexible discriminant analysis
Fuzzy envelope model	
Generalized Dissimilarity Modeling	
Bayesian Statistics	

Use of correlational approach to predict turnover of bird species in SubSaharan protected areas



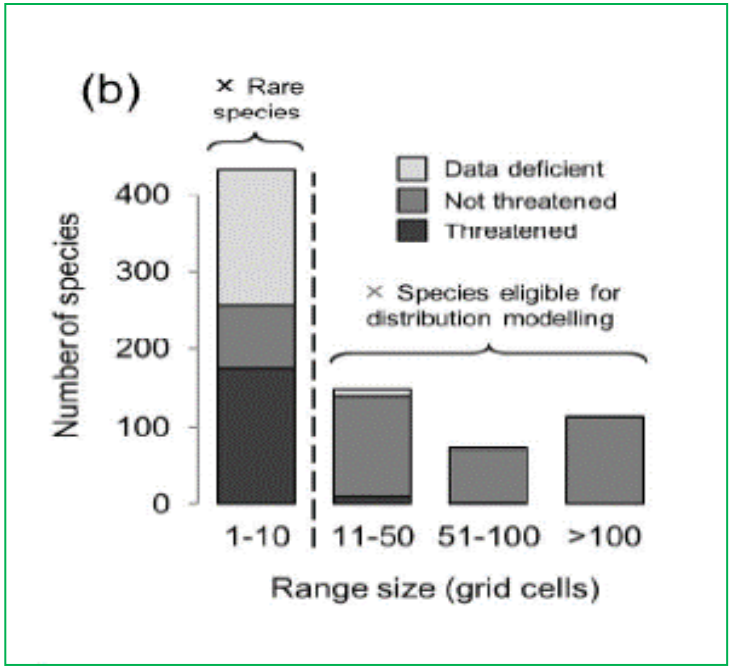
Hole et al., 2009, Ecology Letters



Climate change impacts on species are many, complex and interacting

Conservation implications of omitting rare and threatened species from climate change impact modelling

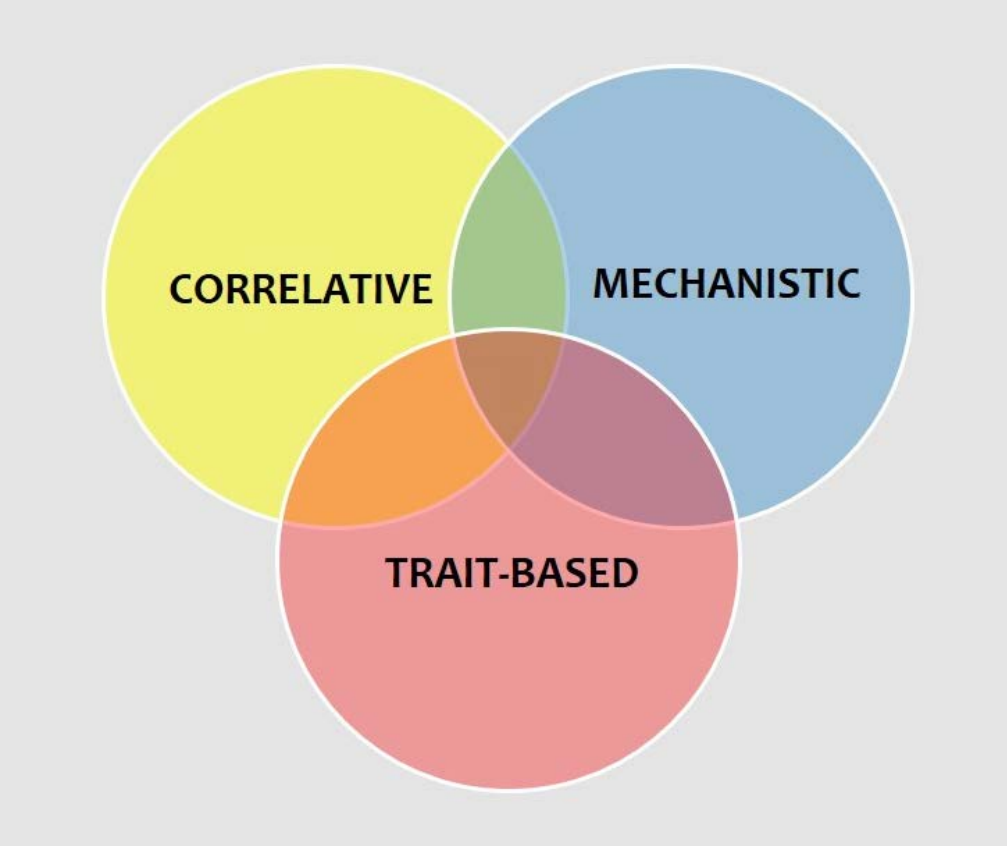
Correlational models require at least 10 species distribution points/localities to meet statistical requirements



Over half of sub-Saharan African amphibians have ranges too small to model using correlational approaches, including 94% of those threatened with extinction."

(Platts et al. 2014, Diversity & Distributions)

Approaches for assessing species' vulnerability to climate change

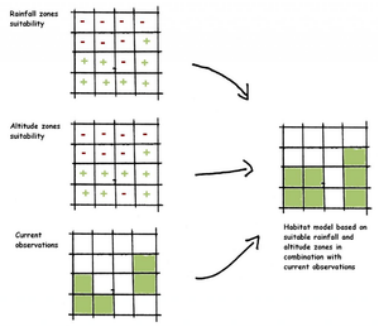


Pacifici et al., in press, Nature Climate Change

MECHANISTIC APPROACH

Use physiological tolerances

+



To calibrate niche models

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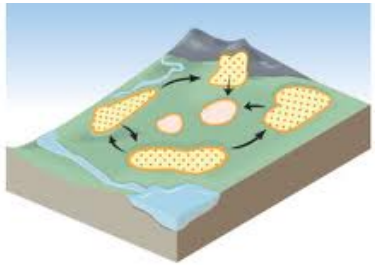

To model meta-population dynamics

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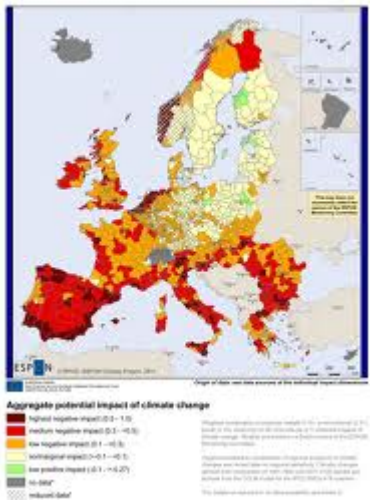


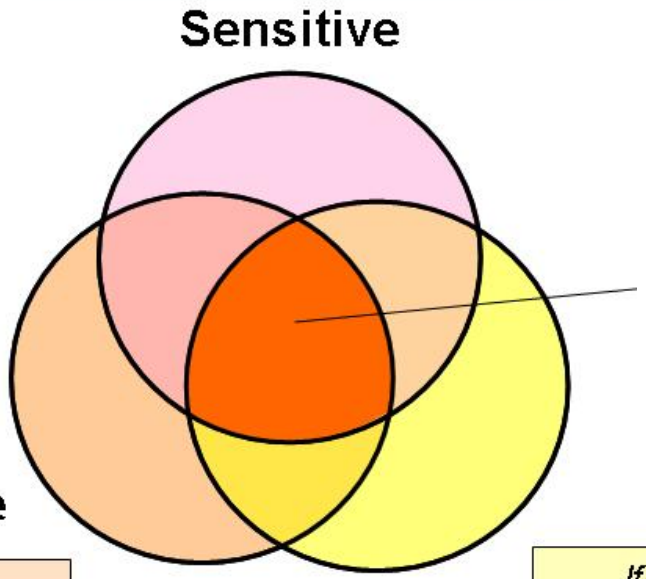
Under changing habitat suitability (climate + fire + SLR + land use + stochasticity, etc.)

e.g. Keith et al (2008) for Proteaceae

TRAIT-BASED APPROACH

For example: IUCN's Assessment method

If ANY of:
Habitat specialist
Narrow tolerance range
Interspecific interaction disruptable
Environmental trigger disruptable
Rare



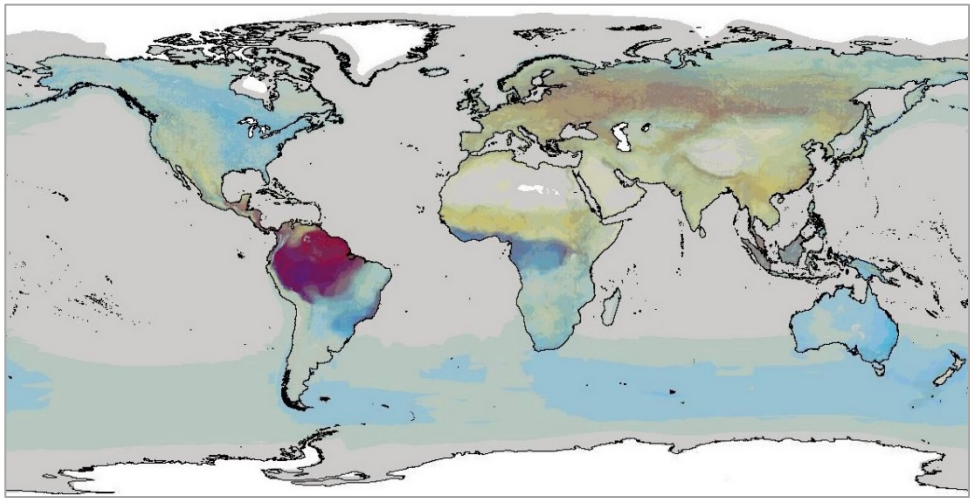
VULNERABLE

If ANY of:
Low dispersal capacity
Poor microevolutionary capacity

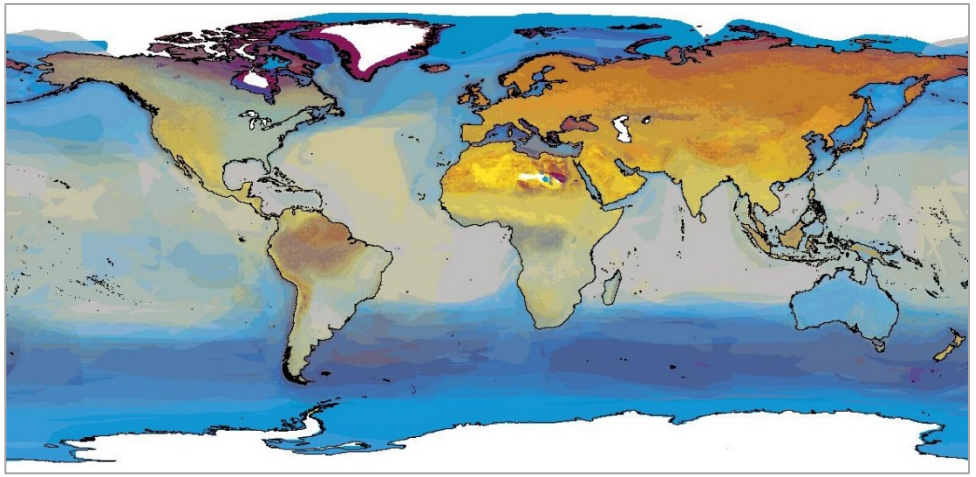
If exposed to ANY of:
Sea Level Rise
Temperature change*
Precipitation change*
Ocean acidification*
**Worst 25% of species affected*

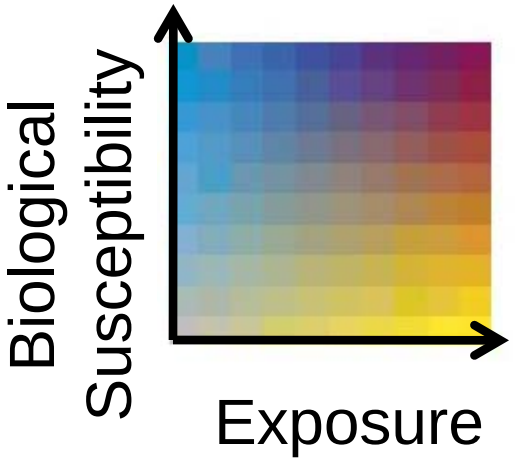
IUCN-BirdLife's Trait-based Assessment of Climate Change Vulnerability of the World's Birds (9,856 spp)

a.



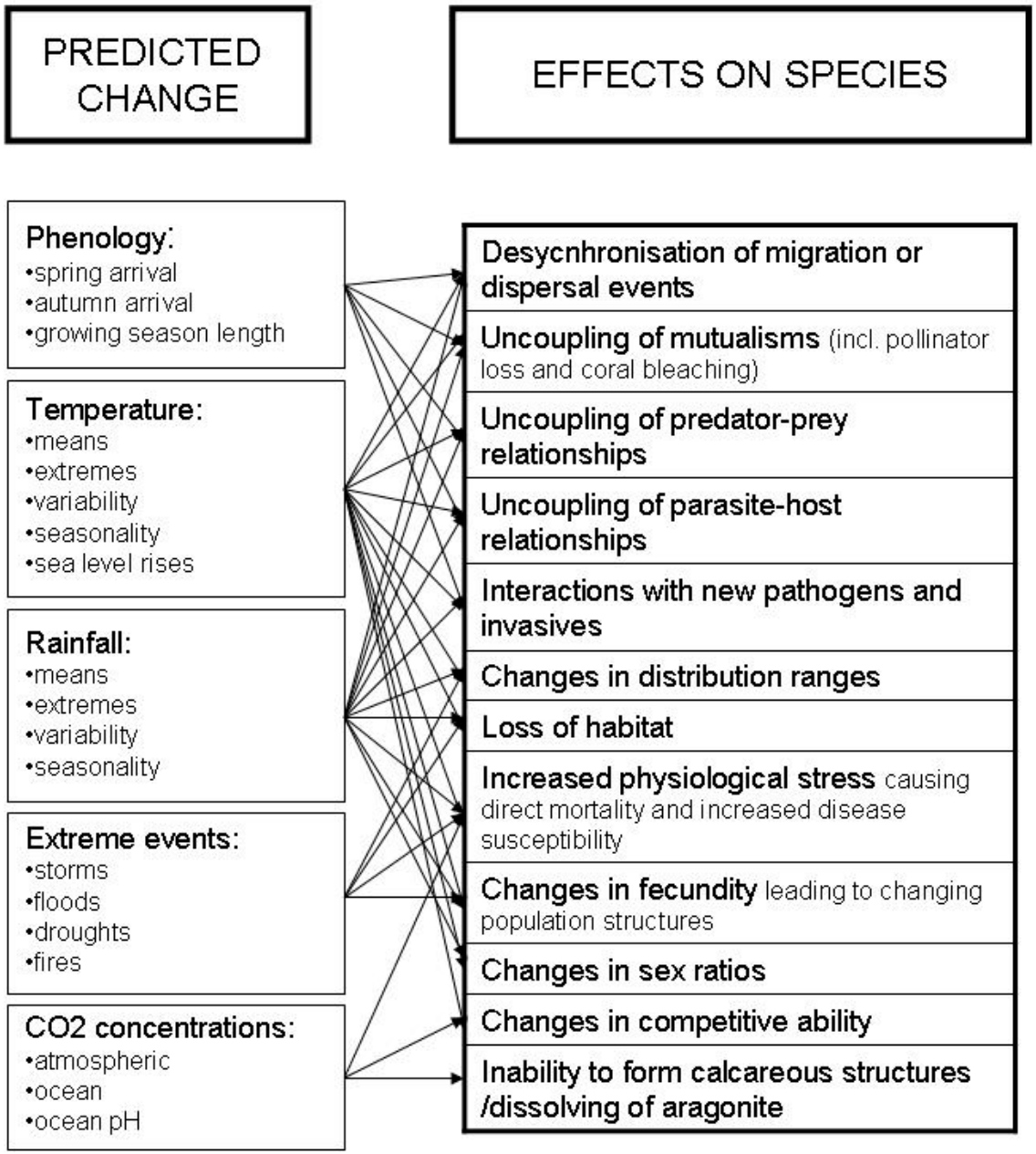
b.





a. Total number
b. Proportion (relative to species richness)

Foden et al. 2013, PLOS ONE

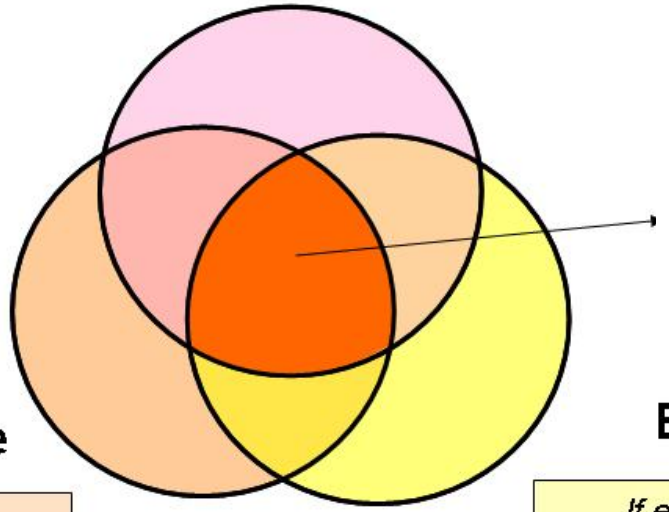


Climate change impacts on species are many, complex and interacting

TRAIT-BASED APPROACH

If ANY of:
Habitat specialist
Narrow tolerance range
Interspecific interaction disruptable
Environmental trigger disruptable
Rare

Sensitive



VULNERABLE

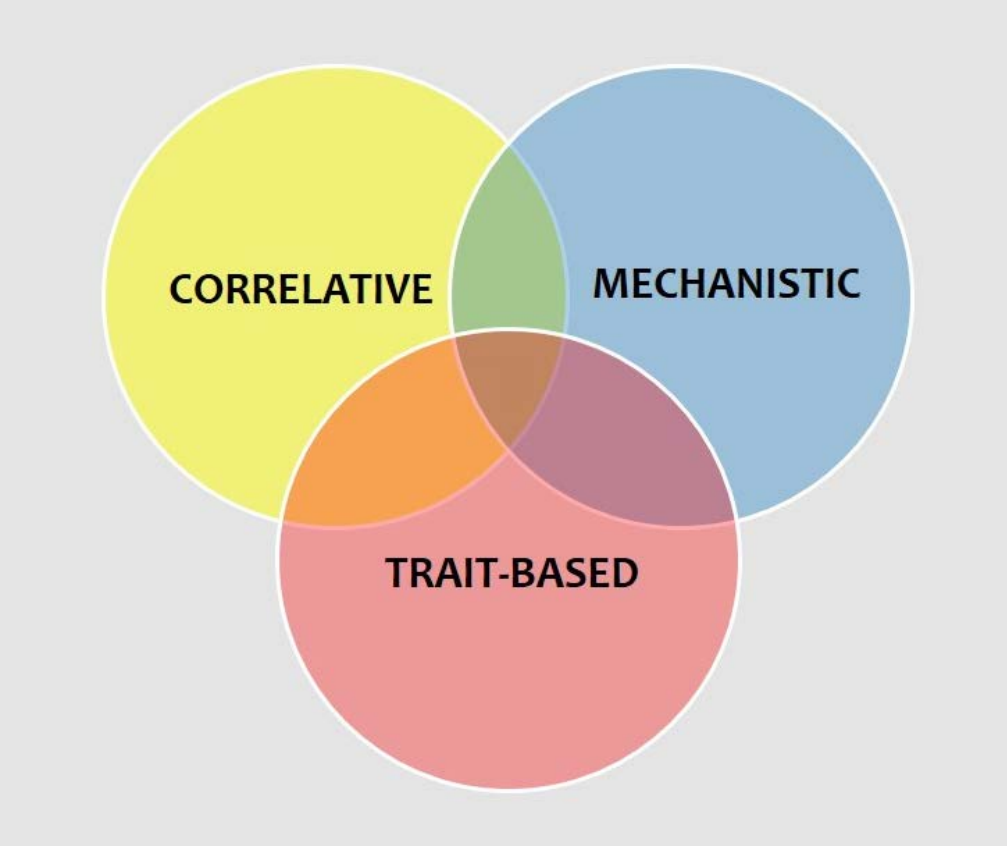
Unadaptable

If ANY of:
Low dispersal capacity
Poor microevolutionary capacity

Exposed

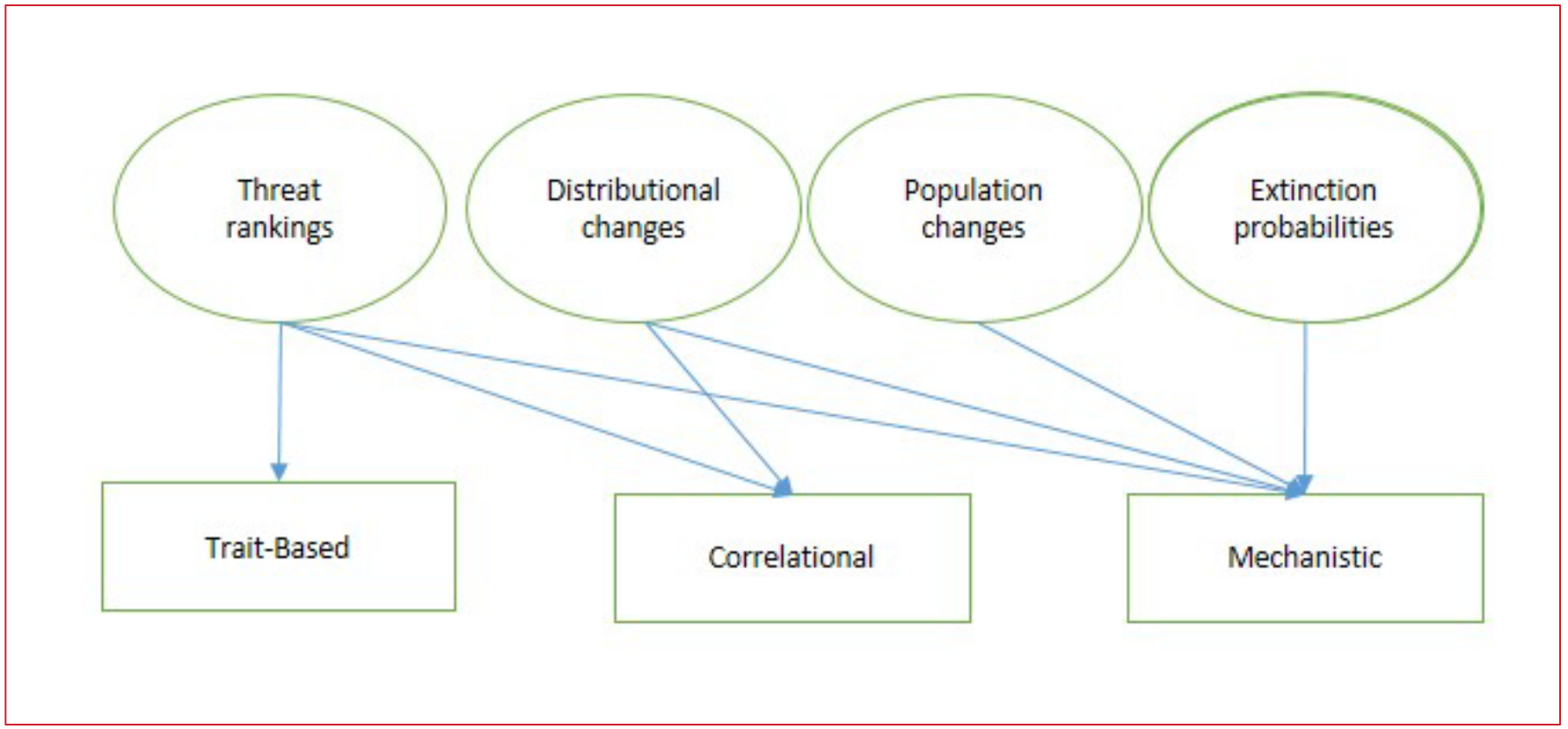
If exposed to ANY of:
Sea Level Rise
Temperature change*
Precipitation change*
Ocean acidification*
**Worst 25% of species affected*

Approaches for assessing species' vulnerability to climate change



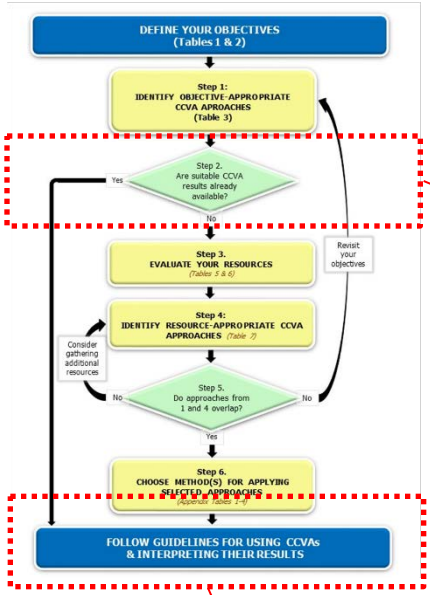
Pacifici et al., in press, Nature Climate Change

The four main types of information required for Climate Change Vulnerability Assessment (CCVA) of species and the approaches that produce them



CCVA Objective categories	CCVA Information Requirements for Addressing Objectives	CCVA		
		Corr	TVA	Mech
Which?	Species vulnerability rankings	Y	Y	Y
	Subpopulation vulnerability rankings or extinction probabilities			Y
How much?	Extinction probabilities of species and/or populations			Y
	Range shifts (magnitude, distance, rate)	Y		Y
	Dispersal potential		Y	Y
Why?	Aspects of vulnerability (i.e., sensitivity, exposure & adaptive capacity)		Y	Y
	Climatic drivers of vulnerability	Y		Y
	Biological drivers of vulnerability		Y	Y
	Human response to climate change as a driver of vulnerability		Y	Y
Where?	Areas with greatest concentrations of most or least vulnerable species	Y	Y	Y
	Areas climatically suitable or unsuitable for species in future	Y		Y
	Location of potential corridors and/or refugia	Y		Y
	Subpopulations outside projected suitable climates	Y		Y
	Areas most impacted by vulnerability drivers including disruption of inter-species interactions and human responses to climate change		Y	Y
When?	Time frame of projected risk to species, site and landscape	Y		Y
	Rate of shift in climate space	Y		Y
	Species/subpopulation turnover rate	Y		Y
What's missing?	Key gaps and uncertainties – climatic	Y		Y
	Key gaps and uncertainties – biological		Y	Y
	Key gaps and uncertainties – in our understanding of impacts and their driving mechanisms	Y	Y	Y
	Key gaps and uncertainties – human responses to climate change as a driver of			

Step 2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Yes
No
Step 3.
EVALUATE YOUR RESOURCES
(Tables 5 & 6)
Revisit your objectives
Step 4:
IDENTIFY RESOURCE-APPROPRIATE CCVA
APPROACHES (Table 7)
Consider gathering additional resources
Step 5.
Do approaches from
1 and 4 overlap?
No
No
Yes
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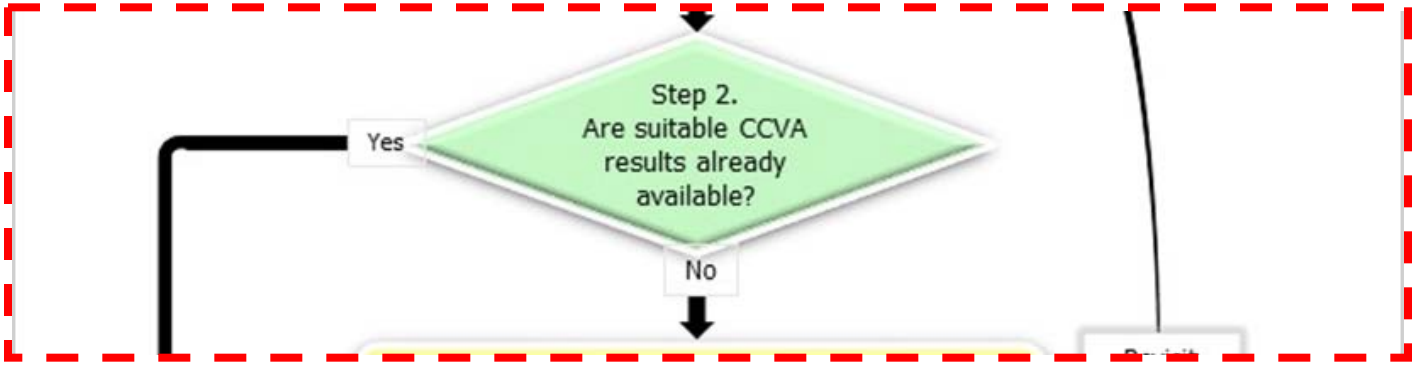
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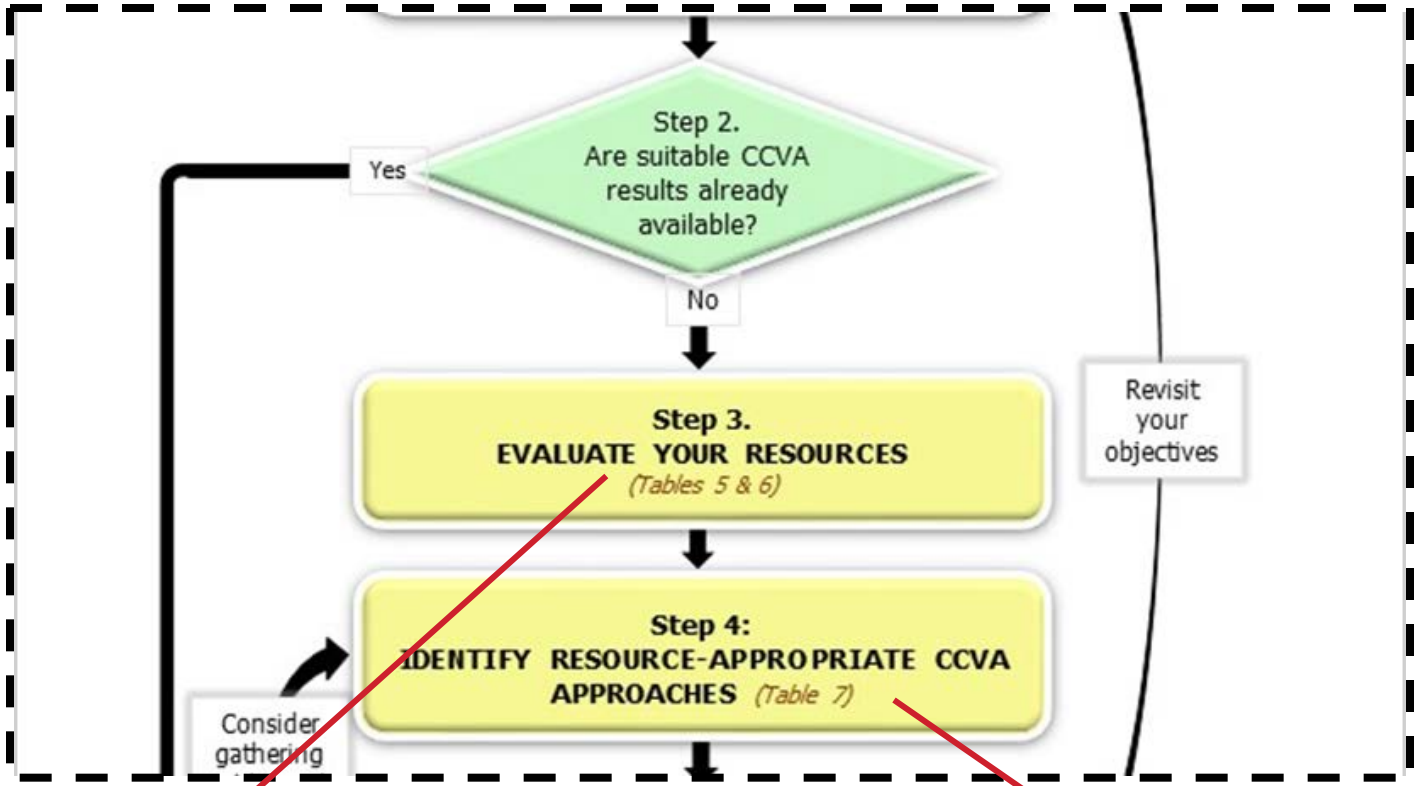
Steps 3 & 4



species, climate and ecological data; expertise; hardware and software

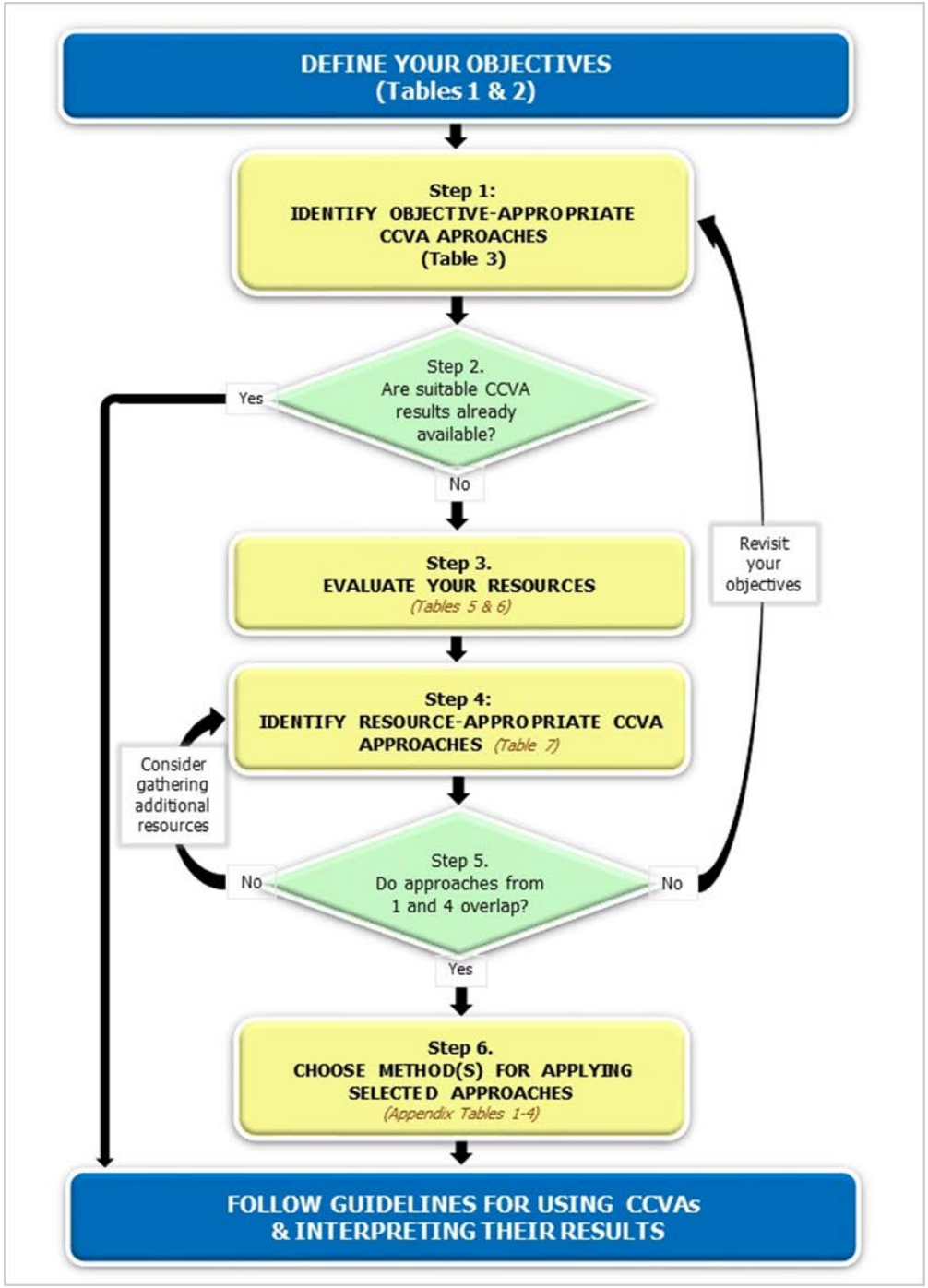
Resource Type	Input requirements	Correlative	Trait-based	Mech-anistic
Species data	Point locality ditribution data; or*	May be used	May be used	May be used
	Gridded distribution data; or*	Required	May be used	Generally required
	Distribution polygons/maps*	Not recom-mended	Generally required	May be used

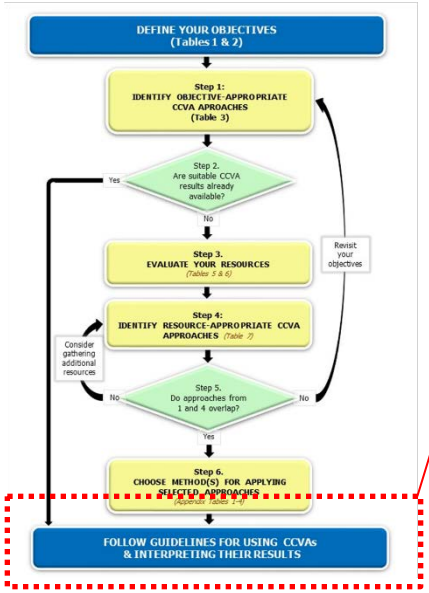
Step 5:

Do any approaches selected in steps 1 (object-based) and 4 (resource-based) overlap?

Step 6:

Choose method(s) for applying selected approaches





Guidelines for choosing appropriate:

- species data
- bioclimatic variables
- climate models and runs
- future scenarios
- spatial and temporal scales.

Guidelines for working with uncertainty:

- Use as many approaches and methods as possible
- Explore best and worst case scenarios (for climate, model parameters, distribution data, land use, etc.)
- Interpret and use the results with understanding of their limitations

Guidelines for presenting and communicating assessment results

PRINCIPLES OF CLIMATE CHANGE VULNERABILITY ASSESSMENT

1. Be clear about your objectives
2. Embrace uncertainty. Use as many approaches, methods, models, etc. as is feasible
3. Use the least complex approach necessary for your purpose
4. Establish mechanisms for iterative assessments
5. Be aware of the limitations of each CCVA approach and what they mean for practical actions
6. Involve stakeholders

Gaps and Areas for New Development

1. Combining the best aspects of approaches
2. Validation of assessments using species' observed responses to climate change (relies on monitoring data)
3. Including impacts of human responses to climate change, and climate change interactions with non-climate change driven threats
4. Translating vulnerability assessments into adaptation management strategies

Please help us to develop and review

the IUCN SSC Best Practice Guidelines for assessing species' vulnerability to climate change

SSC
Species Survival Commission

IUCN

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Climate Change
Specialist Group
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