Persist in Place or Shift in Space?

Applying Assessments of Species' Adaptive Capacity to Inform Climate Adaptation Actions

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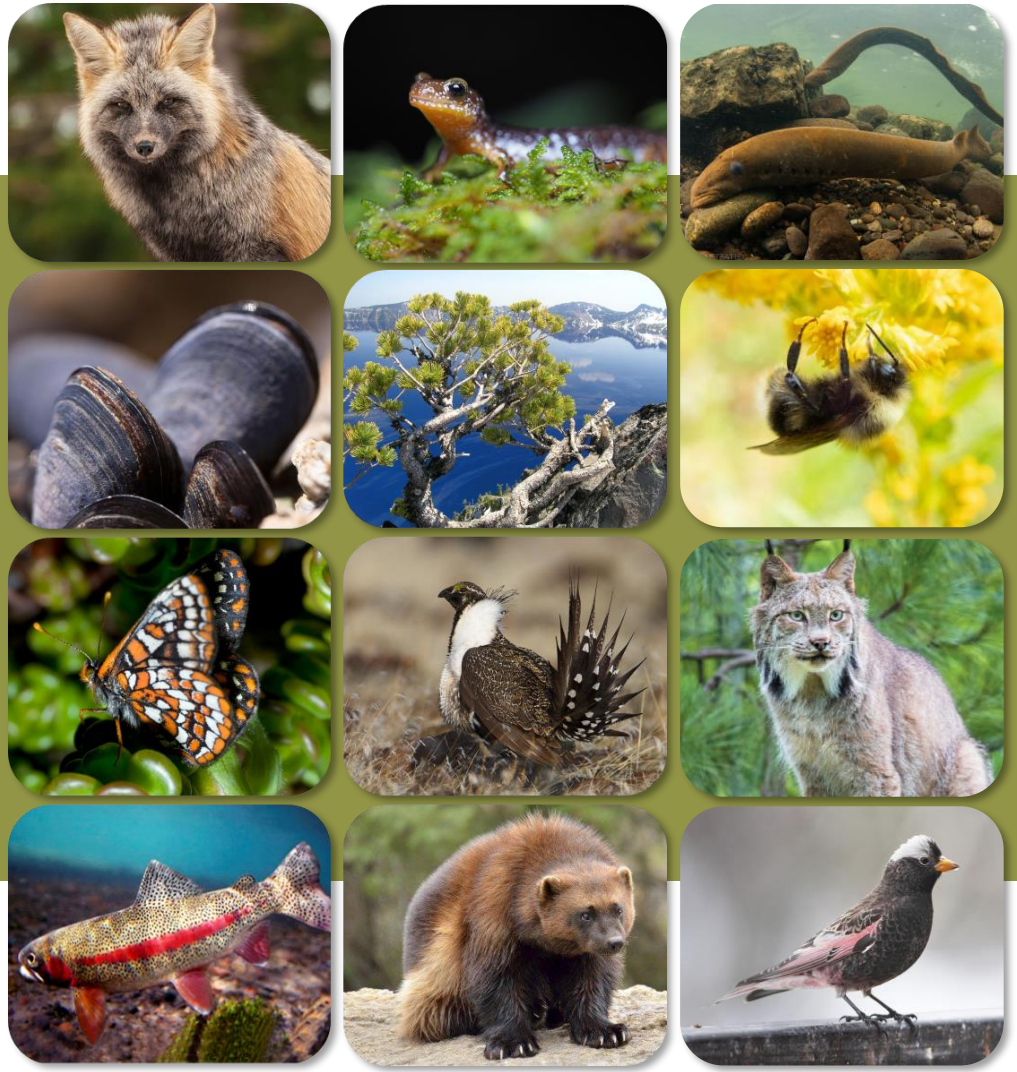

USGS science for a changing world

NORTHWEST Climate Adaptation Science Center

AC Quick Reference Guide & Resources

https://tinyurl.com/AC-how-to

Adaptive Capacity Working Group
Est. Oct 2017
USGS Powell Center, Ft. Collins

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University

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University

B. Wick

Overview

01 **Adaptive Capacity 101**
Advancements in our understanding of species' adaptive capacity

02 **Assessment Framework**
Using the AC "wheel"

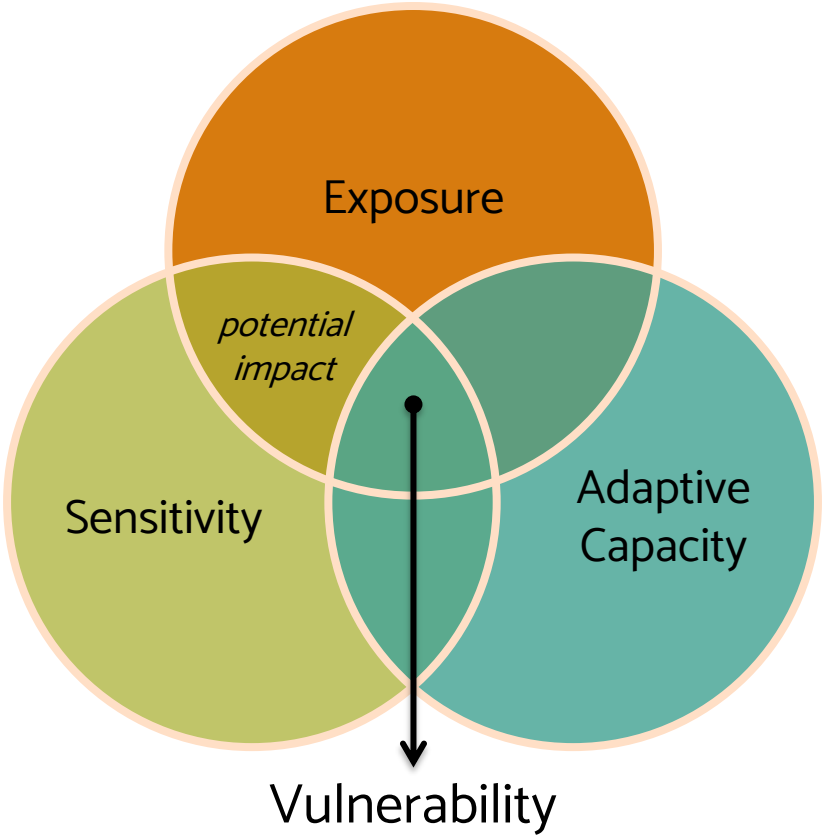
03 **Bridging Research & Practice**
AC-informed adaptation menu

Climate change vulnerability

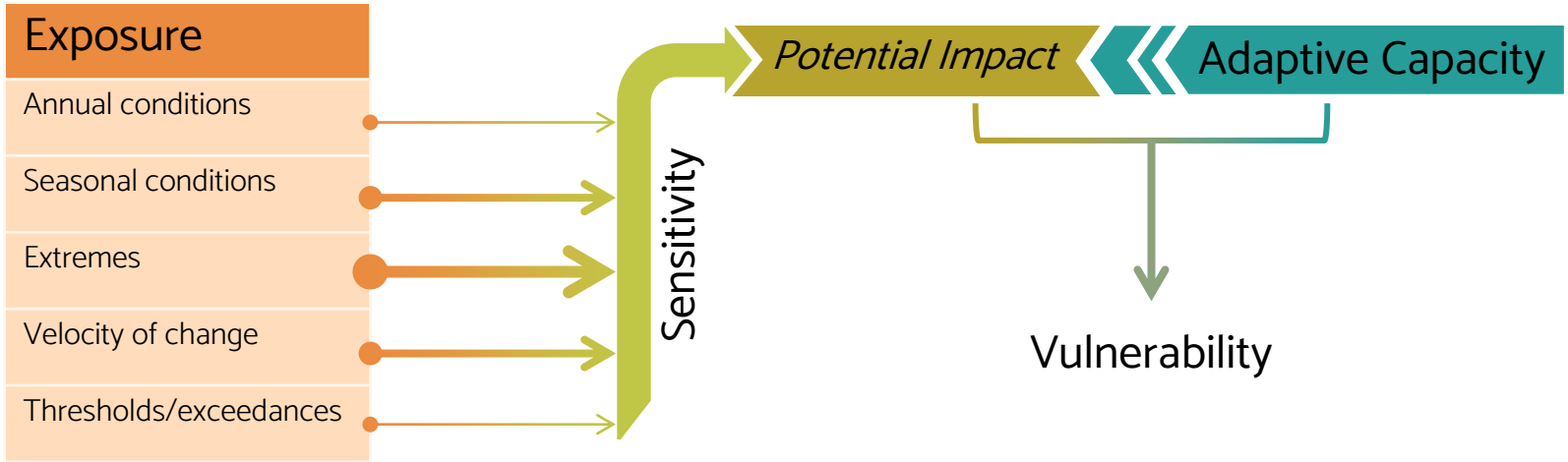
Rate and magnitude of climate change experienced

Dose-response (susceptibility or degree of impact)

Ability to cope with or adjust to changes



Climate change vulnerability



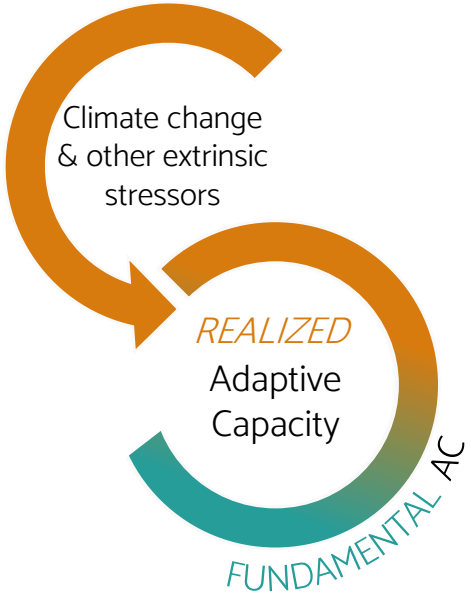
Adaptive Capacity

"The potential, capability, or ability of a species, ecosystem or human system to **adjust** to climate change, to **moderate** potential damage, to **take advantage of opportunities**, or to **respond** to the consequences."
IPCC AR5 (2014)

Davidson et al (2020) https://doi.org/10.1126/science.abb7080

K. Joly / NPS

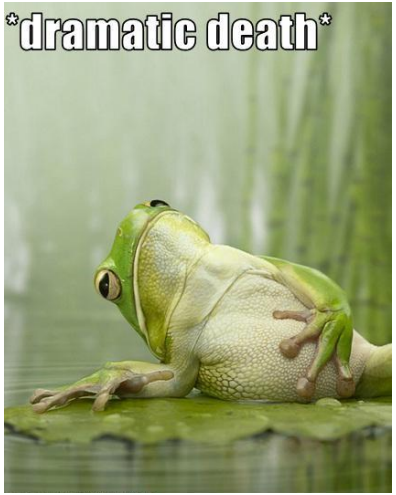
Persist in place or shift in space? Evaluating the adaptive capacity of species to climate change.
Thurman et al (2020) *FrEE*
https://doi.org/10.1002/fee.2253



Improving conservation outcomes with a new paradigm for understanding species adaptive capacity.
Beever et al (2016) *Conserv Lett*
https://doi.org/10.1111/conl.12190

I. Meshcheryakovova

S. McMillan



ICanHasCheezburger.com

Persist in place

(adapt *in situ* /acclimate)

Shift in space

(move to track suitable climate)

Perish

(local/rangewide extinction)

Thurman et al (2020) https://doi.org/10.1002/fee.2253

Persist in place

"Behavioral flexibility as a mechanism for coping with climate change"

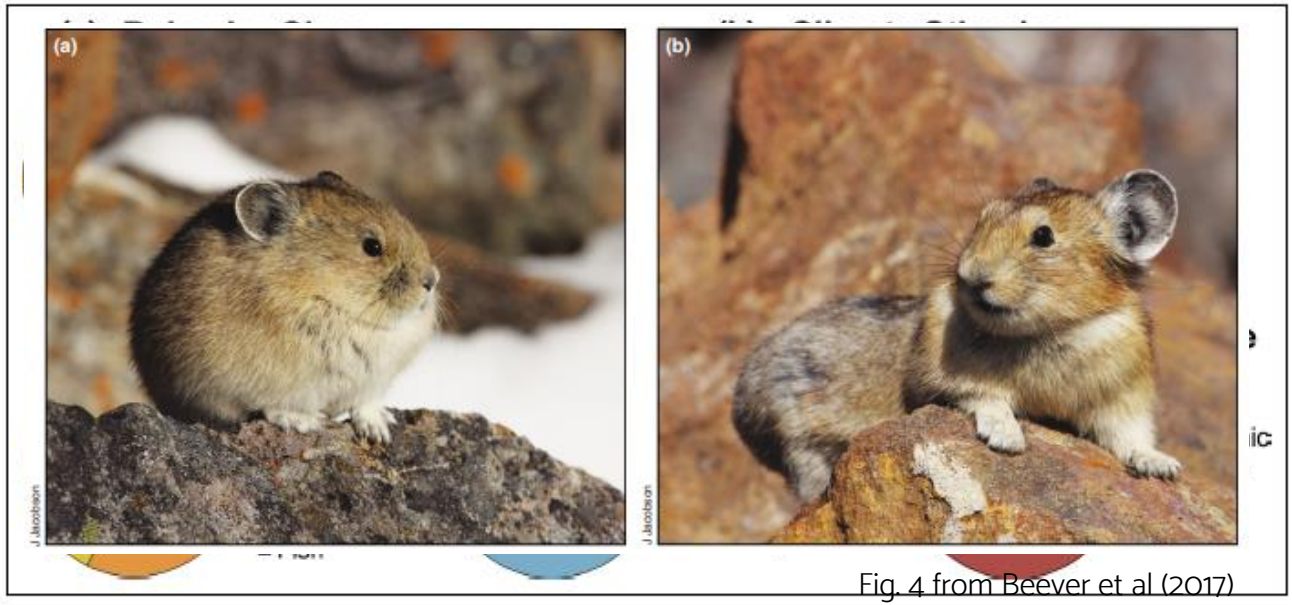


Fig. 4 from Beever et al (2017)

Beever et al (2017) https://doi.org/10.1002/fee.1502

Shift in space

"Modeled distribution shifts of North American birds over four decades..."

Observed / Modeled

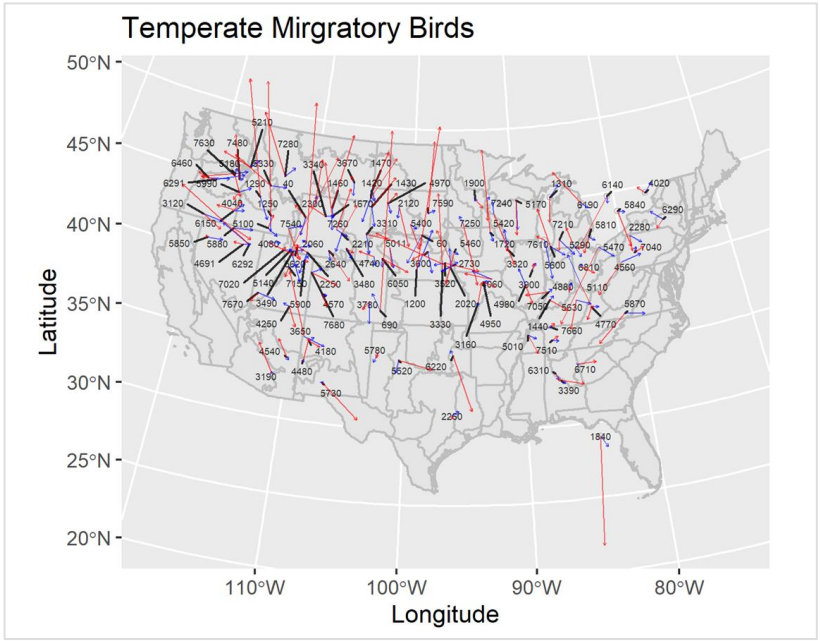


Fig. A1 from Huang et al (2023)

- Examined range shifts in 250 birds across the U.S. (from 1969–2011)
- The velocity of the **observed** range shifts shift are **faster** and more variable than the modeled range shifts
- Differences between observed vs. modeled shifts **best explained by migratory behavior and adaptive capacity!**
- **Temperate (short-distance) migrants, wetland spp.,** and **habitat generalists** tended to have higher velocity of observed shifts than other species
- Substantial physiological tolerances and access to climate refugia may explain lags in range shifts

Huang et al (2023) https://doi.org/10.1016/j.scitotenv.2022.159603

"It's me, hi! I'm the problem, it's me."
- Taylor Swift

Species' attributes that may confer *greater* adaptive capacity

- Shorter generation time
- Higher fecundity
- Greater genetic diversity
- Ecological "generalists"
- Greater dispersal capacity
- Broad spatial distribution
- Populations where climatic changes are of intermediate magnitude

N. Hawkins

Nicotra et al (2015) https://doi.org/10.1111/cobi.12522

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Overview

Migratory

W. Golder

AllCanadaPhotos

Complex Life Cycles

J. Utrup / USFWS

D.T.F. Endresen

Ectothermic Vertebrates

P. Walker

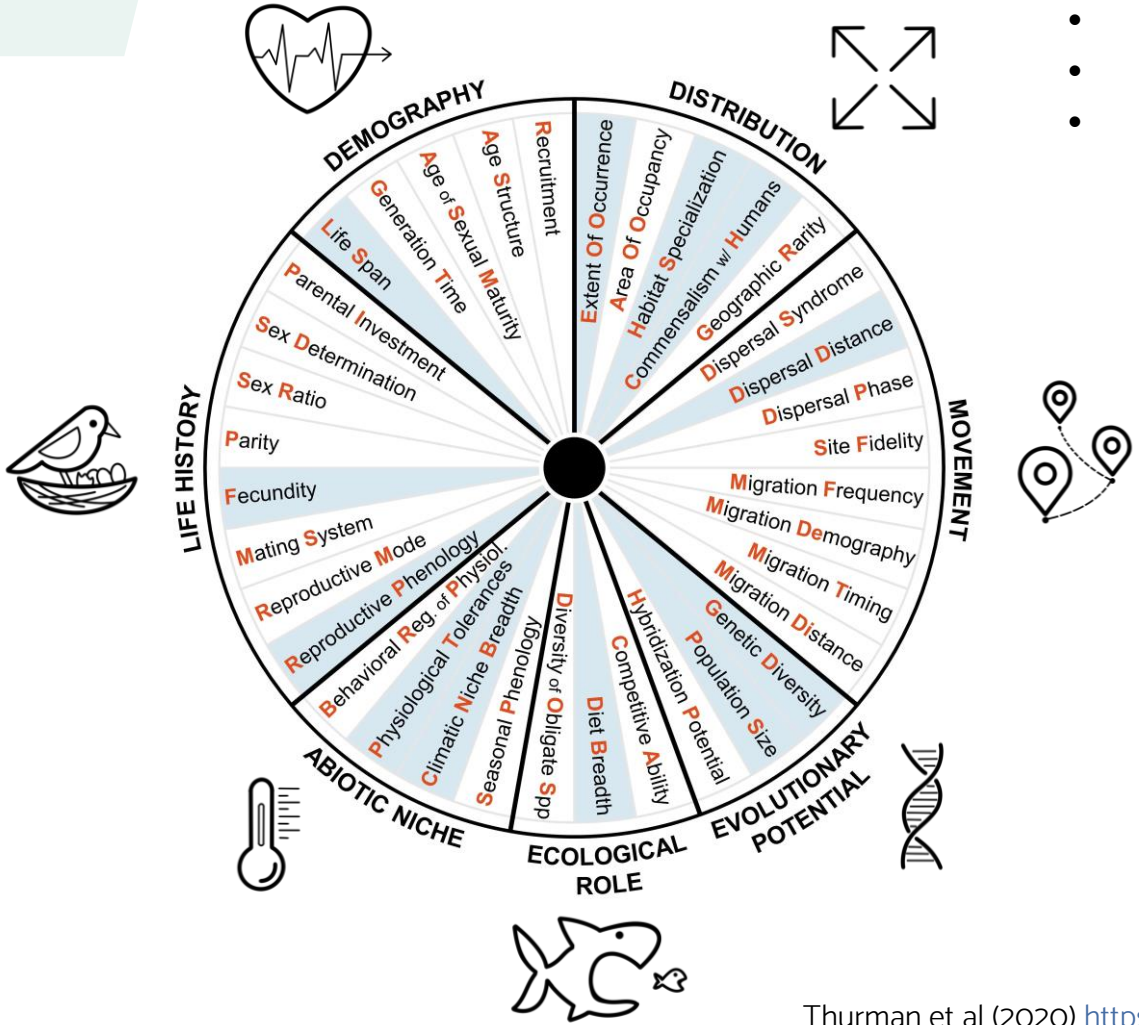
B. Young

Sessile

J. Huber

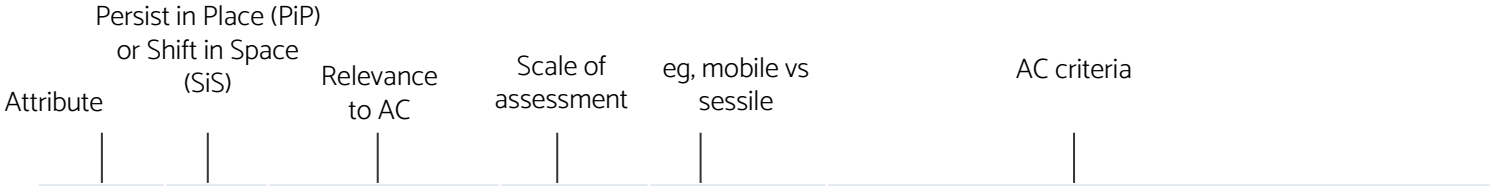
P. Humann

Thurman et al (2020) https://doi.org/10.1002/fee.2253



- 36 attributes
- 7 complexes (groups)
- 12 core attributes

Thurman et al (2020) https://doi.org/10.1002/fee.2253

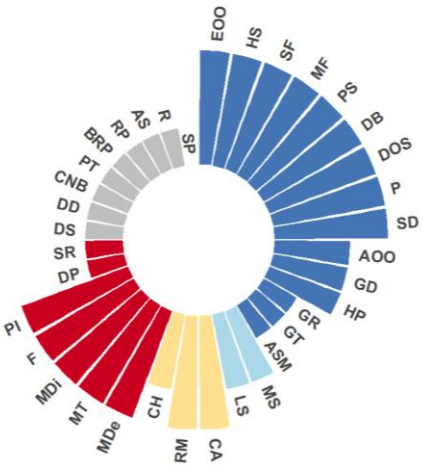


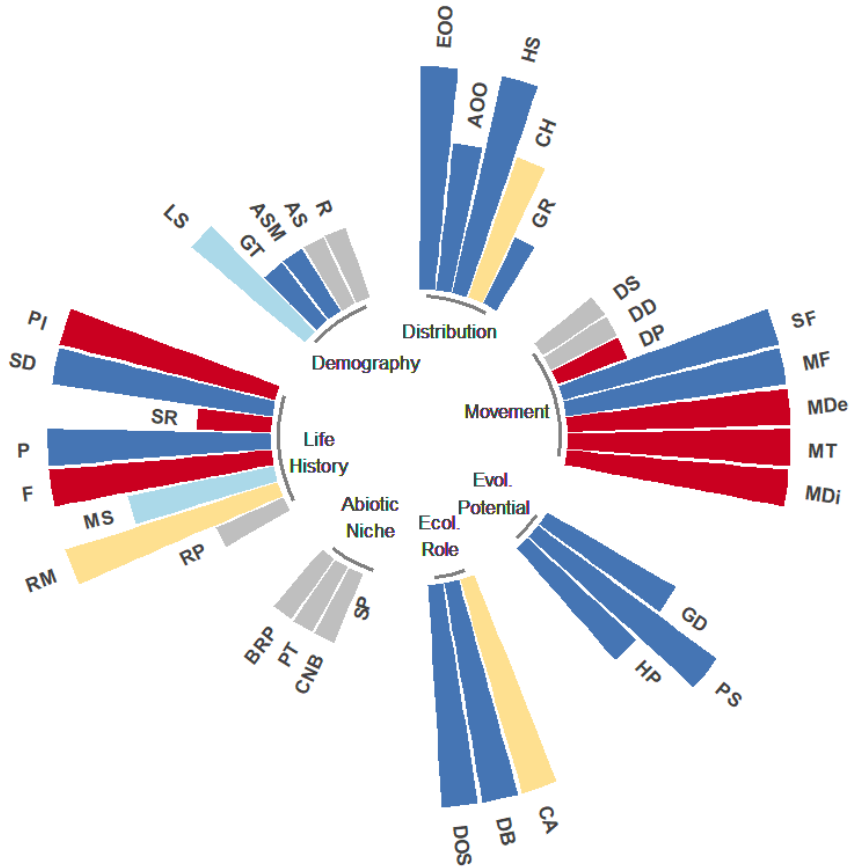
Attributes	PiP and/or SiS	Definition	Relevant taxonomic scale	Additional specifications	Level of AC			
					Low	Moderately low	Moderately high	High
						Moderate		
Extent of occurrence (EOO)	PiP and SiS	The area contained within the shortest continuous boundary that can be drawn to encompass all known, inferred, or projected sites of present occurrence of a taxon, excluding cases of vagrancy (IUCN 2012); in the case of migratory species, EOO should be based on the minimum of breeding or non-breeding areas, but not both because the bulk of the population is found in only one of these areas at any given time	Species level		< 100 km²	100–5000 km²	5000–20,000 km²	> 20,000 km²

Thurman et al (2020) https://doi.org/10.1002/fee.2253

S. Follett

Attributes	Adaptive Capacity	Additional Information/Justification	Evidence
Climatic Niche Breadth (CNB)	Unknown	Information regarding the species' climatic niche breadth is lacking, but forecasts of its future climate envelope and climate impacts are described in two studies. Illán et al (2014) correlated long-term distribution and abundance data with climatic changes for 132 bird species, including the rufous hummingbird. The authors found that precipitation was most frequently the best indicator of changes in bird populations. They cite two possible reasons for precipitation-linked decline in rufous hummingbirds: (1) less snow in the winter, which means less moisture carried into the spring and summer, and thus fewer flowers for the birds to feed on; (2) phenological mismatches between migratory timing and earlier snowmelt and spring bloom. The National Audubon Society (2015) estimates that by 2080, the rufous hummingbird is projected to lose 100% of its non-breeding range in the United States (impacts to its core winter range in Mexico are unknown because they fall outside the study area). While gains are possible to the north, the model projects that the summer range will also be disrupted and move north. See also results from Courter (2017) described in Migratory Timing.	None (or very low): Data unavailable and/or no best estimate), or high degree of variability/ uncertainty in available information





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Evidence: Low Mod High

AC
- high
- moderately high
- moderate
- low
- unknown

(no moderately-low AC traits for this species)

Priority species in the Northwest

Oregon Coast
Adaptation Partnership

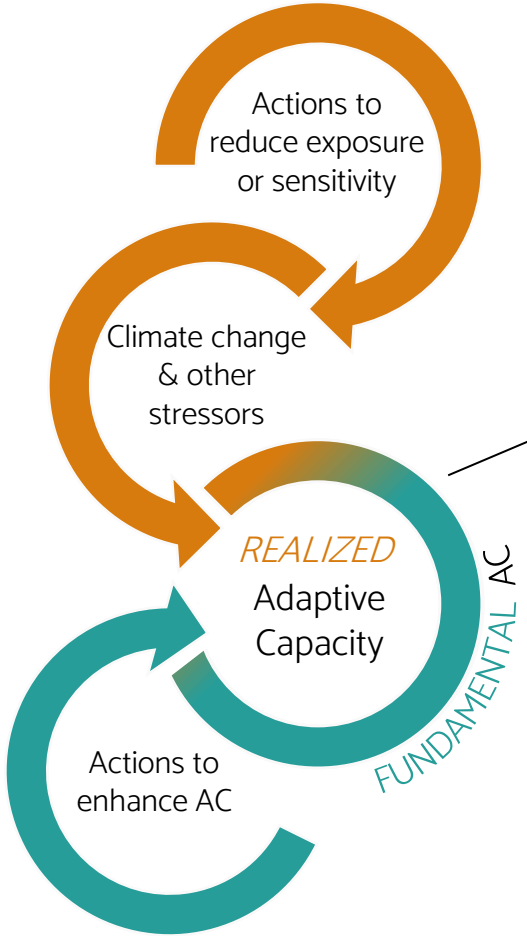
https://adaptationpartners.org/ocap/

B. Wick

Overview

Supporting the adaptive capacity of species through more effective knowledge exchange with conservation practitioners.
Cook et al (2021) *Evol Appl*
http://dx.doi.org/10.1111/eva.13266

Applying assessments of adaptive capacity to inform conservation planning in a changing climate.
Thurman et al (2021) *Conserv Biol*
https://doi.org/10.1111/cobi.13838



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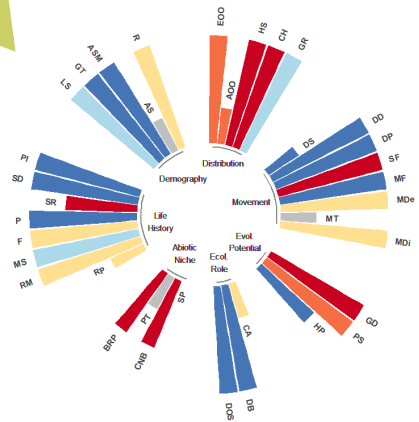
https://doi.org/10.1002/fee.2253

Connecting research and practice to enhance the evolutionary potential of species under climate change. Thompson et al in press, *Conserv Sci Prac*.

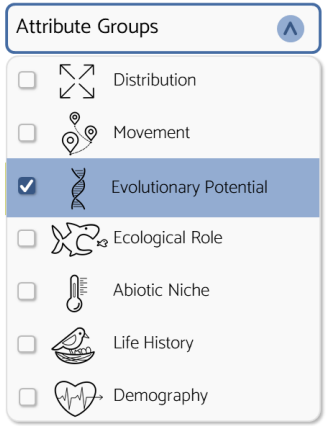
1. Inform the process (set goals)

2. Assess climate vulnerabilities (incl. adaptive capacity)



3. Evaluate implications for management goals

4. Identify and select from AC-informed adaptation menu



5. Implement action(s) and track response/ effectiveness

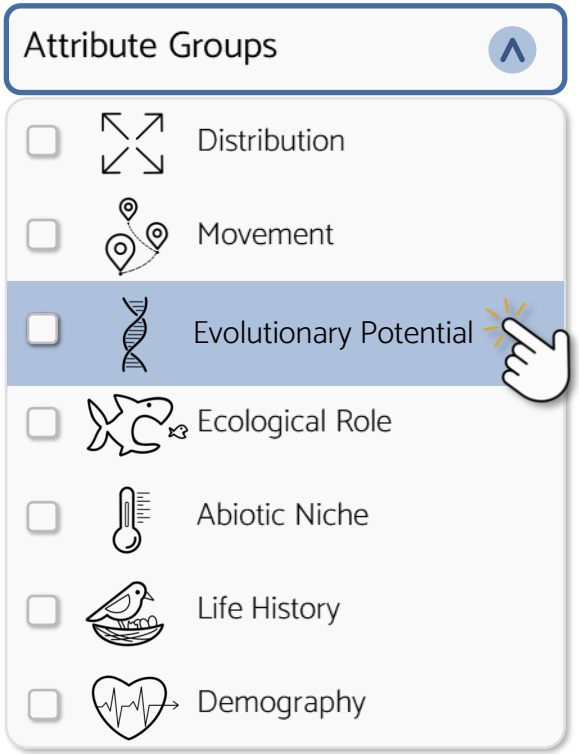
What's more likely: "persist in place" or "shift in space"?

TABLE 1 Examples of general adaptation actions for each of three potential management approaches related to reducing climate change vulnerability

Component of vulnerability	Examples of adaptive-capacity-informed adaptation actions
Directly enhance fundamental adaptive capacity	maintain or maximize genetic diversitymaintain or maximize population sizeintroduce threat-resistant genotypes through non-local or climate-adjusted provenancingsupport flexibility in behaviorsupport flexibility in resource use
Indirectly enhance adaptive capacity (i.e., enhance realized adaptive capacity) by minimizing ecological or anthropogenic constraints or stressors	assisted colonization or translocation to the leading edge of rangeprotect macro- and microclimatic refugia to support phenotypic plasticity and local adaptationprotect or enhance connectivitycontrol biotic stressors (e.g., disease and non-native competitors)ensure availability of key resources
Manage exposure or sensitivity where adaptive capacity cannot feasibly be enhanced	protect macro- and microclimatic refugia to reduce exposureartificially select for threat-resistant genotypes in sensitive speciestranslocation to reduce exposure

Thurman et al (2022) https://doi.org/10.1111/cobi.13838

AC-informed Adaptation Menu



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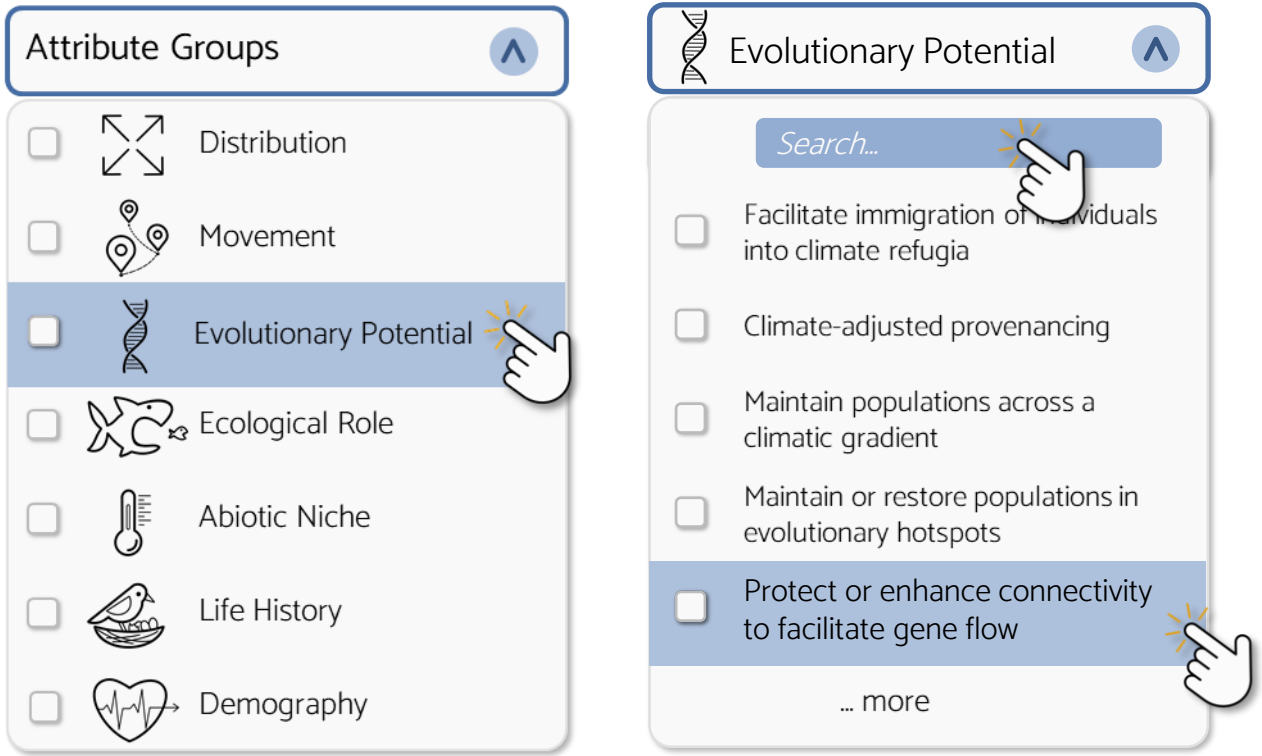
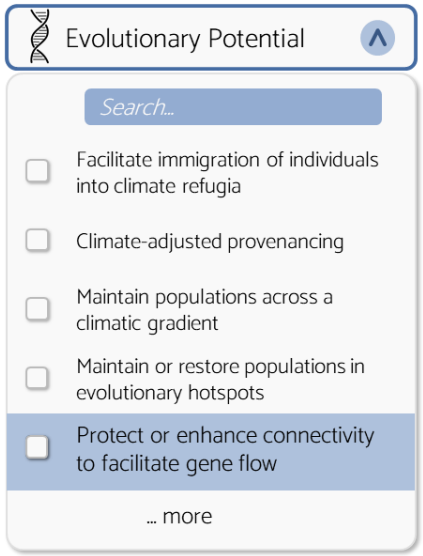
AC-informed Adaptation Menu



"Genetic diversity"

Thurman et al (2022) https://doi.org/10.1111/cobi.13838

AC-informed Adaptation Menu



Action

Protect or enhance connectivity to facilitate gene flow among populations at sites with suitable future climates through maintenance of critical connectivity pinch points, removal of movement barriers (e.g., dam removal or decommissioning roads), or installation of passages (e.g., fish ladders, road culverts, wildlife overpasses, etc.).

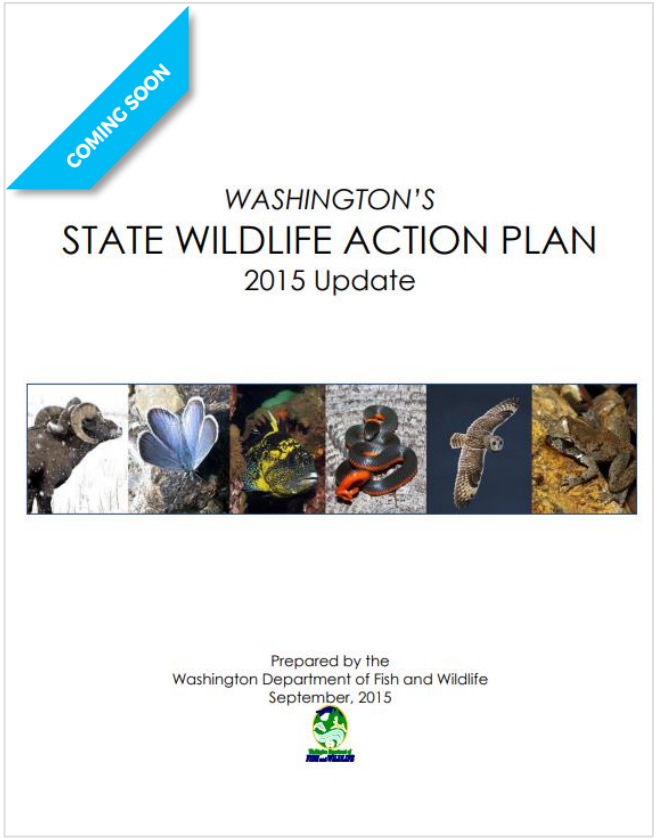
Goals

- Allow for optimal gene flow among populations and increase genetic diversity, especially across broader spatial extents and at the 'leading edge' of the species' range.
- Increase effective dispersal.
- Reduce potential for genetic drift.
- Avoid swamping local adaptation (homogenization) and minimize risk of disease transmission.
- Minimize loss of isolated populations to stochastic events.

Examples

- Low-quality habitat corridors as movement conduits for two butterfly species (Haddad & Tewksbury 2005)
- Long-term viability of Department of the Interior bison under current management and potential metapopulation management strategies (Hartway et al 2020)
- Pacific lamprey recolonization of a Pacific Northwest river following dam removal (Jolley et al 2018)

Thurman et al (2022) https://doi.org/10.1111/cobi.13838



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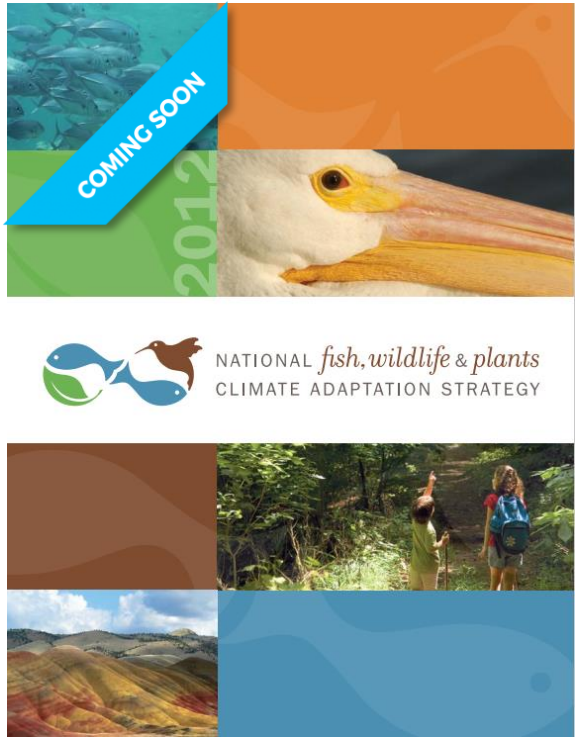
USFWS Grassland Ecosystem Team
Climate Adaptation Training
Jan. 24-25, 2023



Linking Adaptive Capacity to Species Status Assessments

Version 1.0, September 2021

This resource was prepared by U.S. Fish and Wildlife Service (Service) and U.S. Geological Survey staff as an internal job aid for Service species status assessment (SSA) practitioners. It provides answers to frequently asked questions and best practices for applying the concept of adaptive capacity into SSAs. This resource may be updated over time as new information becomes available and we learn from our experiences.

An SSA is a biological risk assessment that describes a species' viability, that is, its ability to maintain populations in the wild over time. To assess viability of species in SSAs, we use the conservation-biology principles of the 3Rs - resiliency, redundancy, and representation (Shaffer and Stein 2000, pp. 308-311). *Resiliency* is the ability of a species to withstand environmental stochasticity, periodic disturbances within the normal range of variation, and demographic stochasticity. *Redundancy* is the ability of a species to withstand catastrophes. *Representation* is the ability of a species to adapt to both near-term and long-term changes in its physical and biological environments (see The 3Rs Defined document for full working definitions). The purpose of this document is to describe the relationship between adaptive capacity and representation and provide a framework for assessing representation in SSAs.

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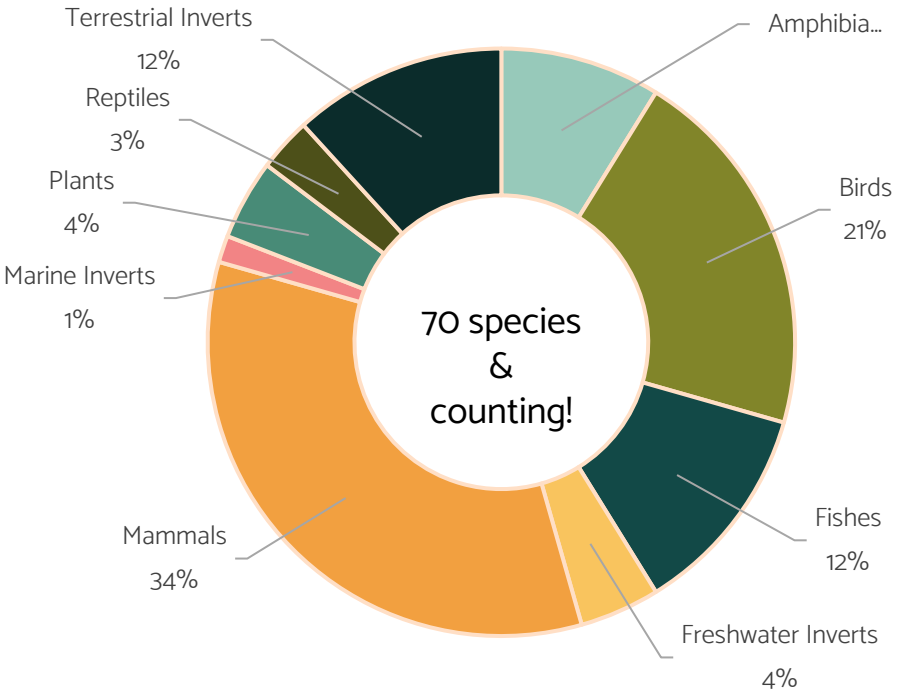

C. Cousins

Please contact me for training or other guidance!

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