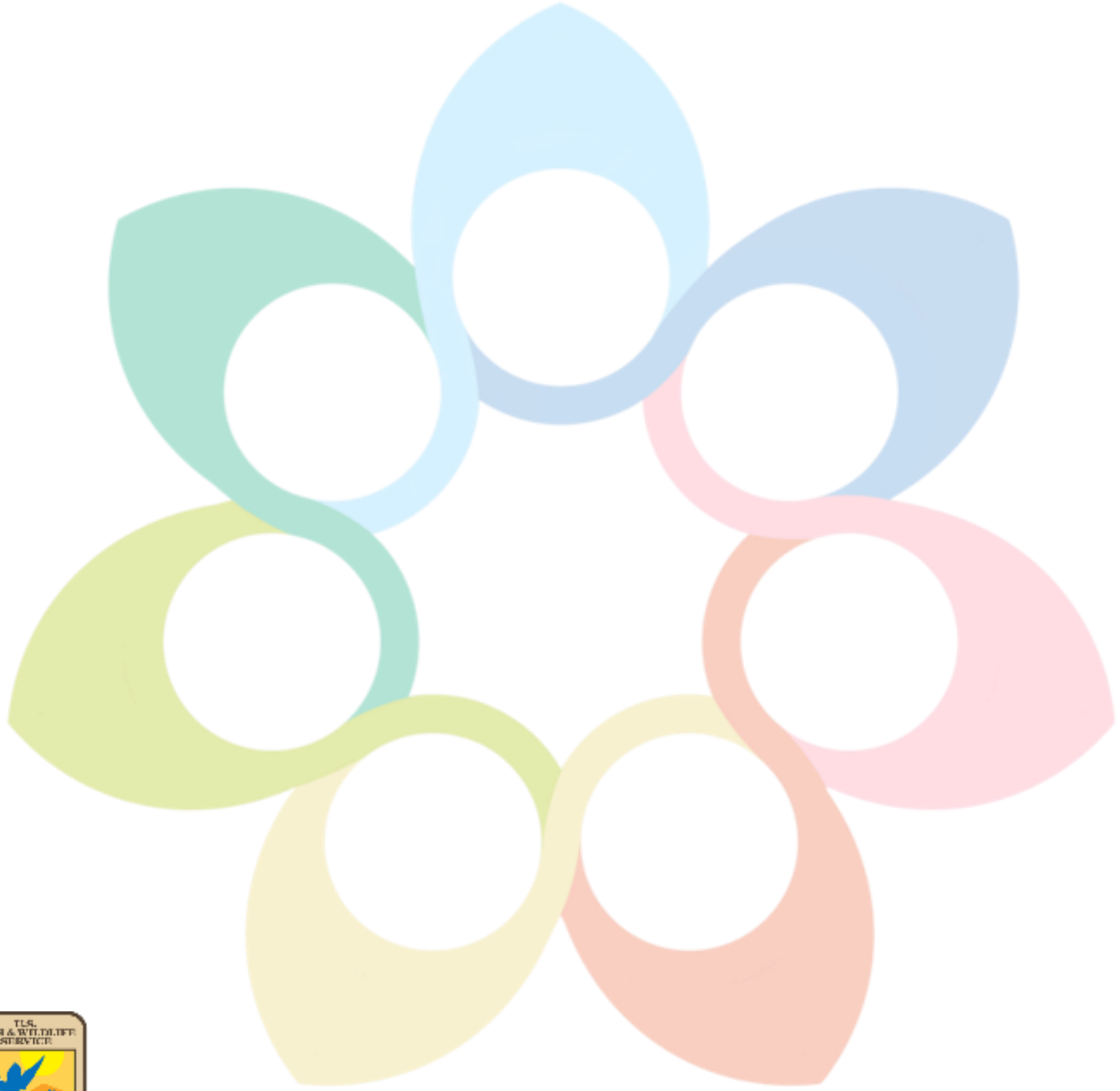
Organizing the Climate Adaptation Toolkit

Brian Miller, USGS North Central Climate Adaptation Science Center

Gregor Schuurman, NPS Climate Change Response Program

D. Todd Jones-Farrand, USFWS Natural Resource Program Center



U.S. Department of the Interior
U.S. Geological Survey

USGS science for a changing world

FRONTIERS IN ECOLOGY and the ENVIRONMENT

Concepts and Questions | Open Access

Toward a shared vision for climate-informed resource stewardship

Brian W Miller, Gregor W Schuurman, Wylie Carr, David J Lawrence, Lindsey L Thurman, Aparna Bamzai-Dodson, Leslie A Brandt, Shelley D Crausbay, Molly S Cross, Mitchell J Eaton, Maria K Janowiak, D Todd Jones-Farrand, Julian Reyes ... See fewer authors

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“Natural resource managers and conservation practitioners are working in a world very different from that in which most agencies and management traditions formed…”

Slide adapted from G. Schuurman

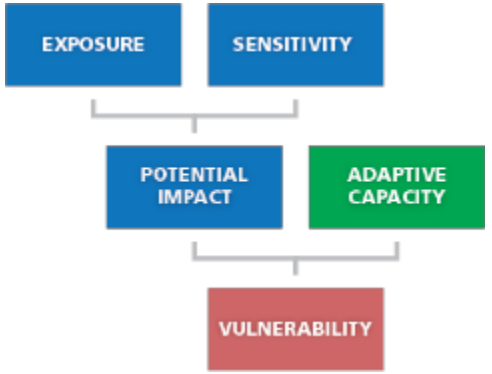
Schuurman et al. 2022. BioScience.

"Natural resource managers and conservation practitioners are working in a world very different from that in which most agencies and management traditions formed, and non-stationarity places a manager in a *terra incognita* in which tools and assumptions from the past are increasingly unhelpful and new approaches to address novel climatic and ecological circumstances are urgently needed…"

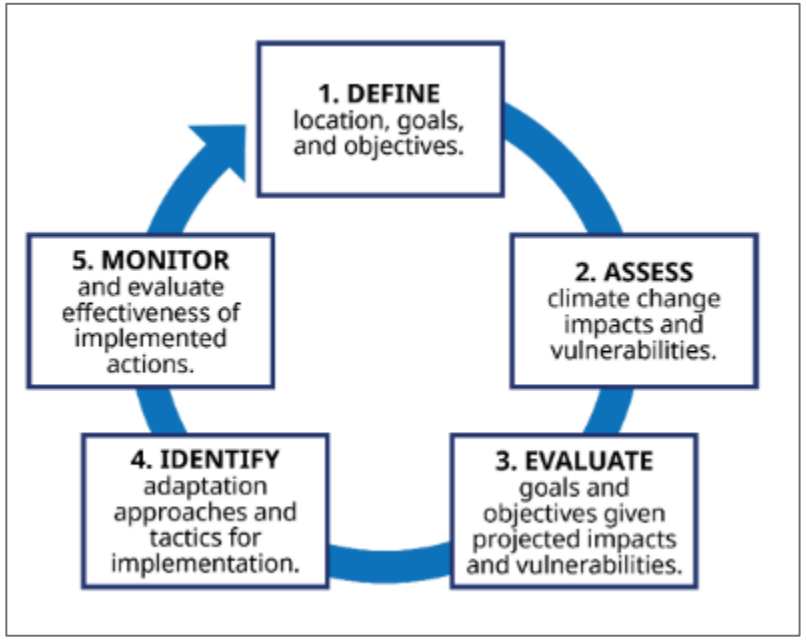
Slide adapted from G. Schuurman

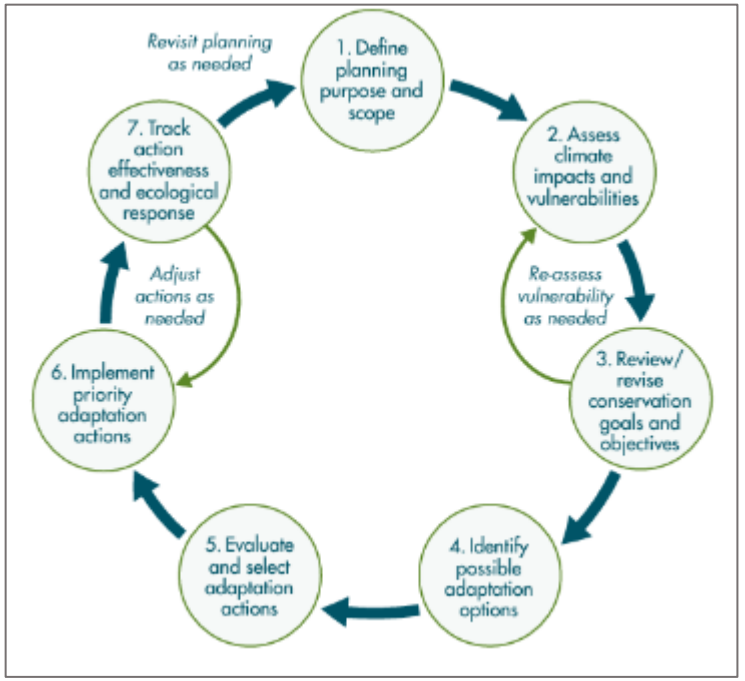
Schuurman et al. 2022. BioScience.

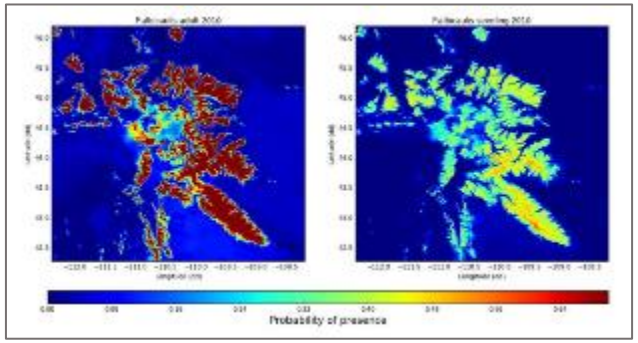
Vulnerability Assessments

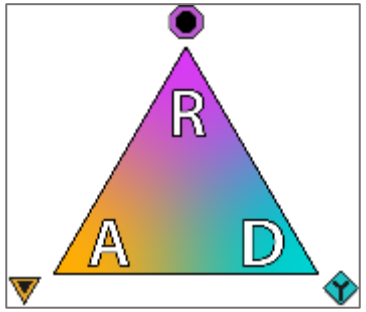


Climate Change Scenario Planning

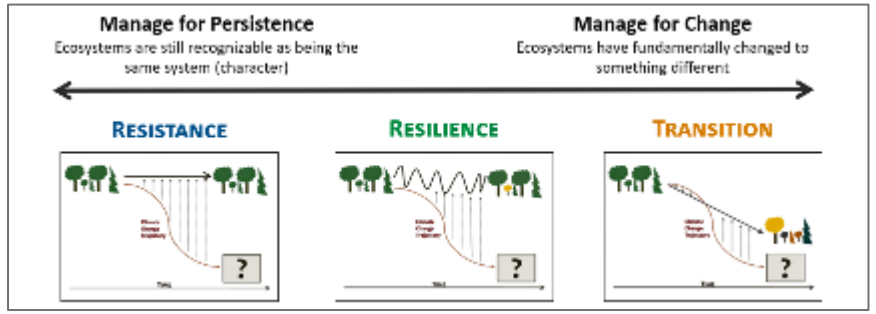


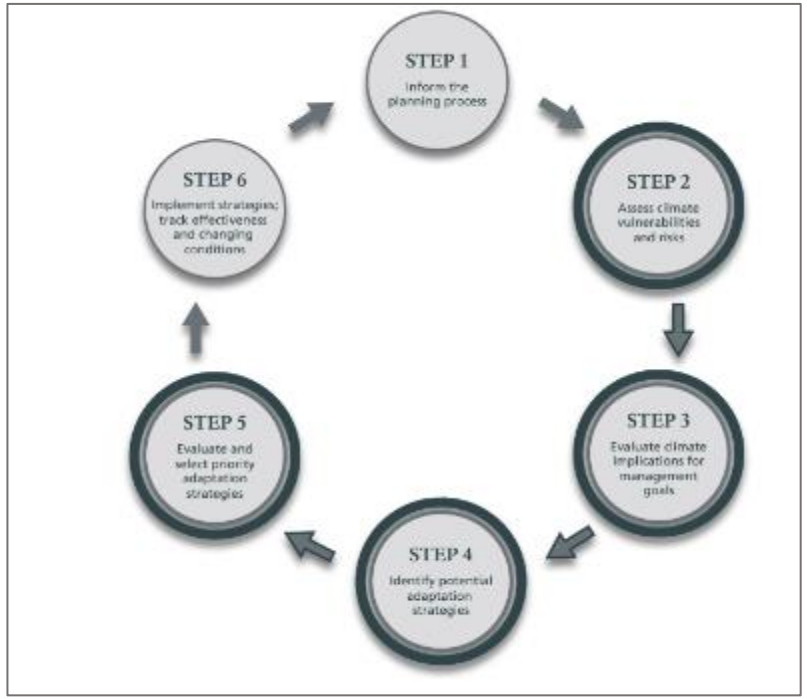






Structured Decision Making



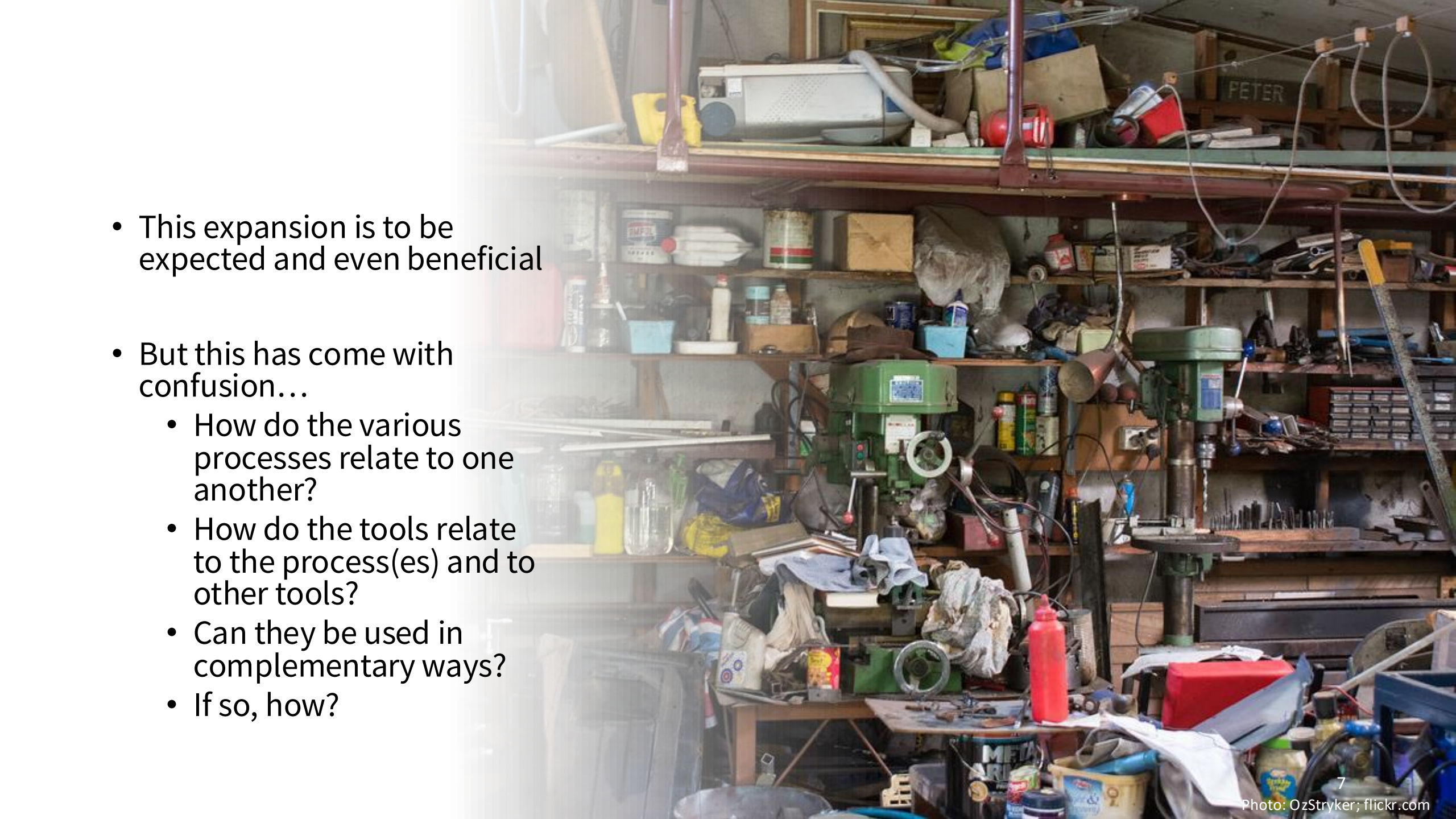


- This expansion is to be expected and even beneficial

Photo: OzStryker; flickr.com

- This expansion is to be expected and even beneficial

- But this has come with confusion…
  - How do the various processes relate to one another?
  - How do the tools relate to the process(es) and to other tools?
  - Can they be used in complementary ways?
  - If so, how?



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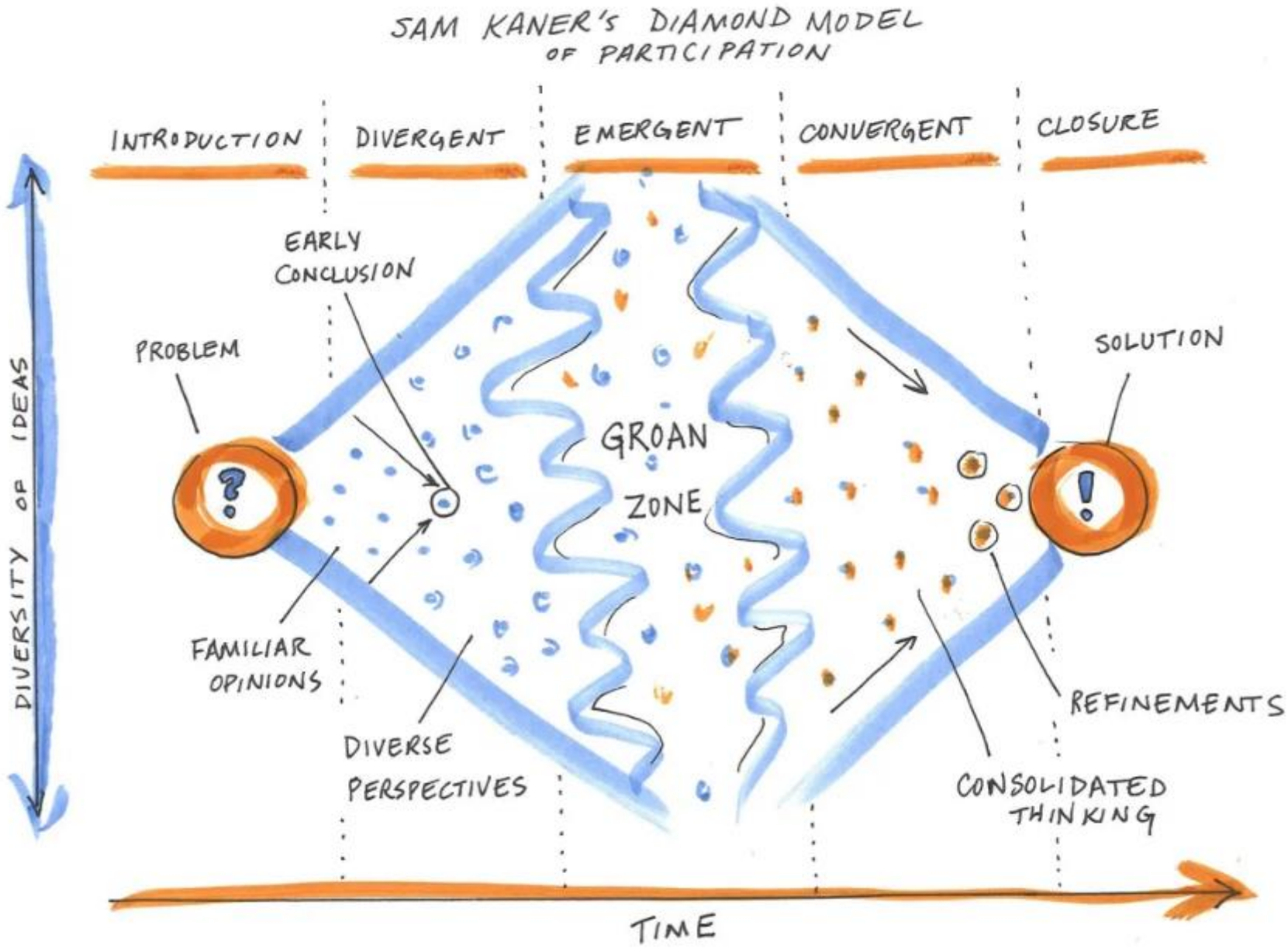

Figure credit: Kappel, C. (2019, May 28). Collaboration: From groan zone to growth zone. https://i2insights.org/2019/05/28/collaboration-groan-zone/. Adapted from: Kaner, S. (2014). *Facilitator's guide to participatory decision-making*. John Wiley & Sons.

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(1) clear communication among scientists, adaptation practitioners, resource managers, stakeholders, and rights-holders;

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(3) cross-jurisdictional collaboration

Photo: https://amyblaschka.substack.com/p/inconceivable

Table 1. Terms and operational definitions

Term	Definition
Adaptation	"Preparing for and managing change" (Stein *et al.* 2013)
Approach	Application of general and flexible principles toward a particular purpose
Implication	Anticipated positive or negative effect of climate change and related stressors on a resource
Planning process	A systematic and consistent series of steps for developing and implementing a plan
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Traditional framing

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Prefabricated

Photo: blokmodular.com

3D printing

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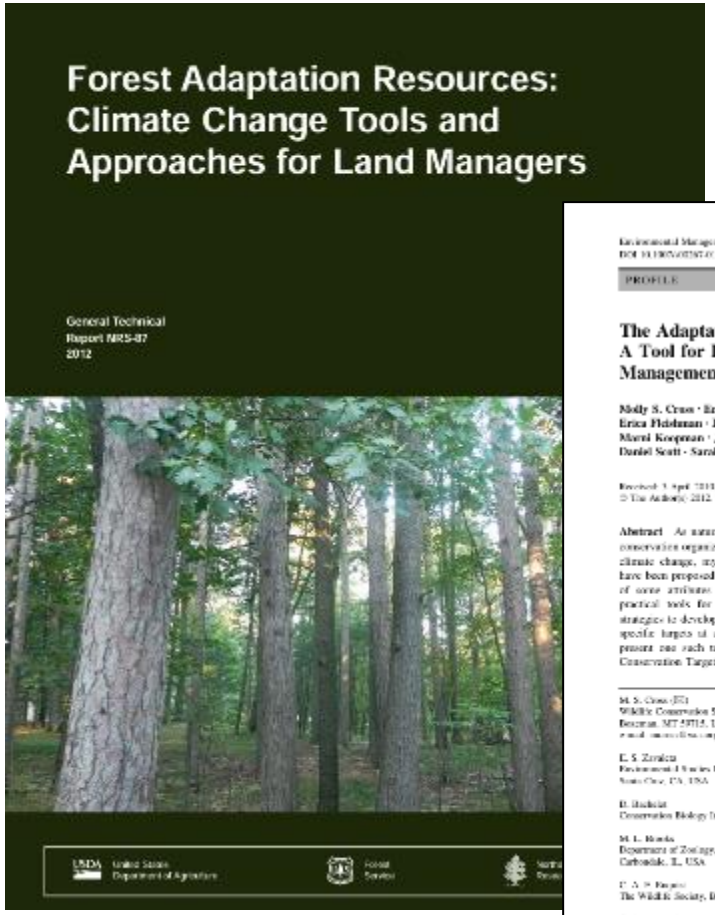
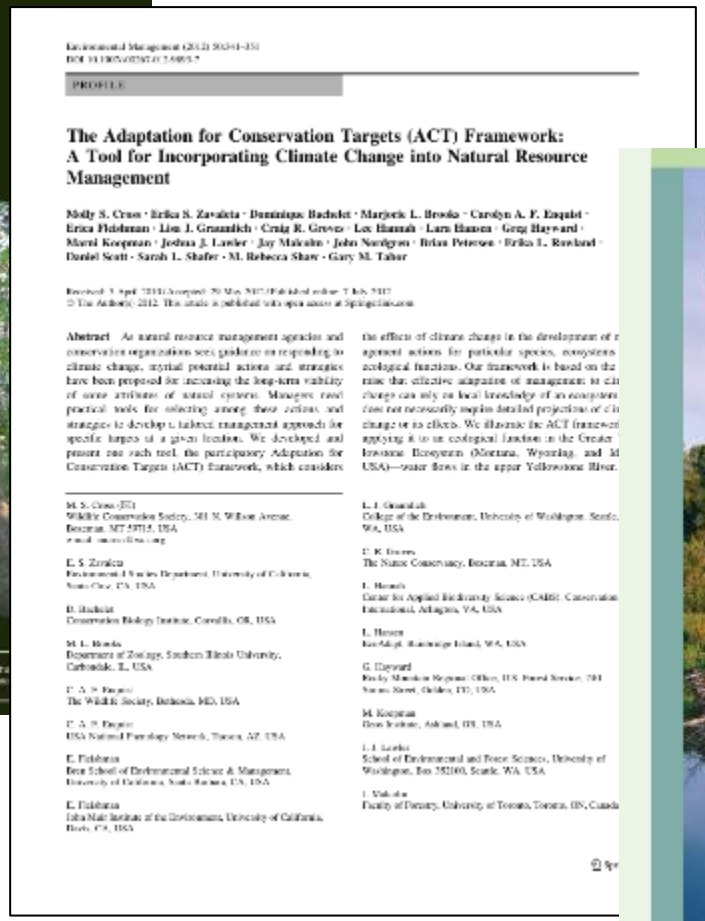
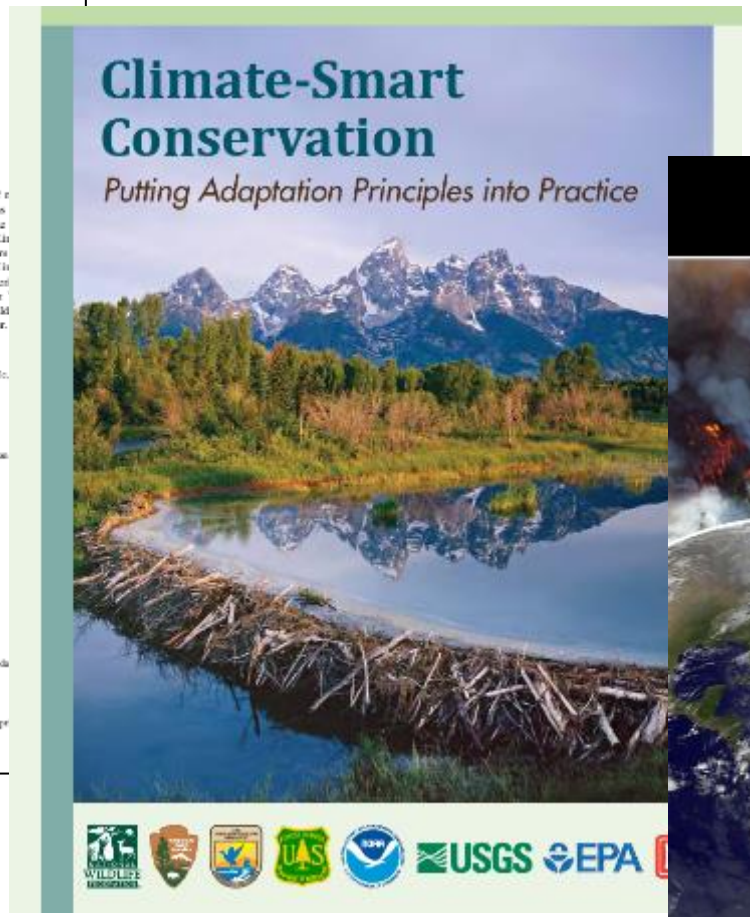

Forest Adaptation Resources:
Climate Change Tools and
Approaches for Land Managers
General Technical
Report NRS-87
2012
USDA United States
Department of Agriculture
Forest
Service


PROFILE
The Adaptation for Conservation Targets (ACT) Framework:
A Tool for Incorporating Climate Change into Natural Resource
Management
Abstract


Climate-Smart
Conservation
Putting Adaptation Principles into Practice
USGS
EPA


National Park Service
U.S. Department of the Interior
Planning for a Changing Climate
Climate-Smart Planning and Management in the National Park Service

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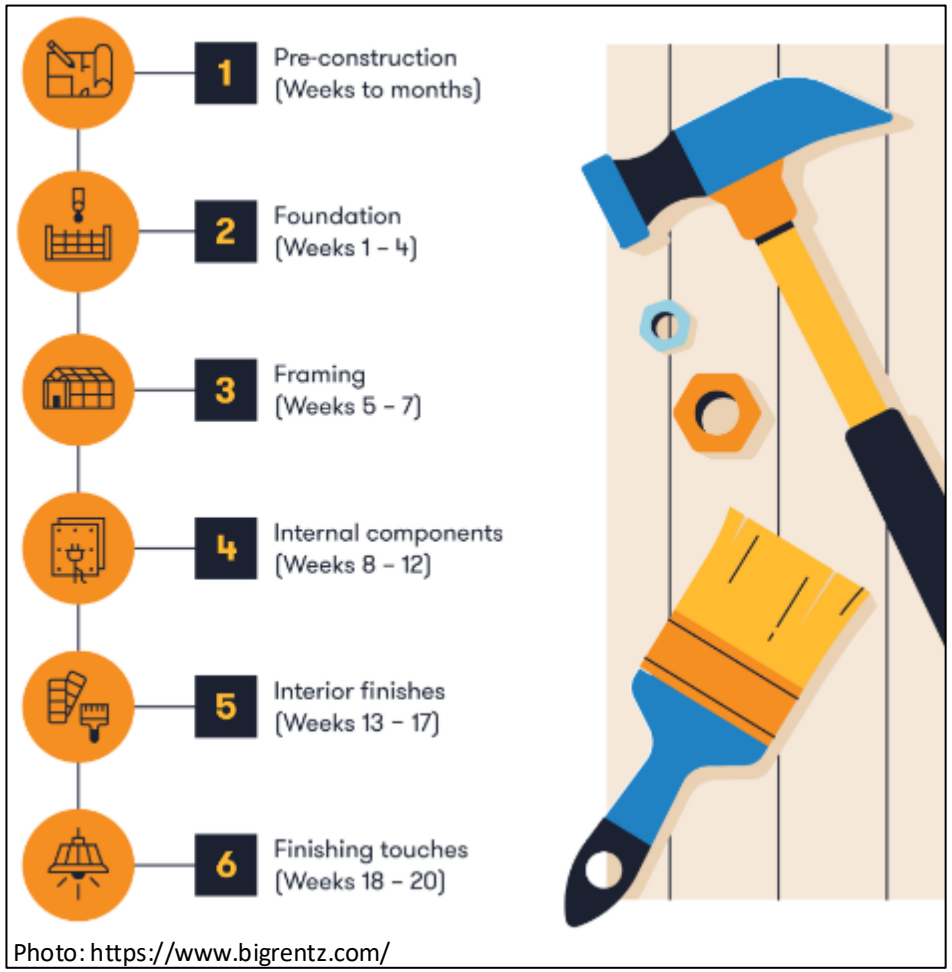

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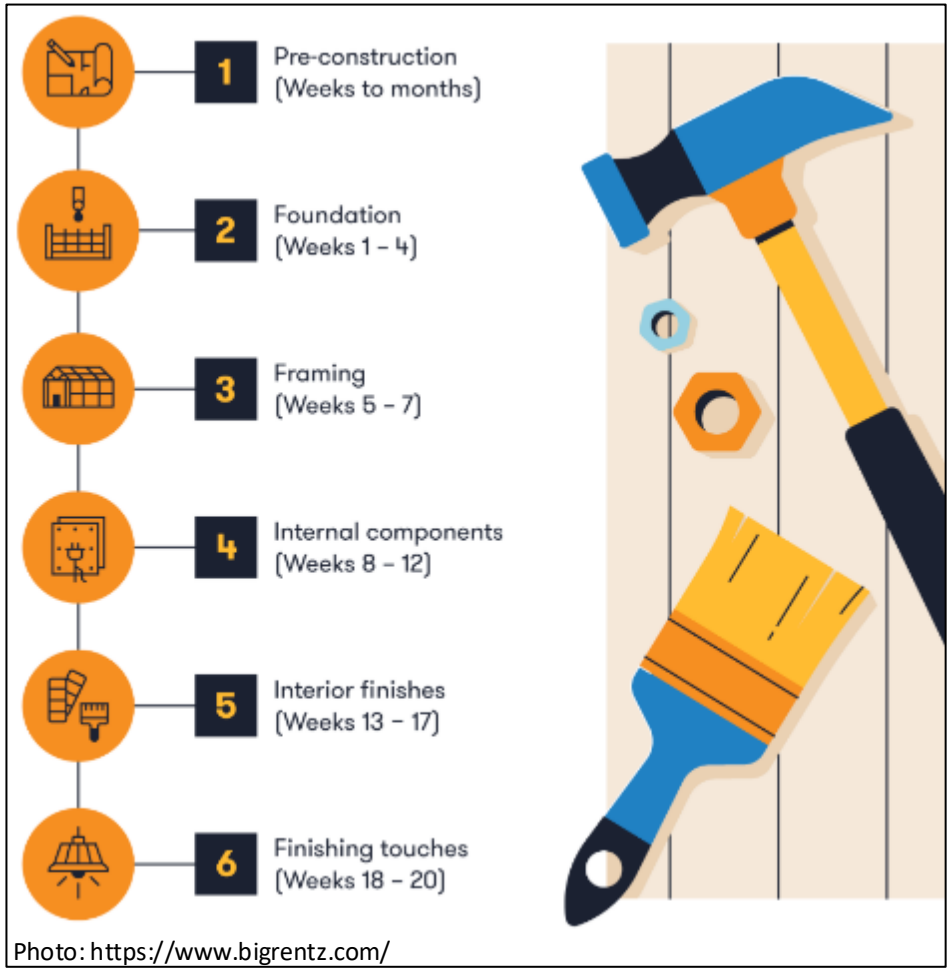

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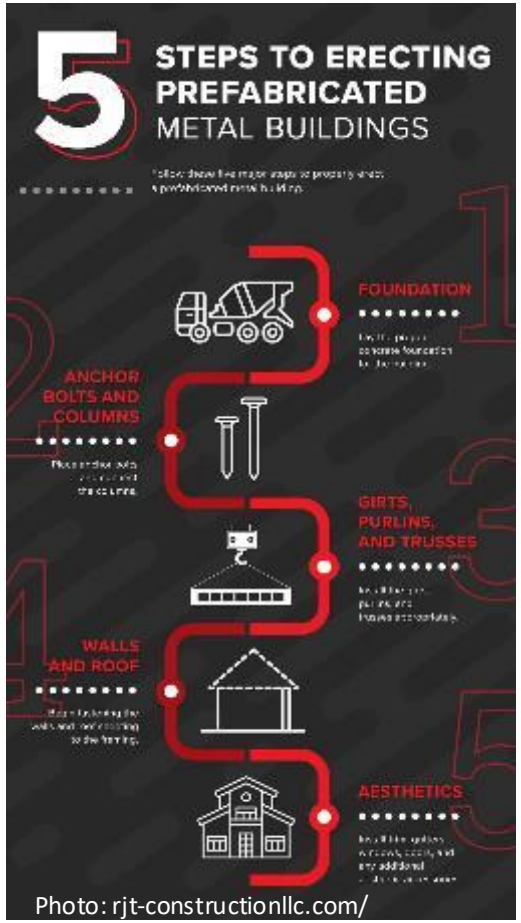

Photo: rjt-constructionllc.com/


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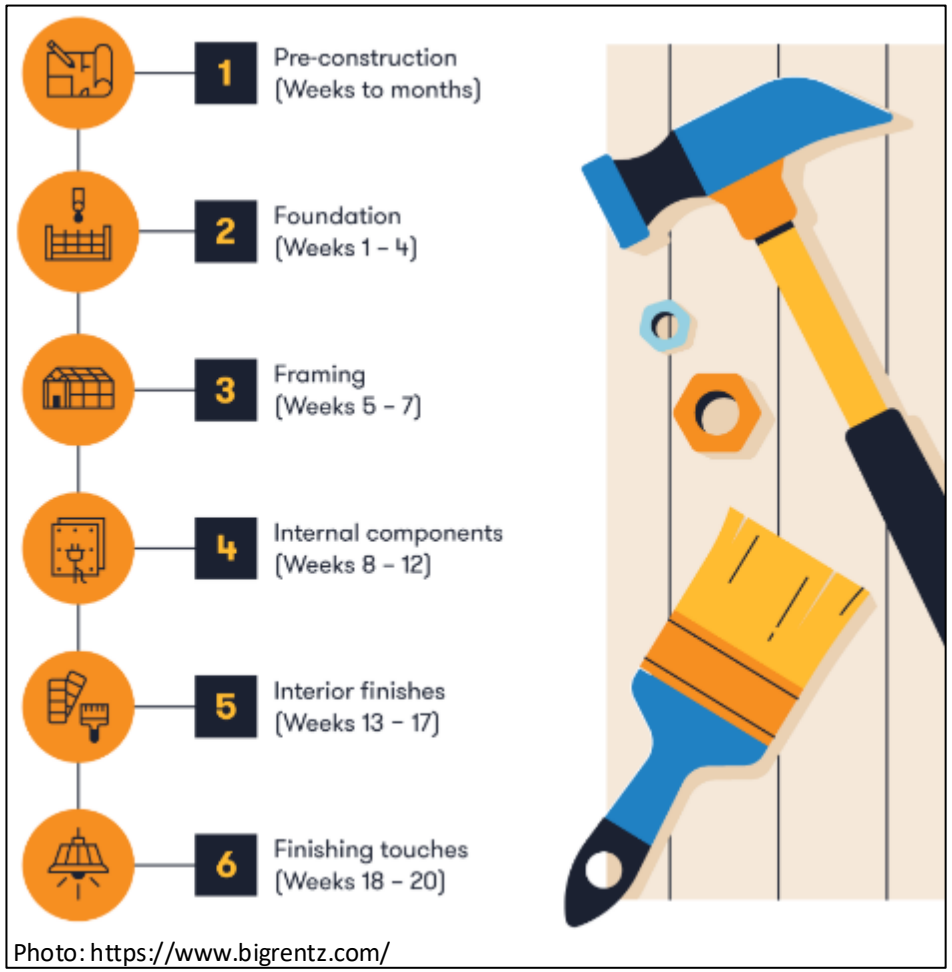

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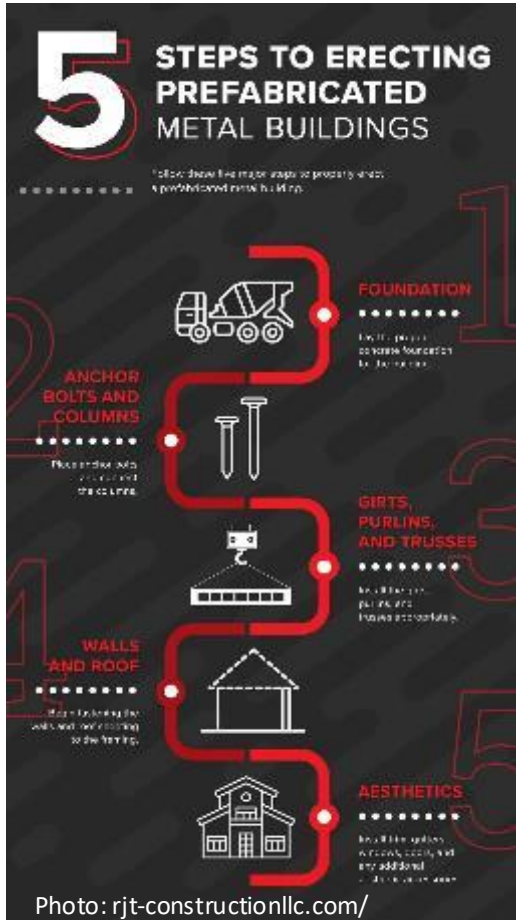

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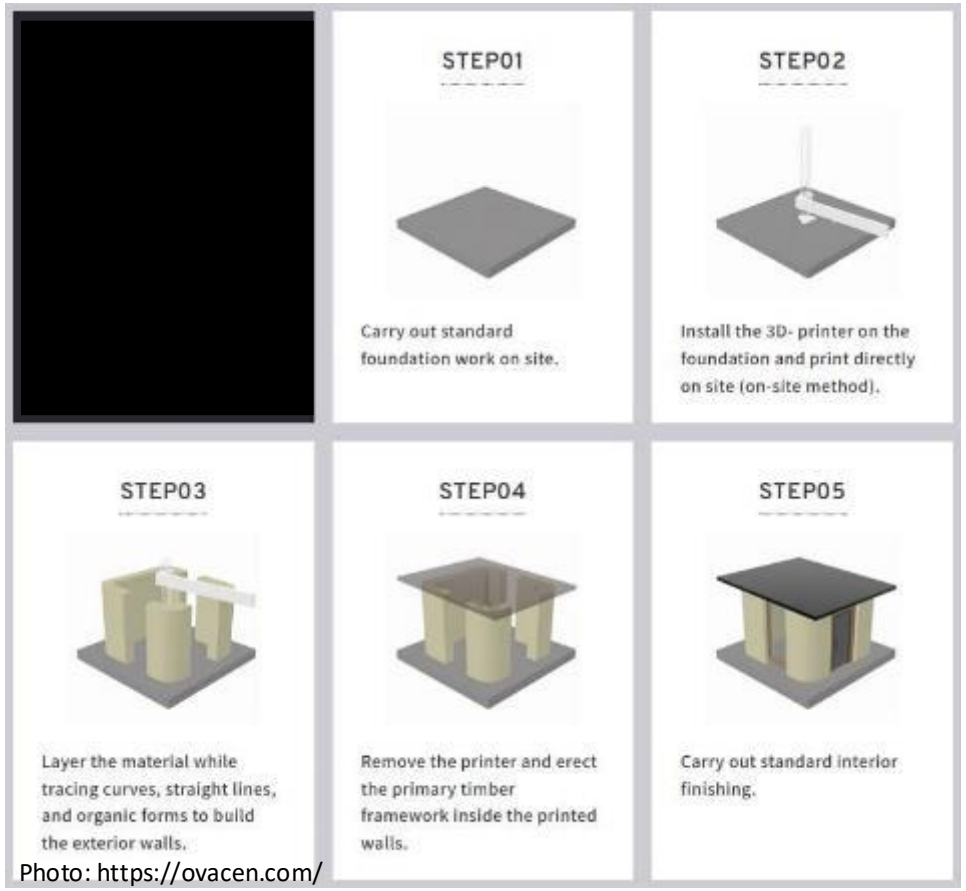

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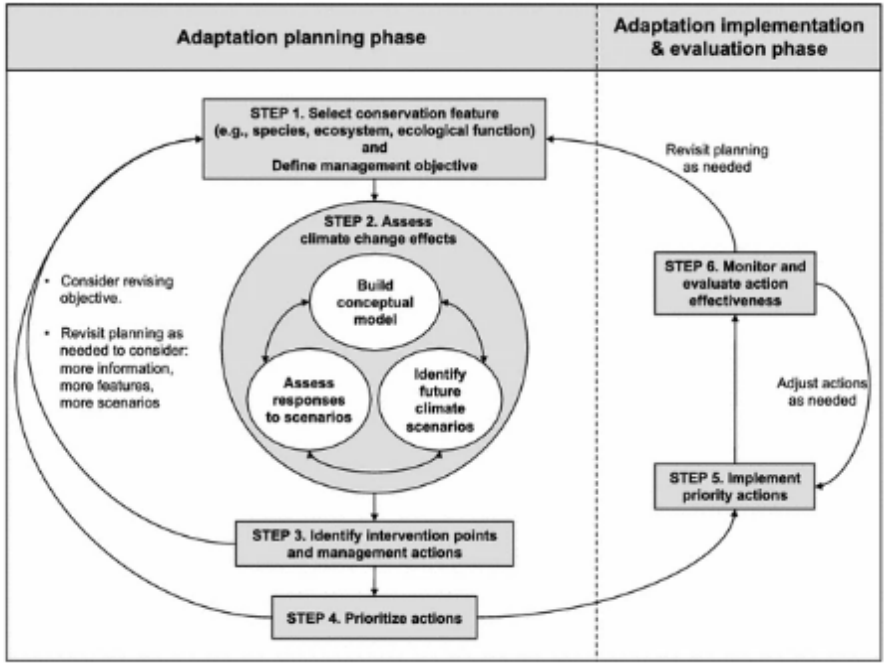
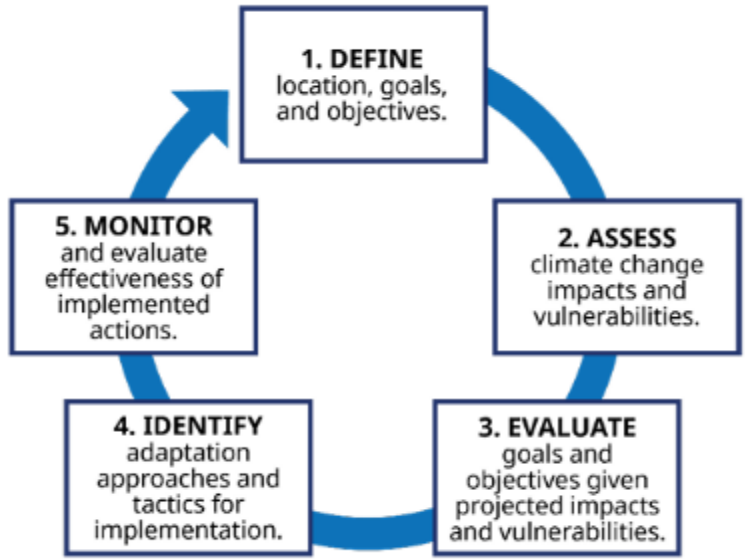
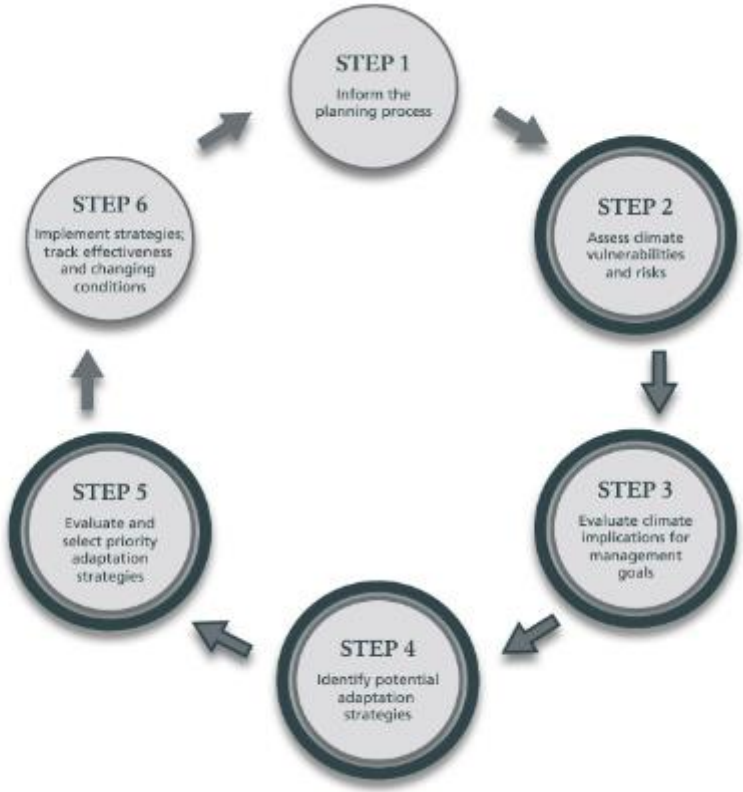
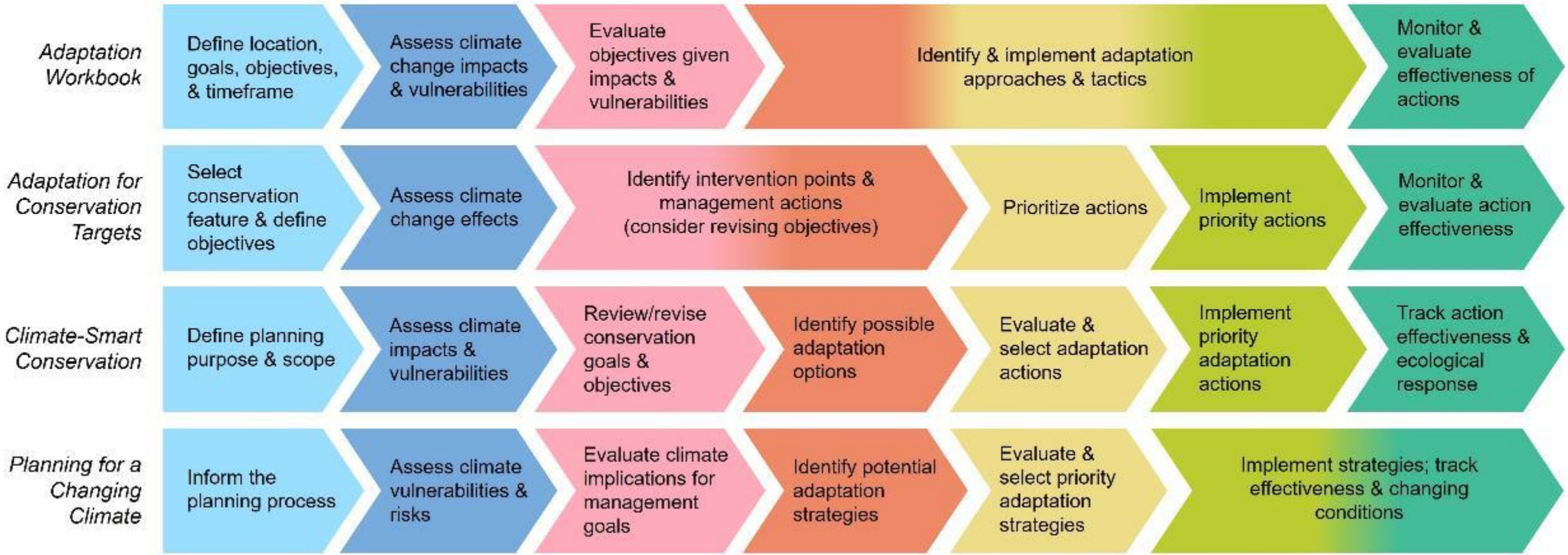
Photo: Alfredo Milano commons.wikimedia.org/


Adaptation planning phase
Adaptation implementation & evaluation phase
STEP 1. Select conservation feature (e.g., species, ecosystem, ecological function) and Define management objective
STEP 2. Assess climate change effects
Build conceptual model
Assess responses to scenarios
Identify future climate scenarios
Consider revising objective.
Revisit planning as needed to consider: more information, more features, more scenarios
STEP 3. Identify intervention points and management actions
STEP 4. Prioritize actions
STEP 5. Implement priority actions
STEP 6. Monitor and evaluate action effectiveness
Revisit planning as needed
Adjust actions as needed


1. Define planning purpose and scope
2. Assess climate impacts and vulnerabilities
3. Review/ revise conservation goals and objectives
4. Identify possible adaptation options
5. Evaluate and select adaptation actions
6. Implement priority adaptation actions
7. Track action effectiveness and ecological response
Revisit planning as needed
Re-assess vulnerability as needed
Adjust actions as needed


1. DEFINE location, goals, and objectives.
2. ASSESS climate change impacts and vulnerabilities.
3. EVALUATE goals and objectives given projected impacts and vulnerabilities.
4. IDENTIFY adaptation approaches and tactics for implementation.
5. MONITOR and evaluate effectiveness of implemented actions.


STEP 1
Inform the planning process
STEP 2
Assess climate vulnerabilities and risks
STEP 3
Evaluate climate implications for management goals
STEP 4
Identify potential adaptation strategies
STEP 5
Evaluate and select priority adaptation strategies
STEP 6
Implement strategies; track effectiveness and changing conditions


Adaptation Workbook
Define location, goals, objectives, & timeframe
Assess climate change impacts & vulnerabilities
Evaluate objectives given impacts & vulnerabilities
Identify & implement adaptation approaches & tactics
Monitor & evaluate effectiveness of actions
Adaptation for Conservation Targets
Select conservation feature & define objectives
Assess climate change effects
Identify intervention points & management actions (consider revising objectives)
Prioritize actions
Implement priority actions
Monitor & evaluate action effectiveness
Climate-Smart Conservation
Define planning purpose & scope
Assess climate impacts & vulnerabilities
Review/revise conservation goals & objectives
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Implement priority adaptation actions
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Planning for a Changing Climate
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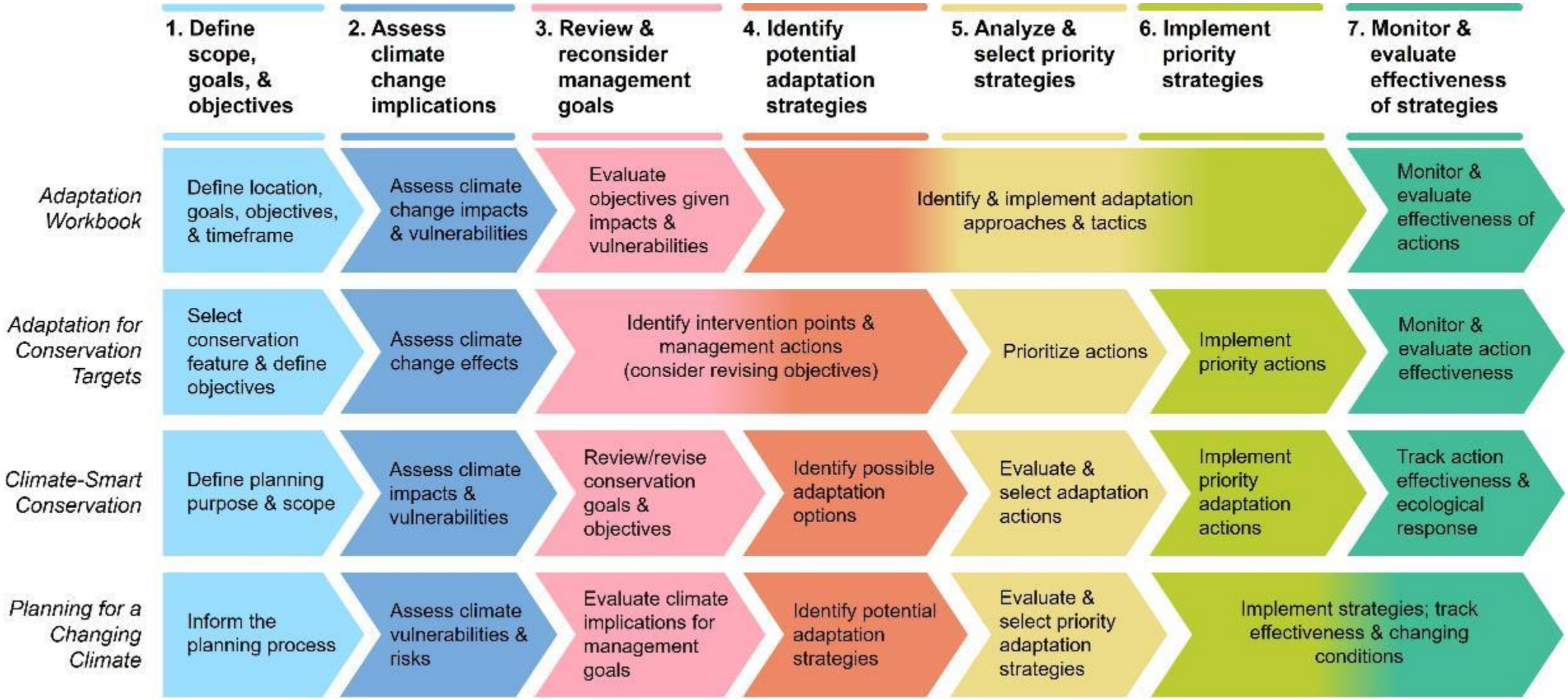
1. Define scope, goals, & objectives
2. Assess climate change implications
3. Review & reconsider management goals
4. Identify potential adaptation strategies
5. Analyze & select priority strategies
6. Implement priority strategies
7. Monitor & evaluate effectiveness of strategies
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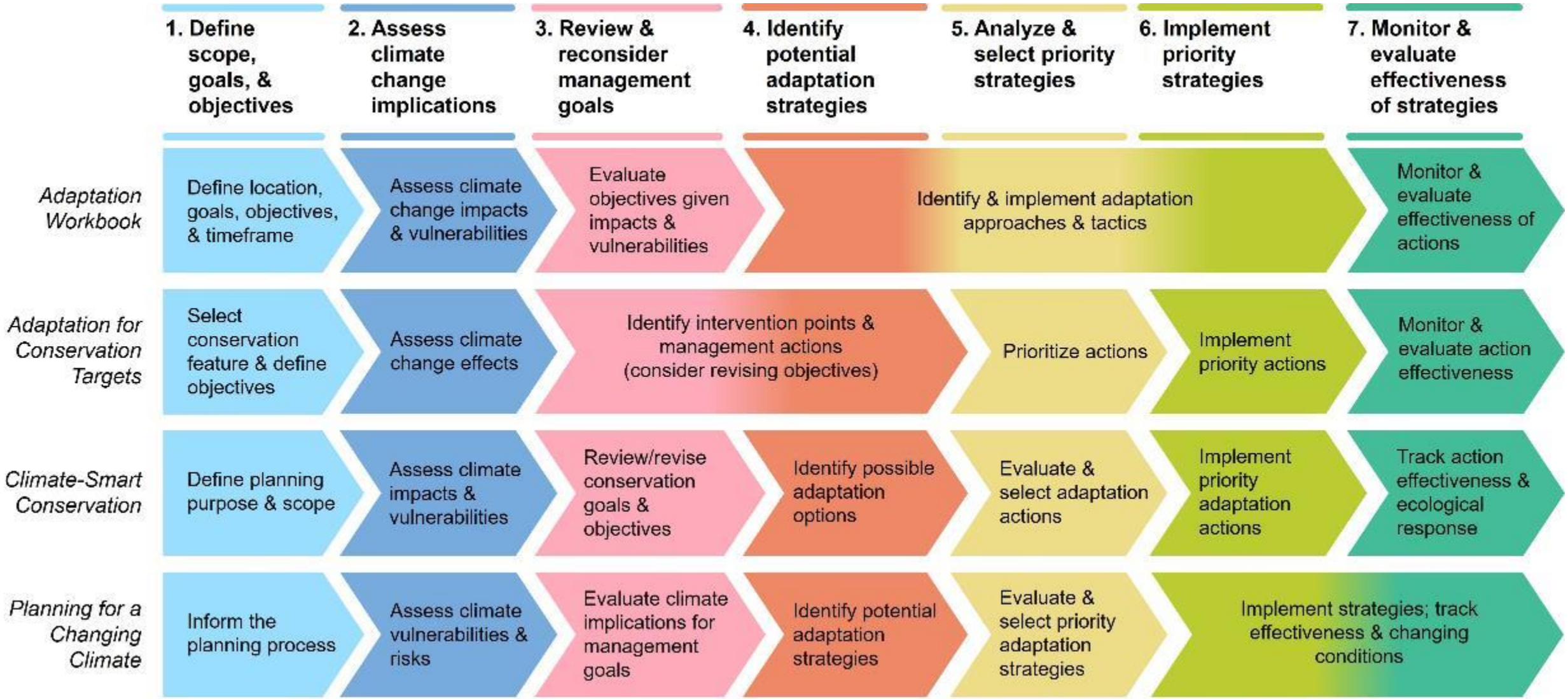
Photo: www.pickpik.com/

Table 2. Prevailing climate-change adaptation tools

Tool	Description
Adaptation menu	Set of previously developed strategies and actions that help practitioners consider a range of options and develop a portfolio or suite of strategies for a given area (Swanston *et al.* 2016)
Climate Change Scenario Planning (CCSP)	Development of a manageable set of divergent, challenging, relevant, and plausible descriptions of how climate may change and affect resources and of a plan to address such effects (Miller *et al.* 2022)
Climate change vulnerability assessment (CCVA)	Evaluation of resource exposure, sensitivity, and (for living resources) adaptive capacity in response to changes in climate (Glick *et al.* 2011; Thurman *et al.* 2020)
Impact evaluation	Understanding the effects of adaptation strategies and how effectiveness may be influenced by site-specific characteristics (Stem *et al.* 2005; Hansen *et al.* 2023); also referred to as "effectiveness evaluation"
Management action	Activities (including cessation of past practice) undertaken to influence the condition of a resource
Resist–Accept–Direct (RAD)	A conceptual framework that defines the general range of adaptation response options, including resisting ecological change, accepting it, or directing it toward new conditions (Schuurman *et al.* 2020, 2022; Lynch *et al.* 2021)
Resistance–Resilience–Transition (RRT)	A conceptual framework that defines the general range of adaptation response options, including resisting ecological change, fostering resilience (enhancing an ecosystem's ability to return to prior conditions following disturbance), or facilitating transition to new ecological conditions (Swanston *et al.* 2016)
Response modeling	Building an understanding of how specific climate drivers affect a resource
Scenario-Based Decision Analysis (SBDA)	Defining resource management problems and solutions while evaluating the influence of potential uncertainties (Miller *et al.* 2023)
Structured Decision Making (SDM)	Framing resource management problems, setting objectives, and analyzing and selecting management strategies (Runge *et al.* 2020)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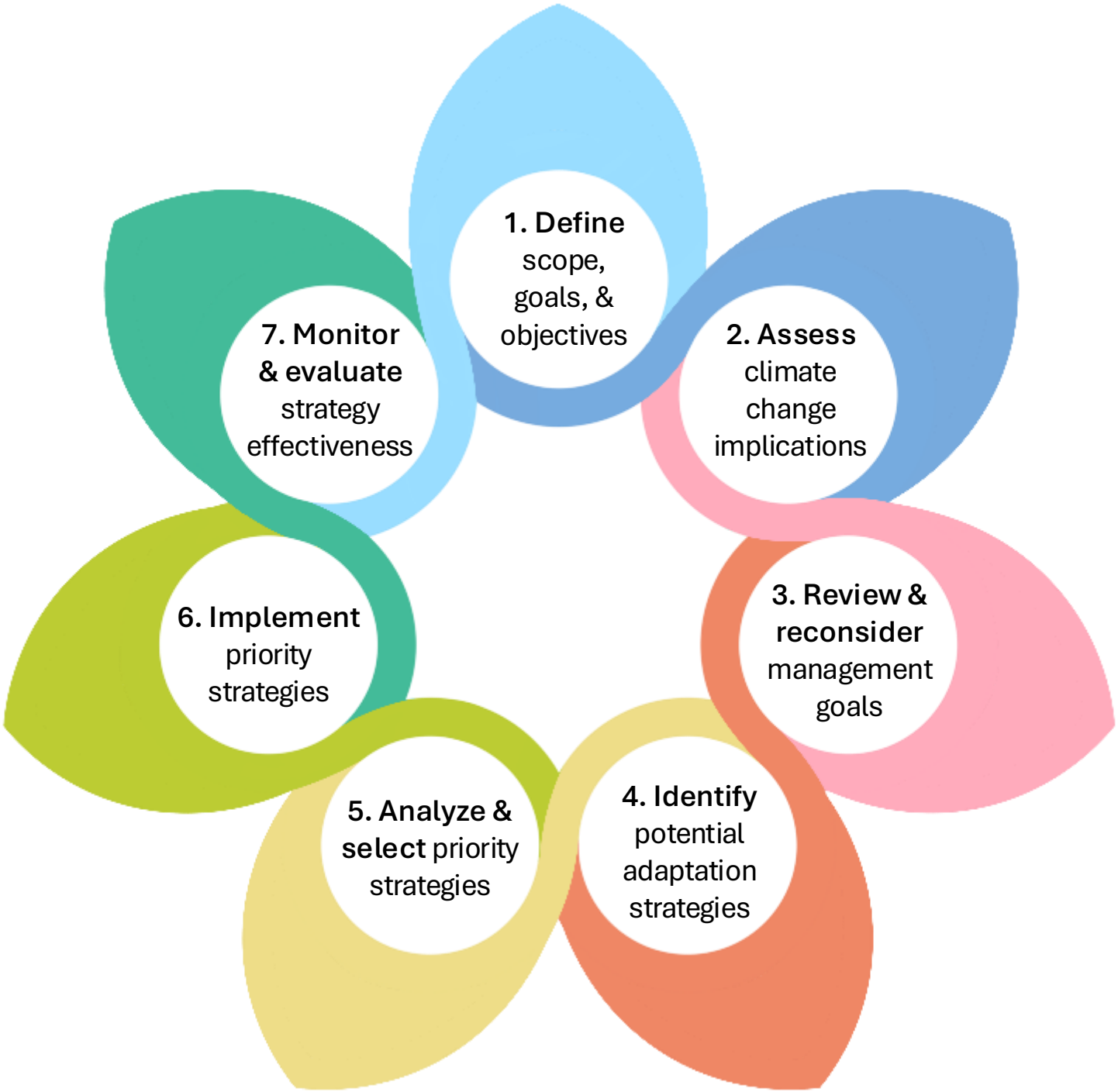
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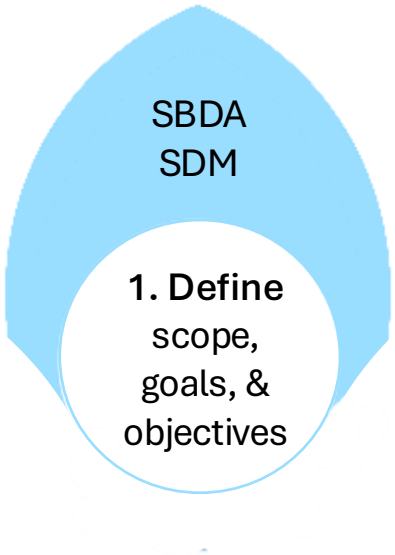
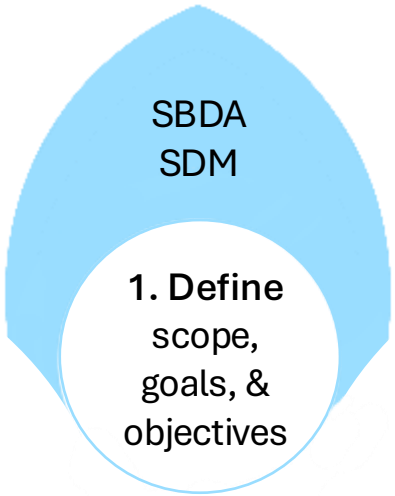


Legend

SDM = Structured Decision Making
SBDA = Scenario-Based Decision Analysis



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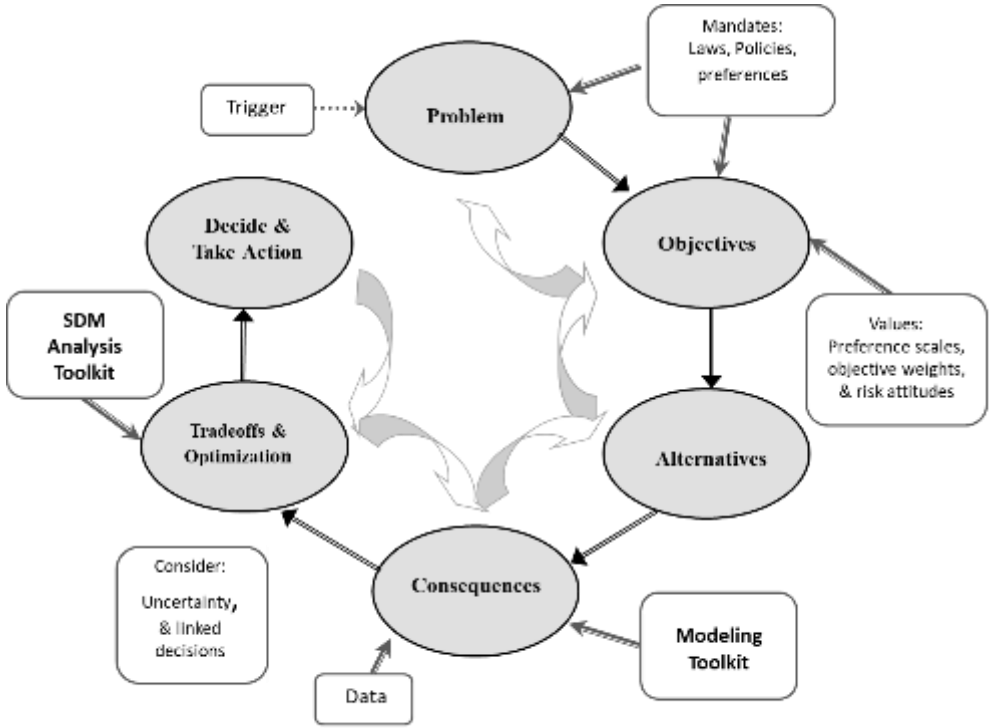
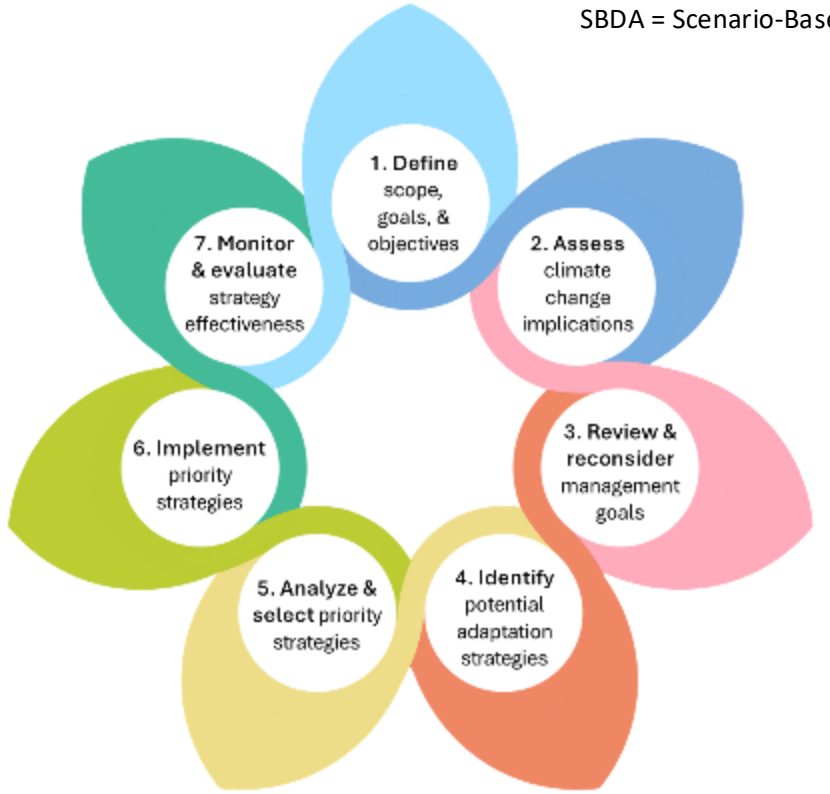
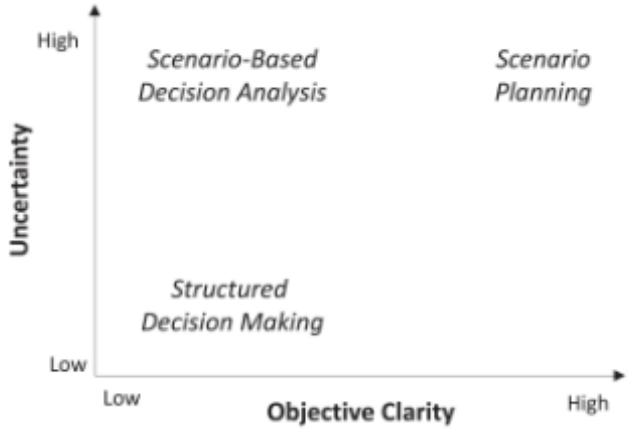
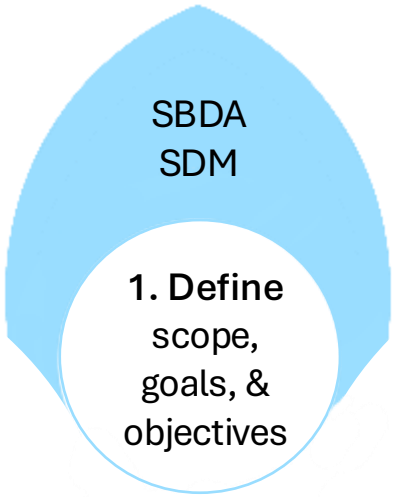


Source: Jean Fitts Cochrane







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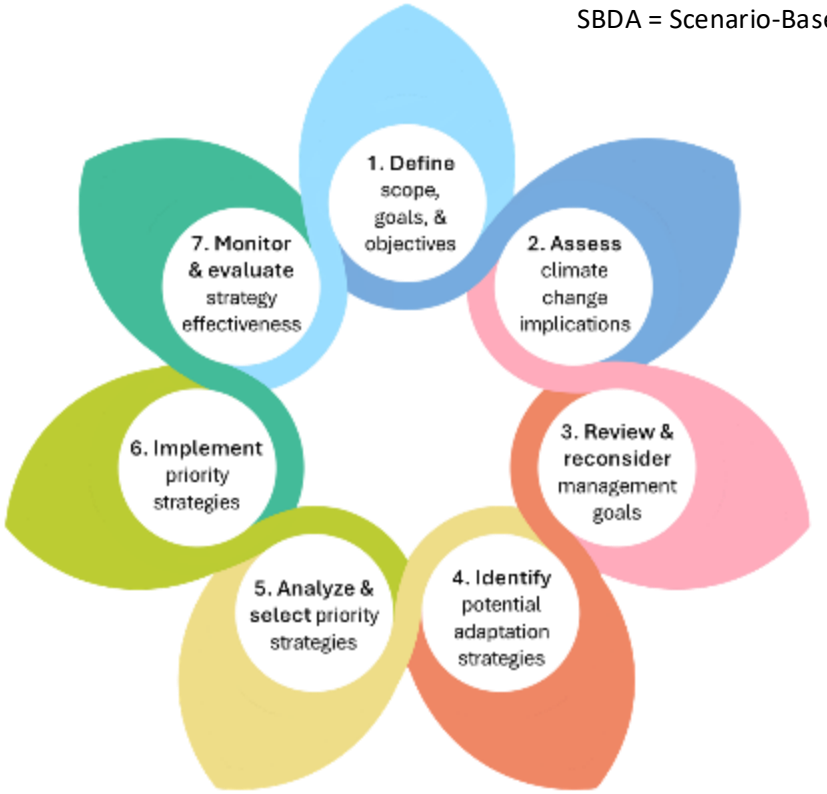

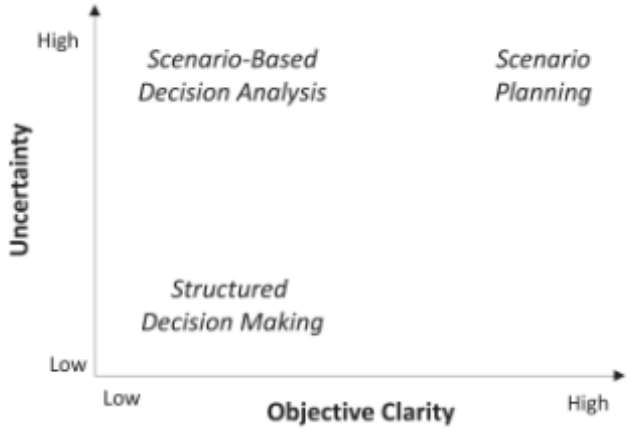

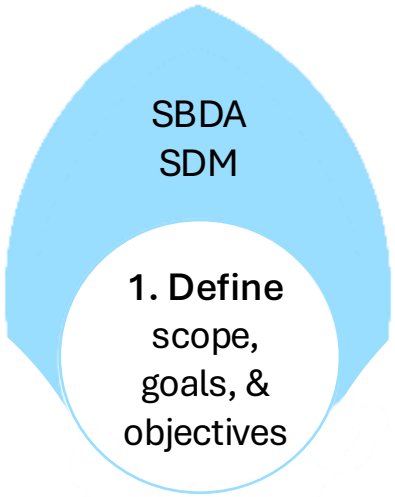

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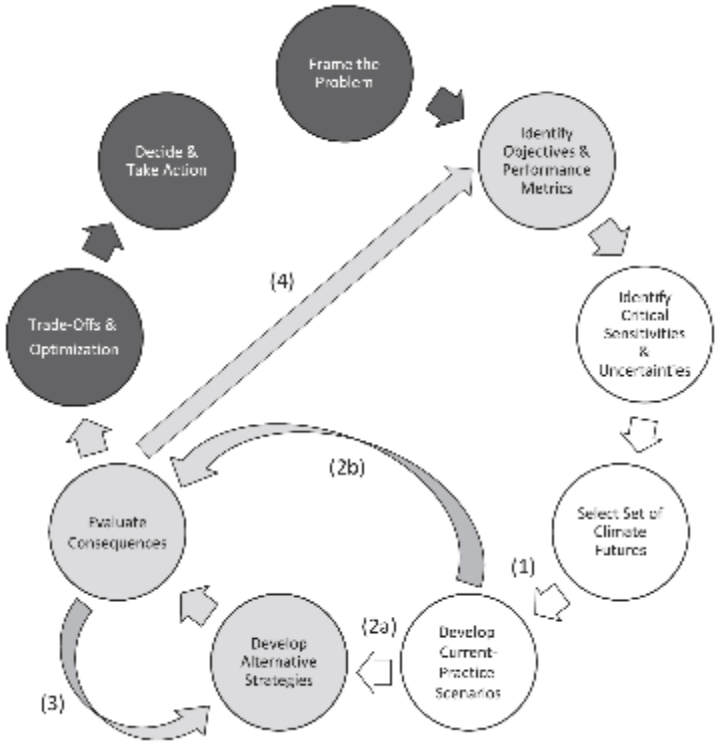

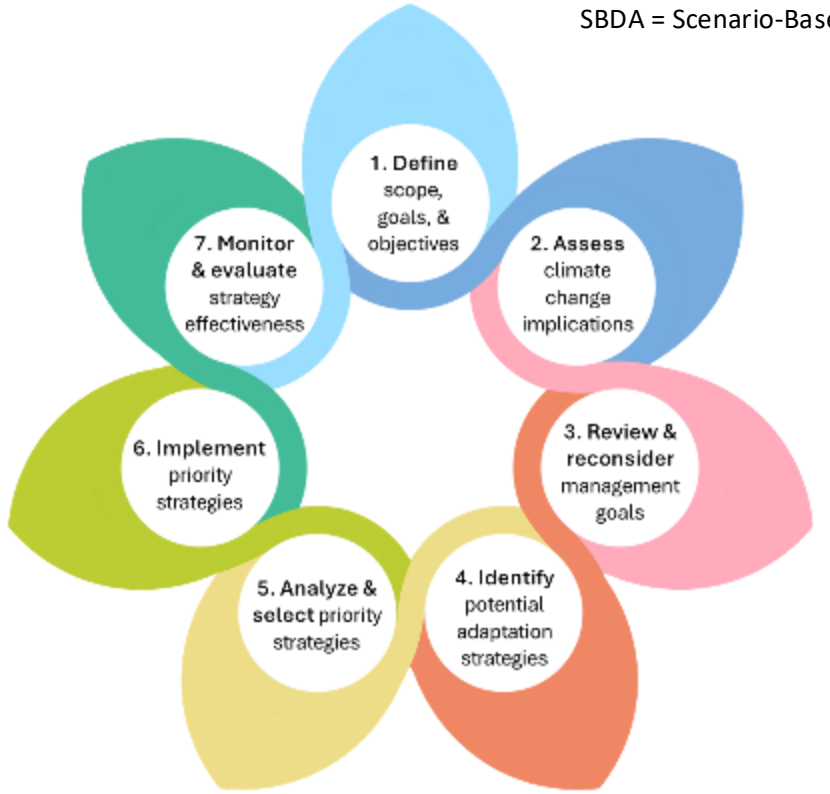

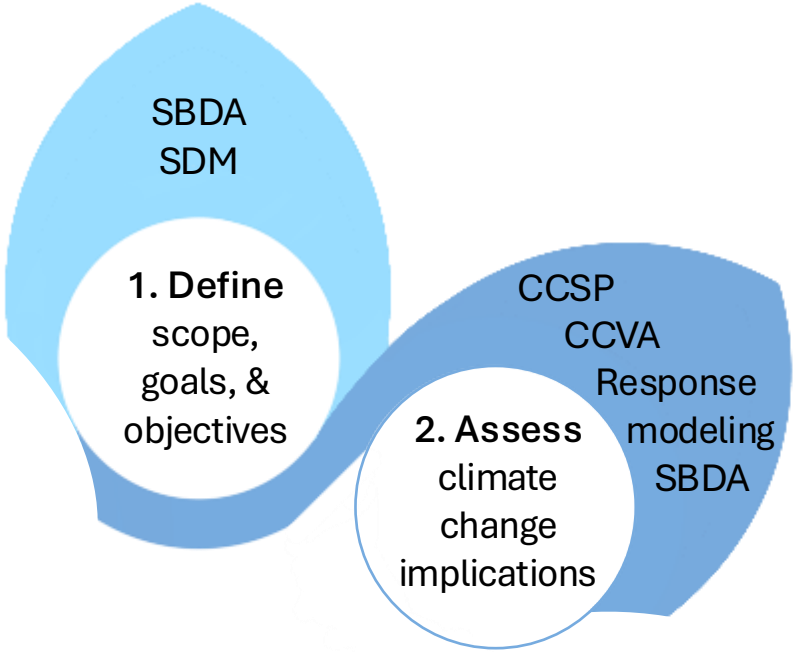

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SDM = Structured Decision Making
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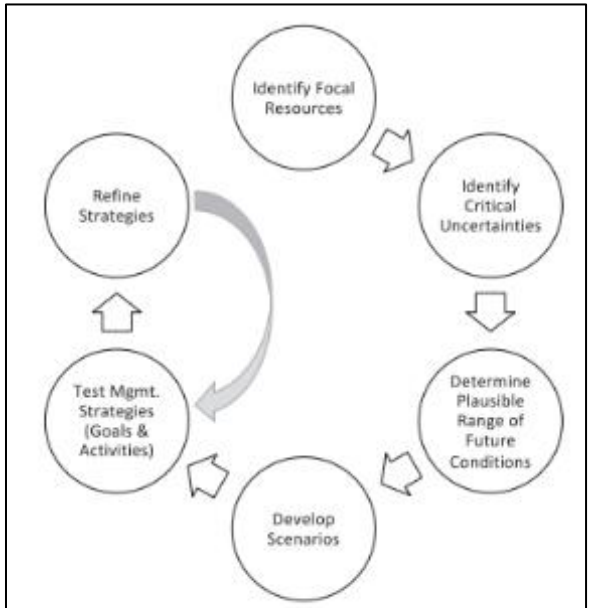
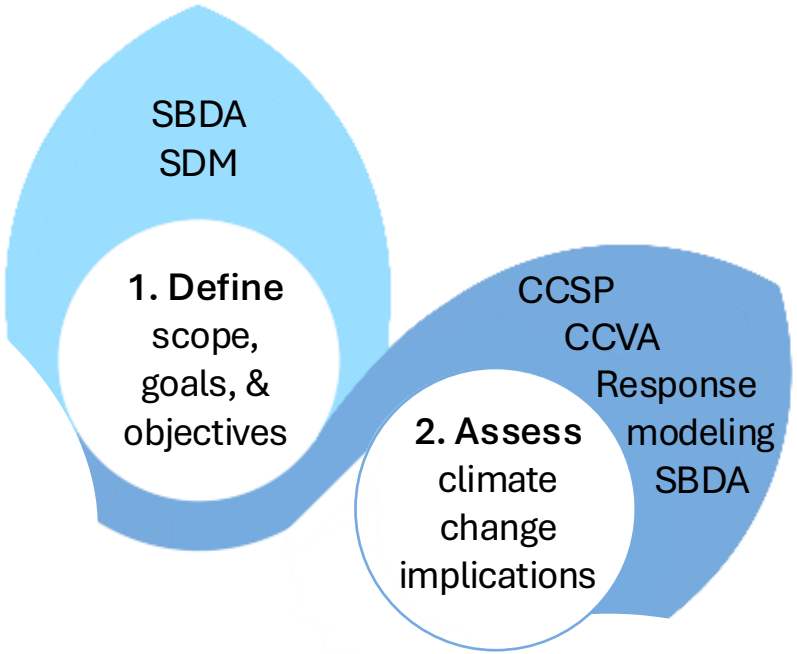


Fig. 2. Generalized Climate Change Scenario Planning process (from Miller et al., 2022).



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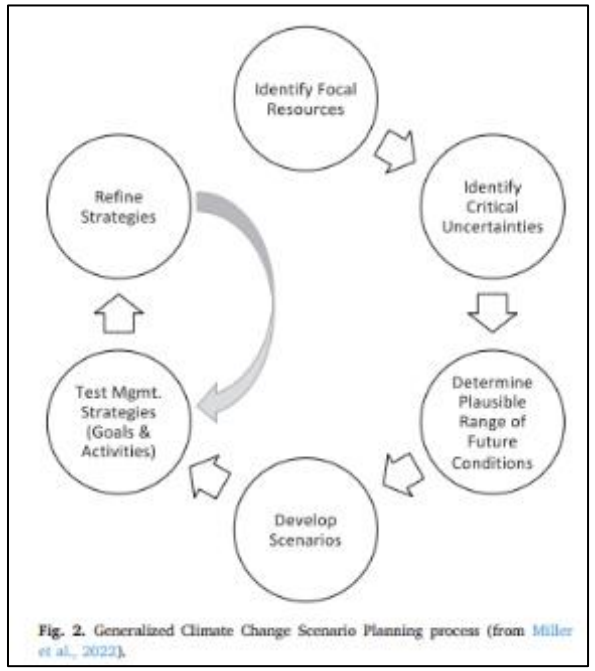

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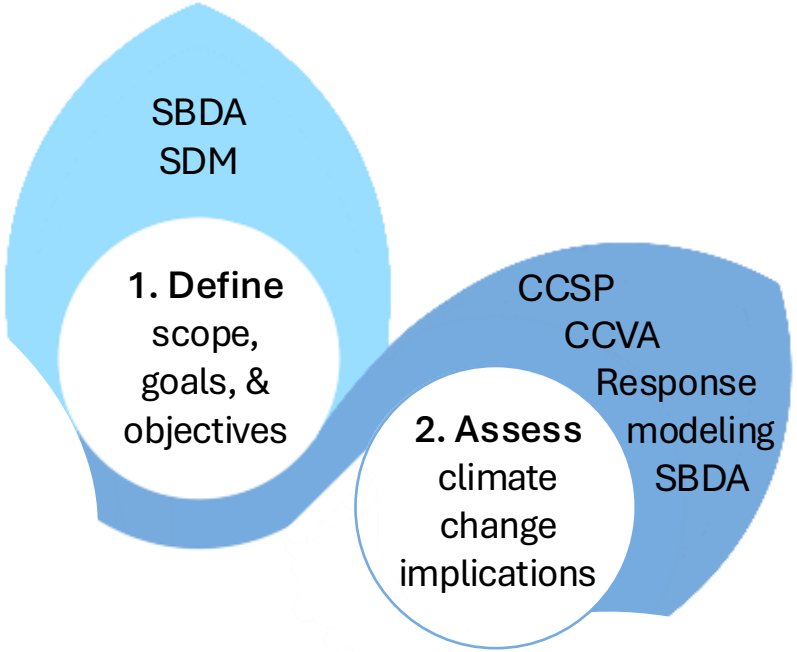

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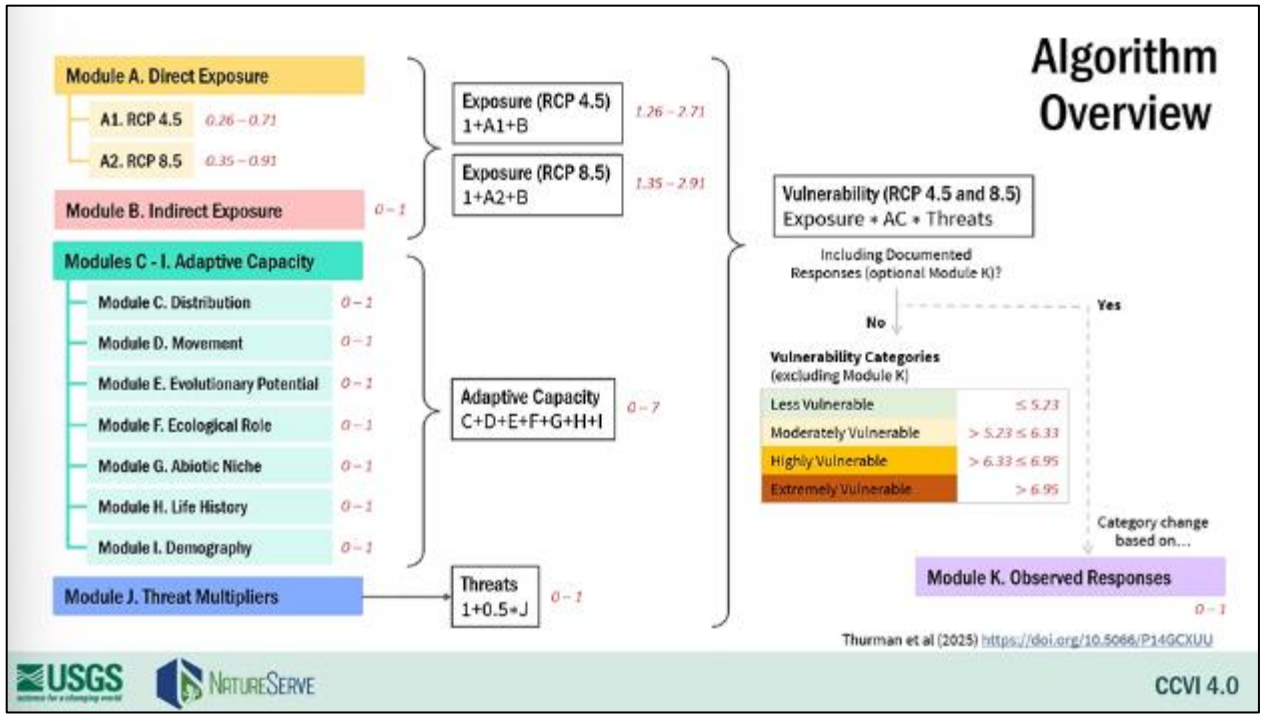
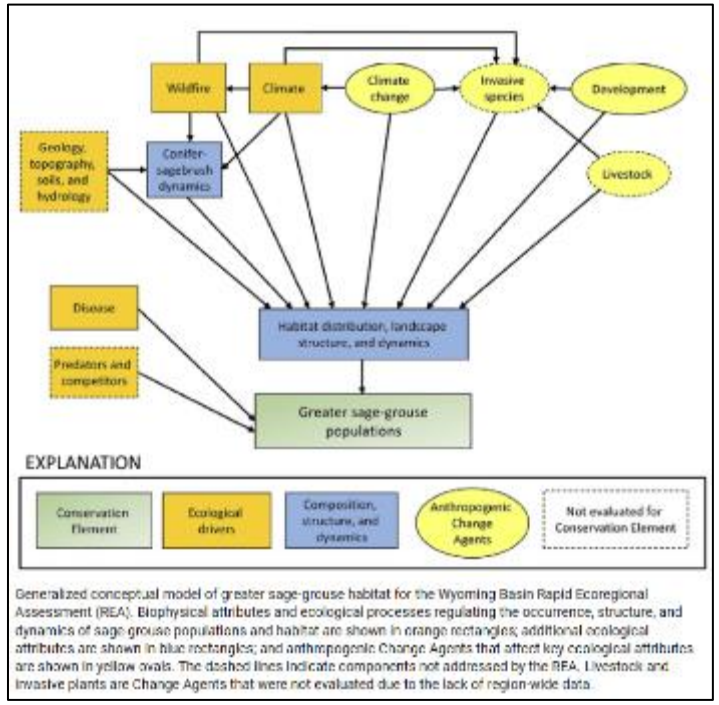
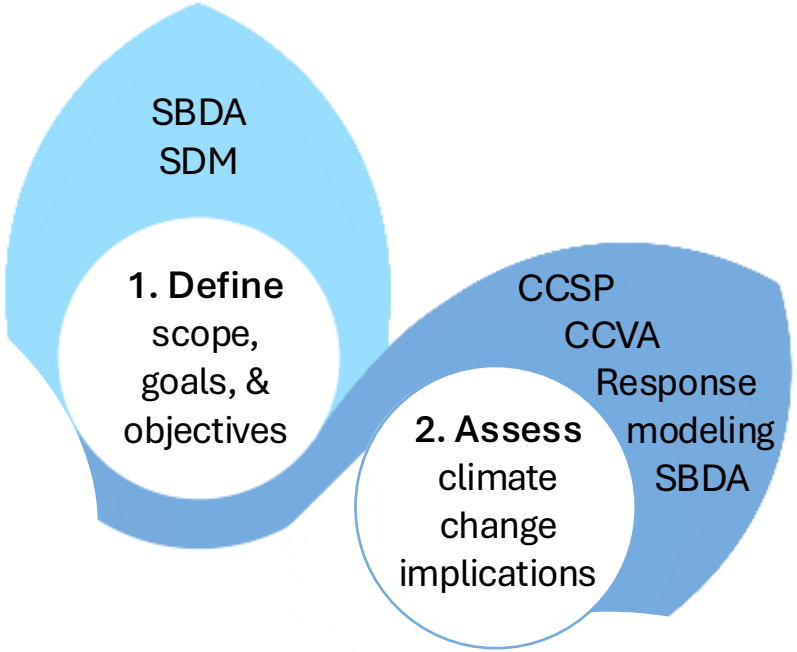




Generalized conceptual model of greater sage-grouse habitat for the Wyoming Basin Rapid Ecoregional Assessment (REA). Biophysical attributes and ecological processes regulating the occurrence, structure, and dynamics of sage-grouse populations and habitat are shown in orange rectangles; additional ecological attributes are shown in blue rectangles; and anthropogenic Change Agents that affect key ecological attributes are shown in yellow ovals. The dashed lines indicate components not addressed by the REA. Livestock and invasive plants are Change Agents that were not evaluated due to the lack of region-wide data.

George et al. (2015). Wyoming Basin Rapid Ecoregional Assessment Chapter 23 Greater Sage-grouse.



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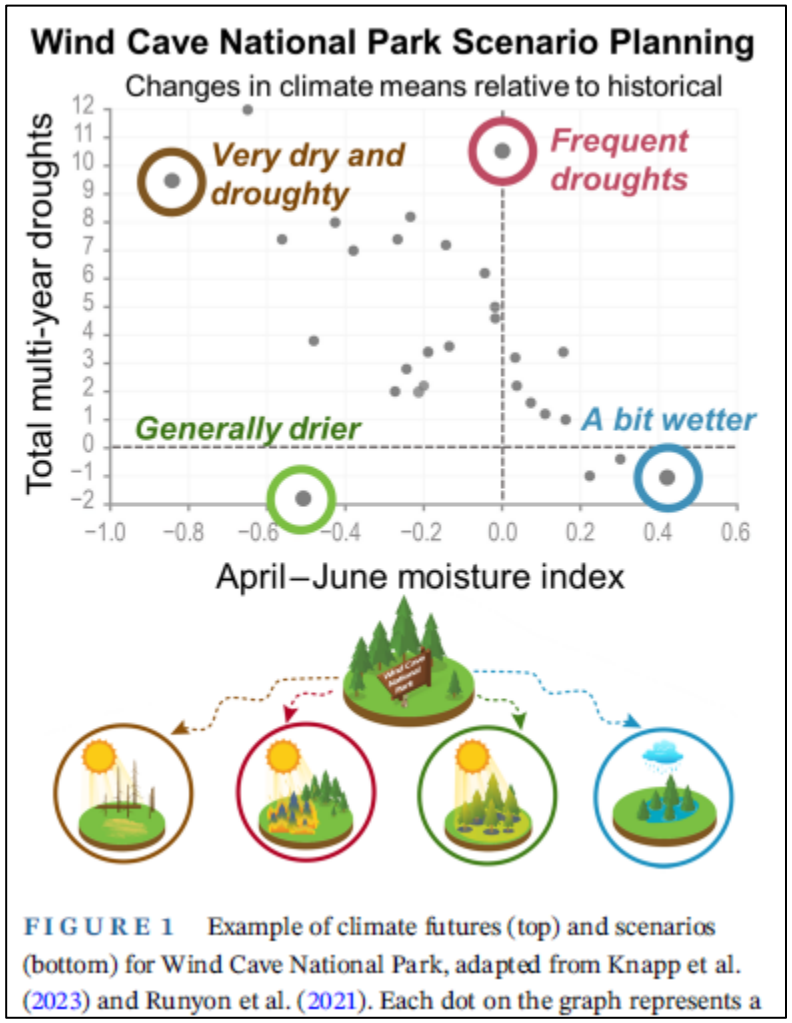
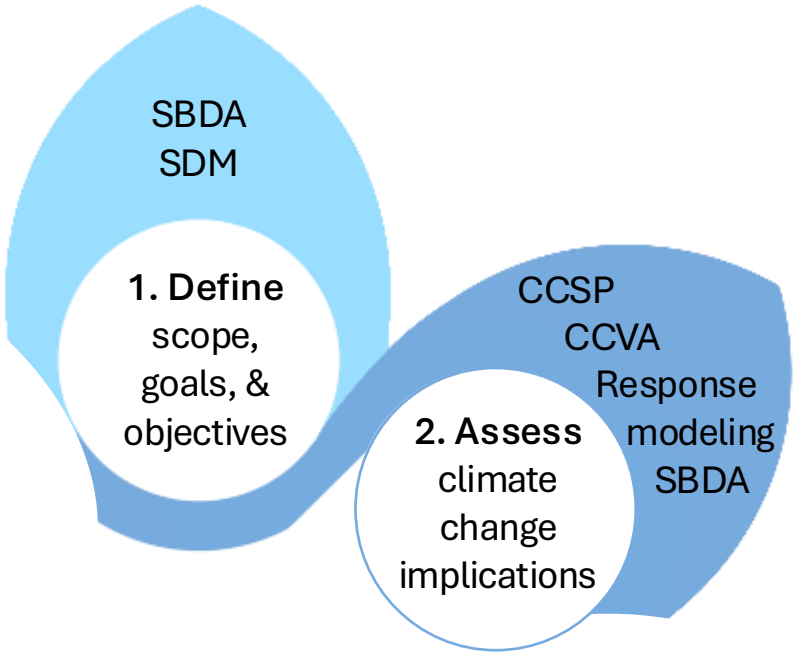


FIGURE 1 Example of climate futures (top) and scenarios (bottom) for Wind Cave National Park, adapted from Knapp et al. (2023) and Runyon et al. (2021). Each dot on the graph represents a



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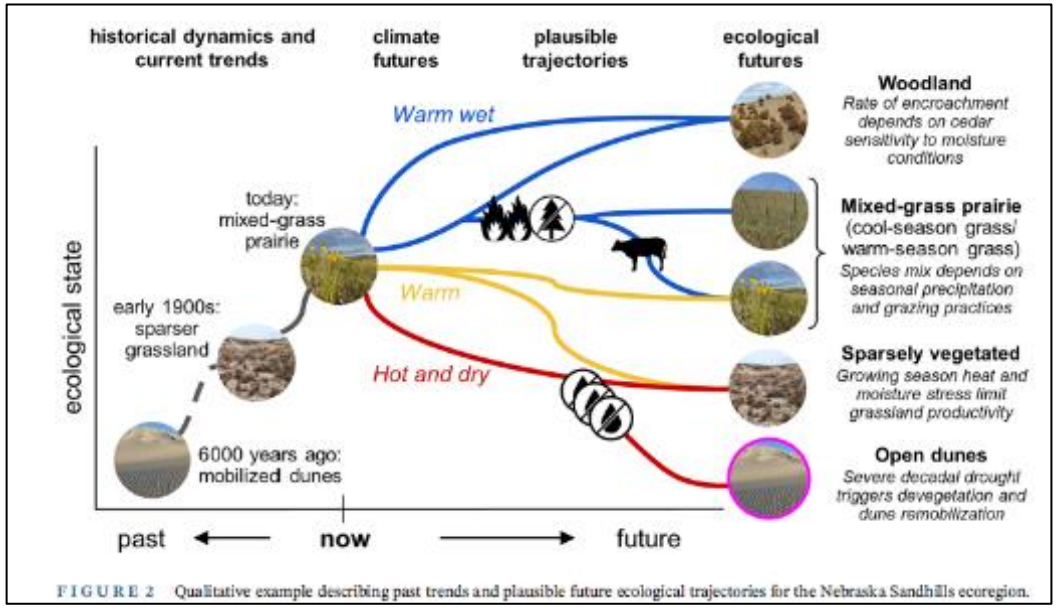
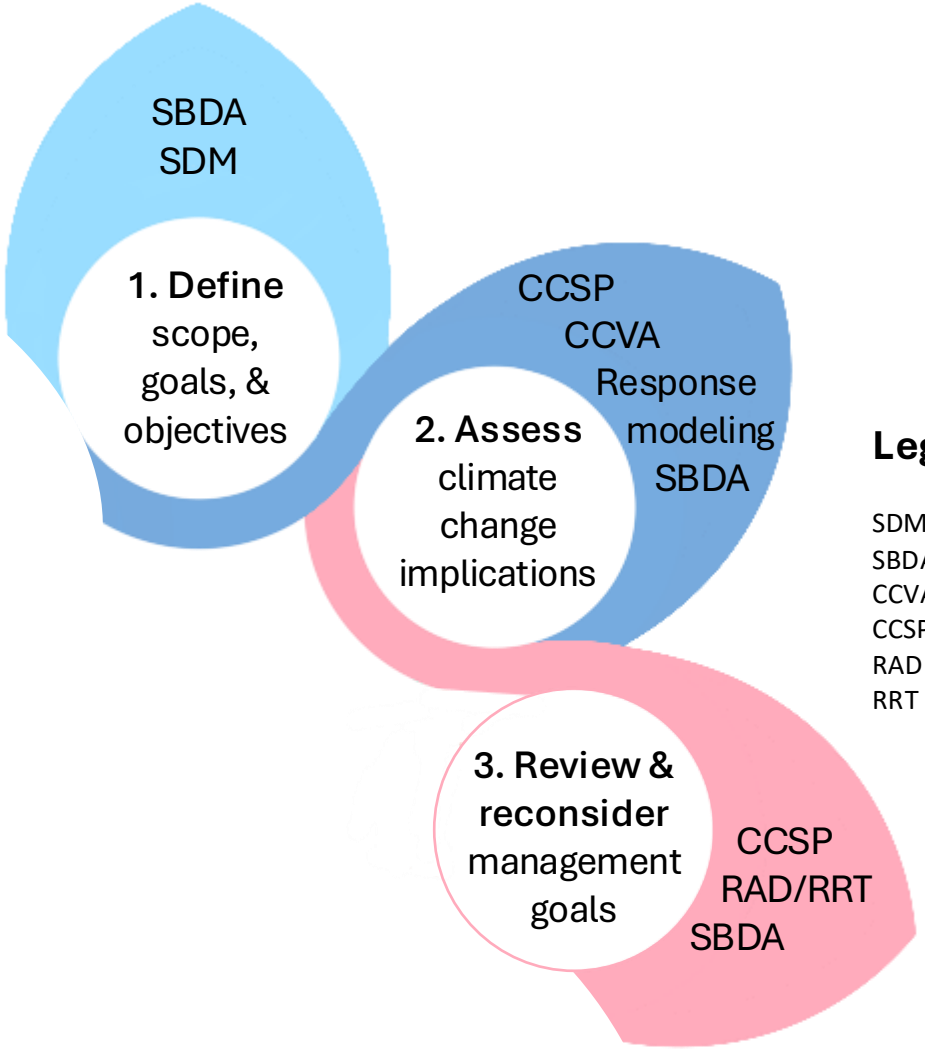


FIGURE 2 Qualitative example describing past trends and plausible future ecological trajectories for the Nebraska Sandhills ecoregion.

Clark-Wolf et al. 2025. Ecological scenarios: Embracing ecological uncertainty in an era of global change.



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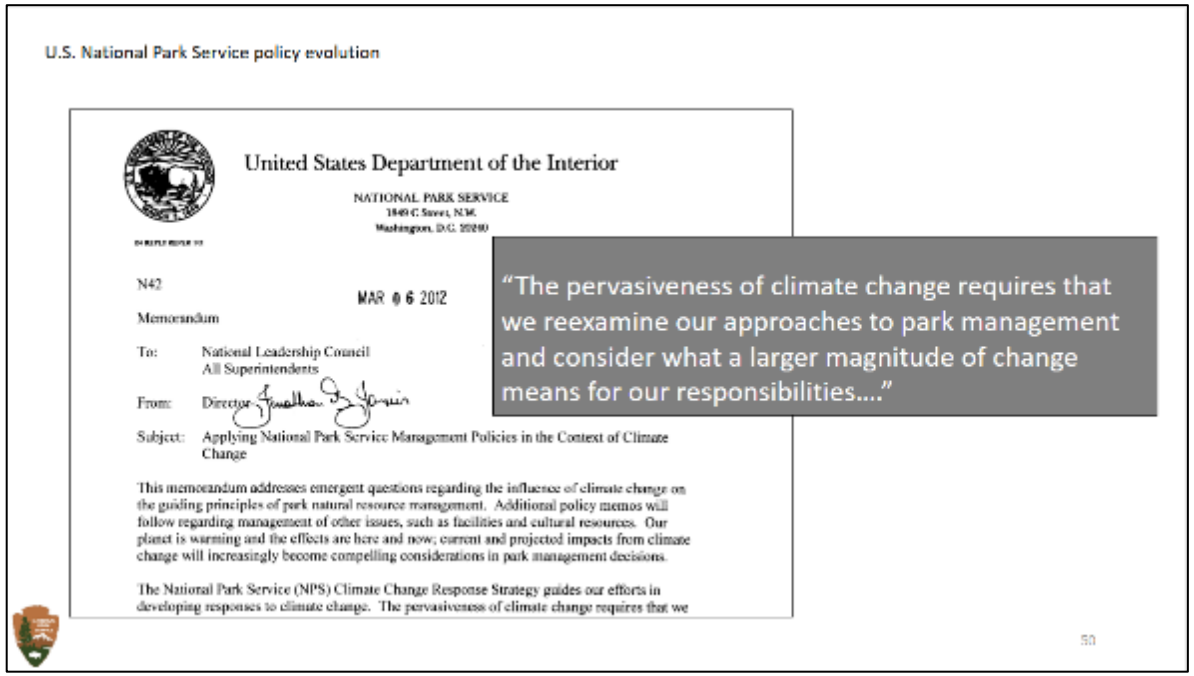

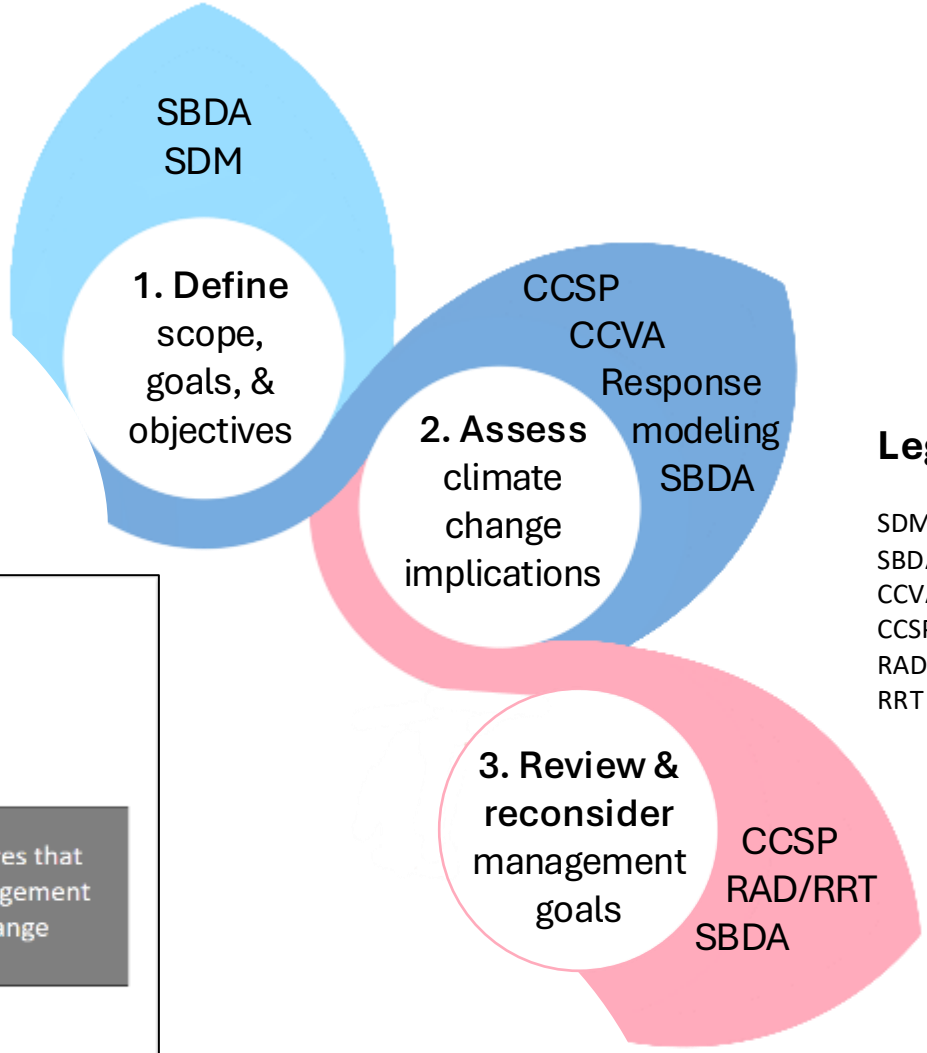

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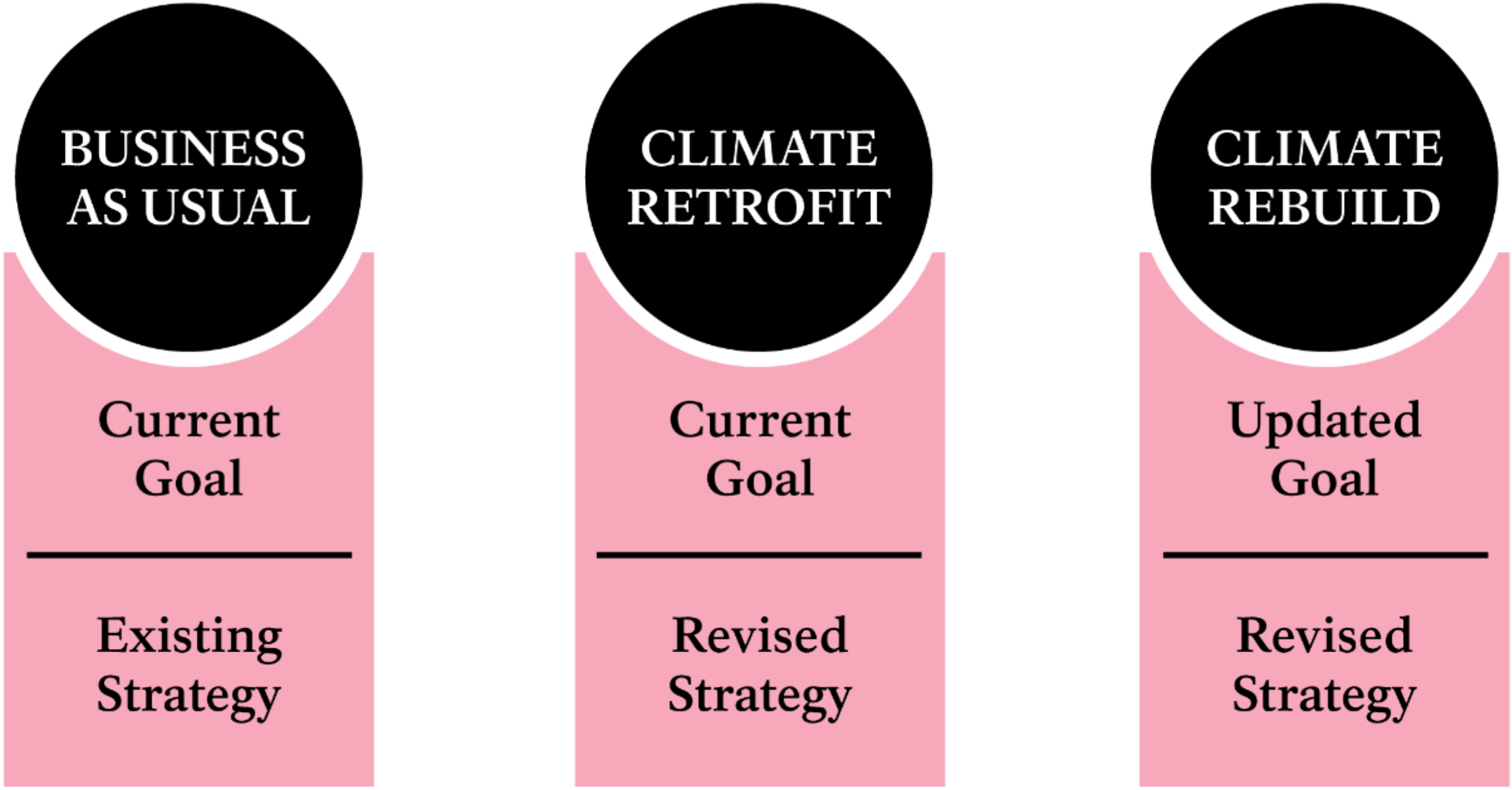
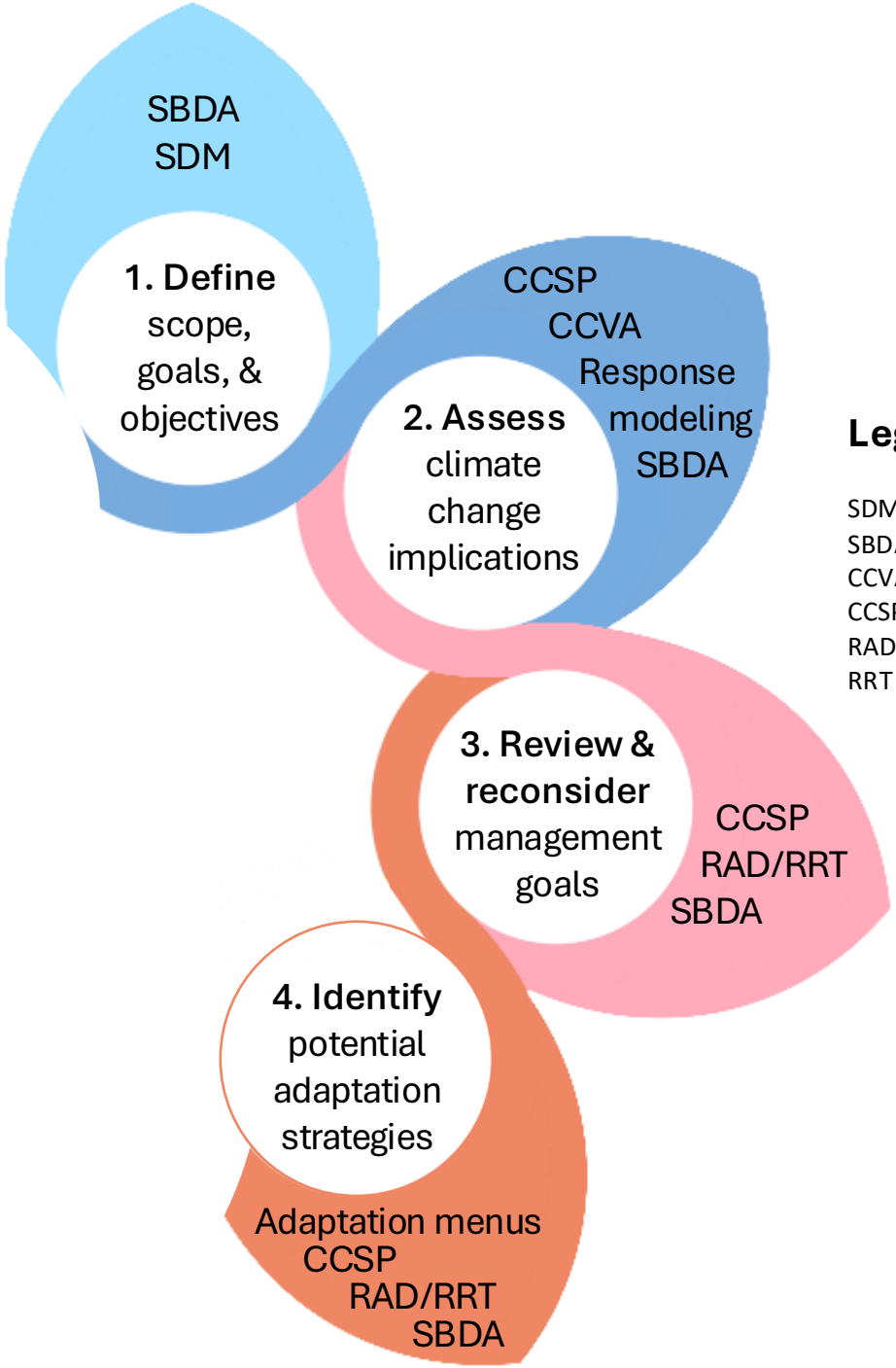

BUSINESS AS USUAL
Current Goal
Existing Strategy
CLIMATE RETROFIT
Current Goal
Revised Strategy
CLIMATE REBUILD
Updated Goal
Revised Strategy



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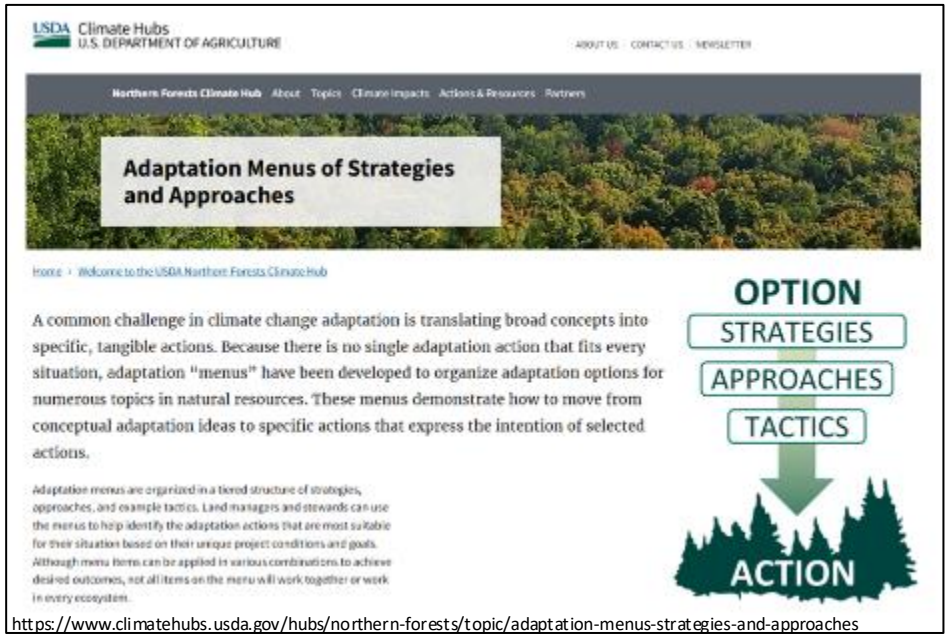
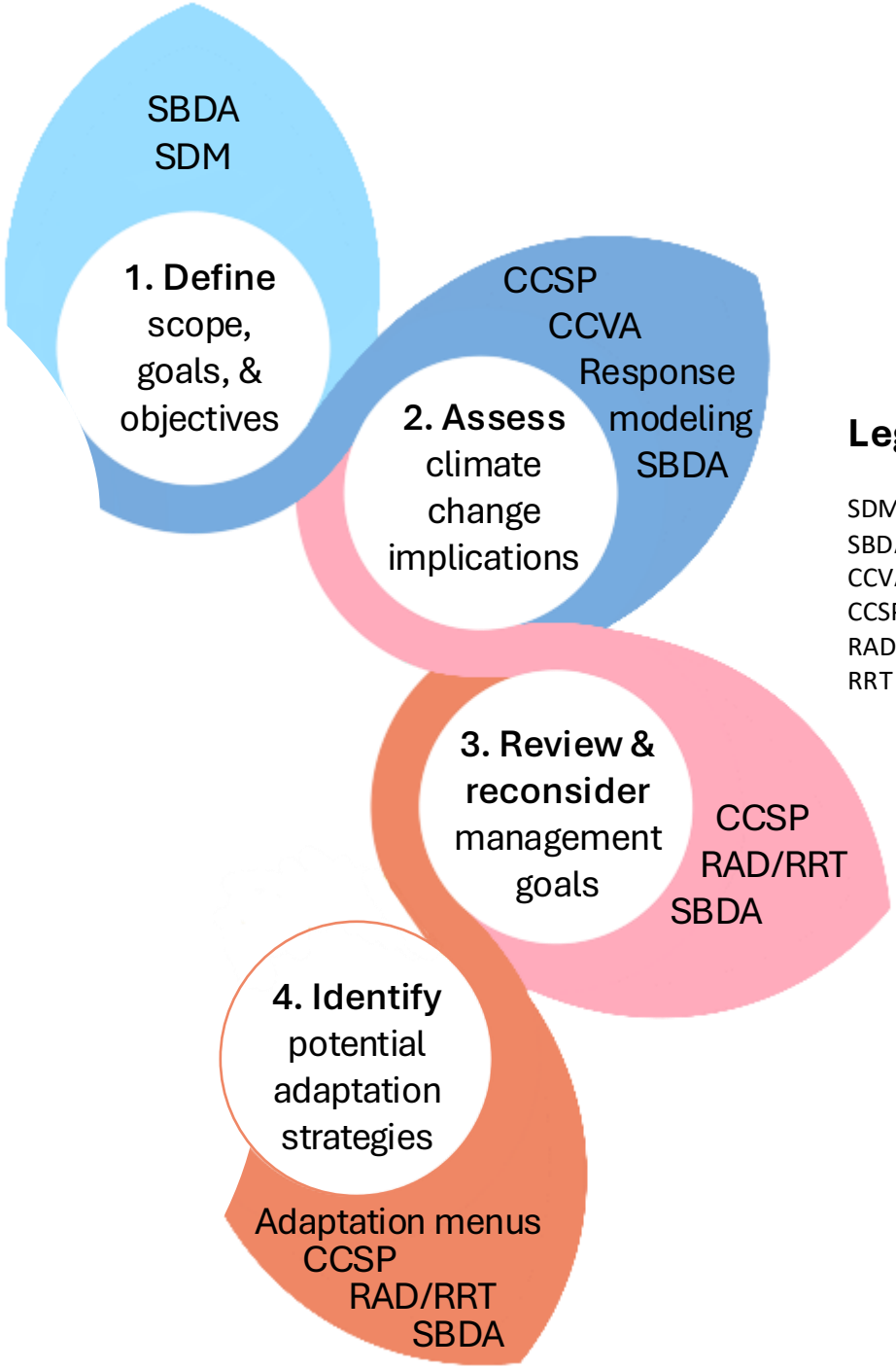


https://www.climatehubs.usda.gov/hubs/northern-forests/topic/adaptation-menus-strategies-and-approaches



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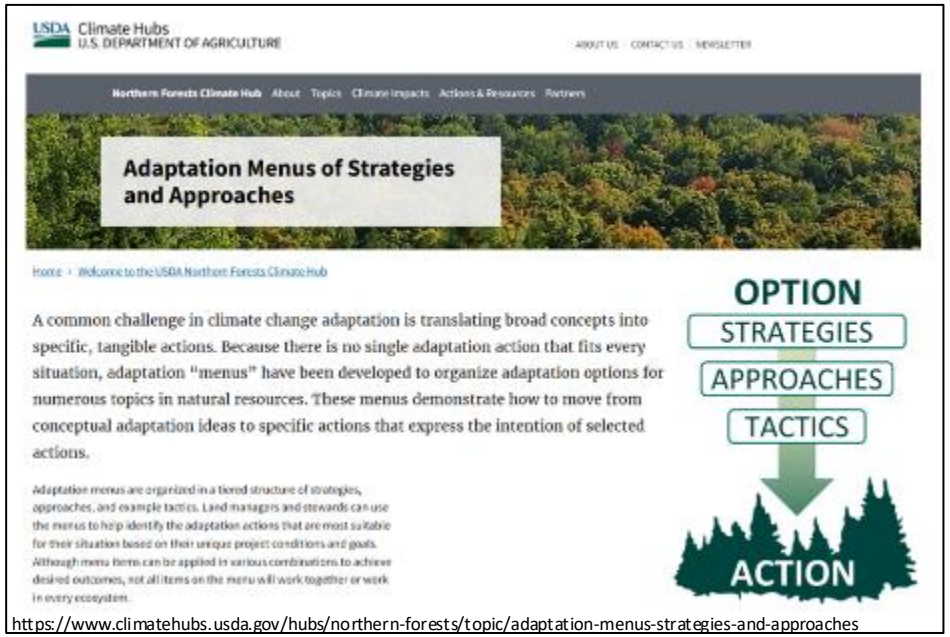

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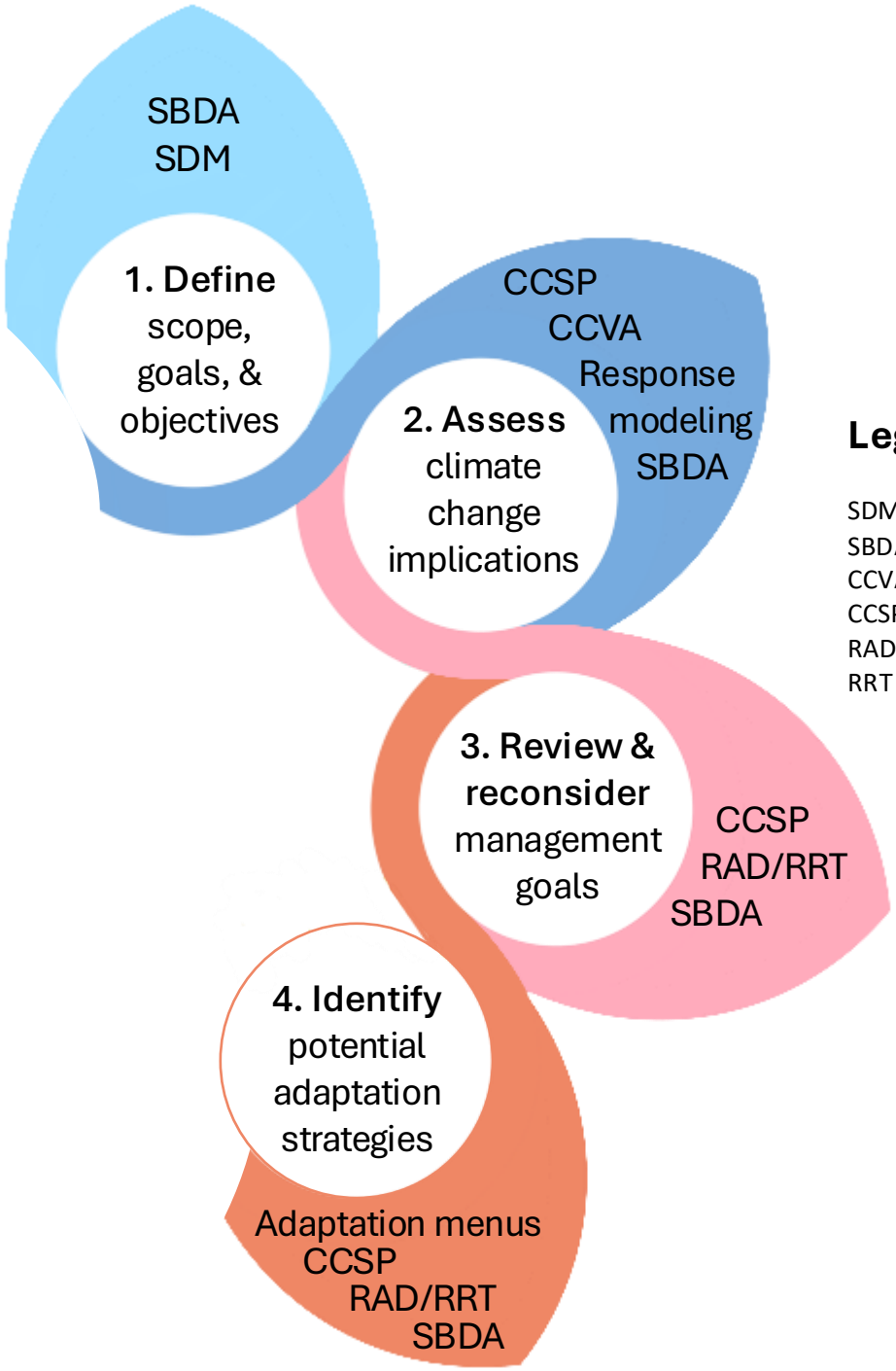

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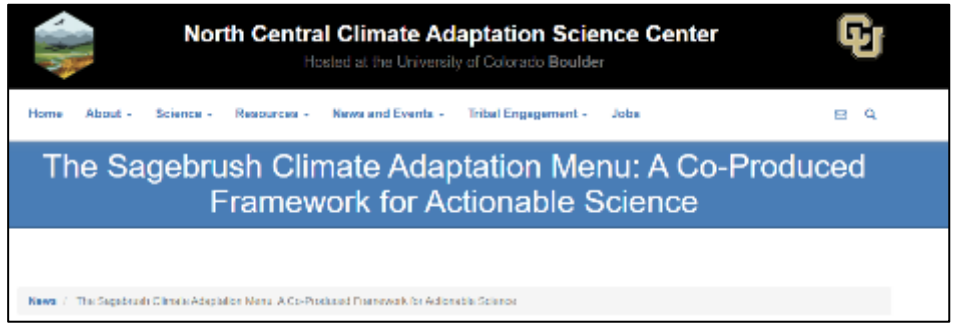

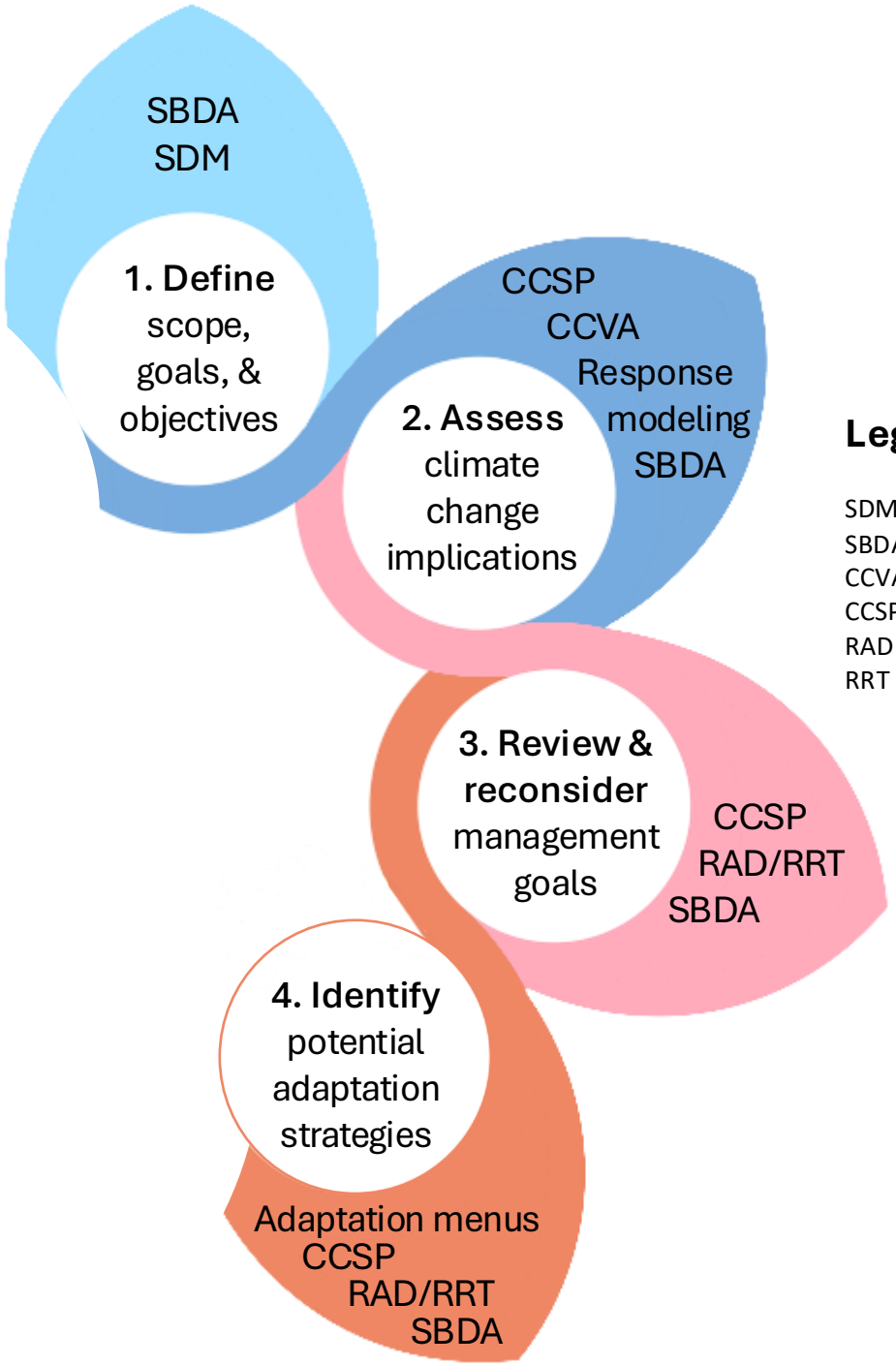

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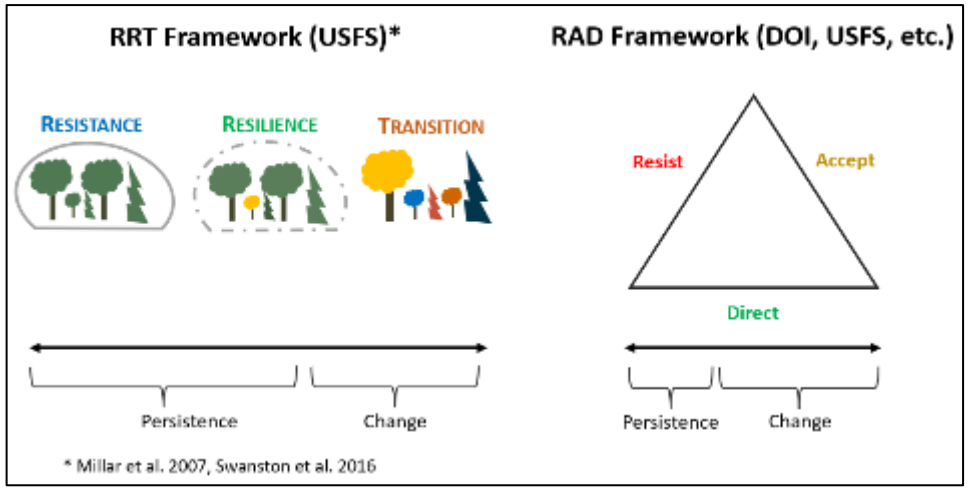
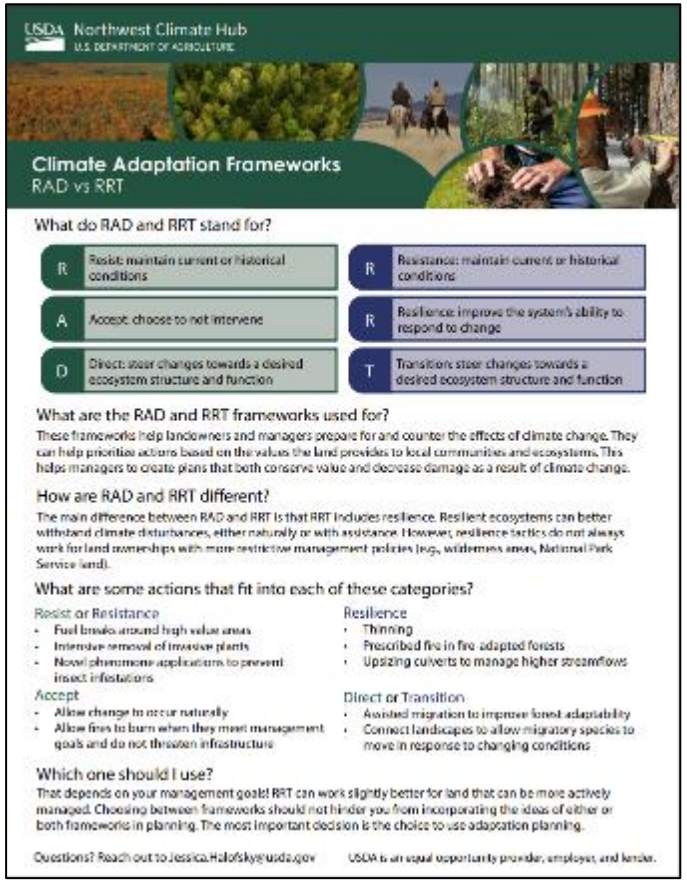
Sister Frameworks: RRT & RAD

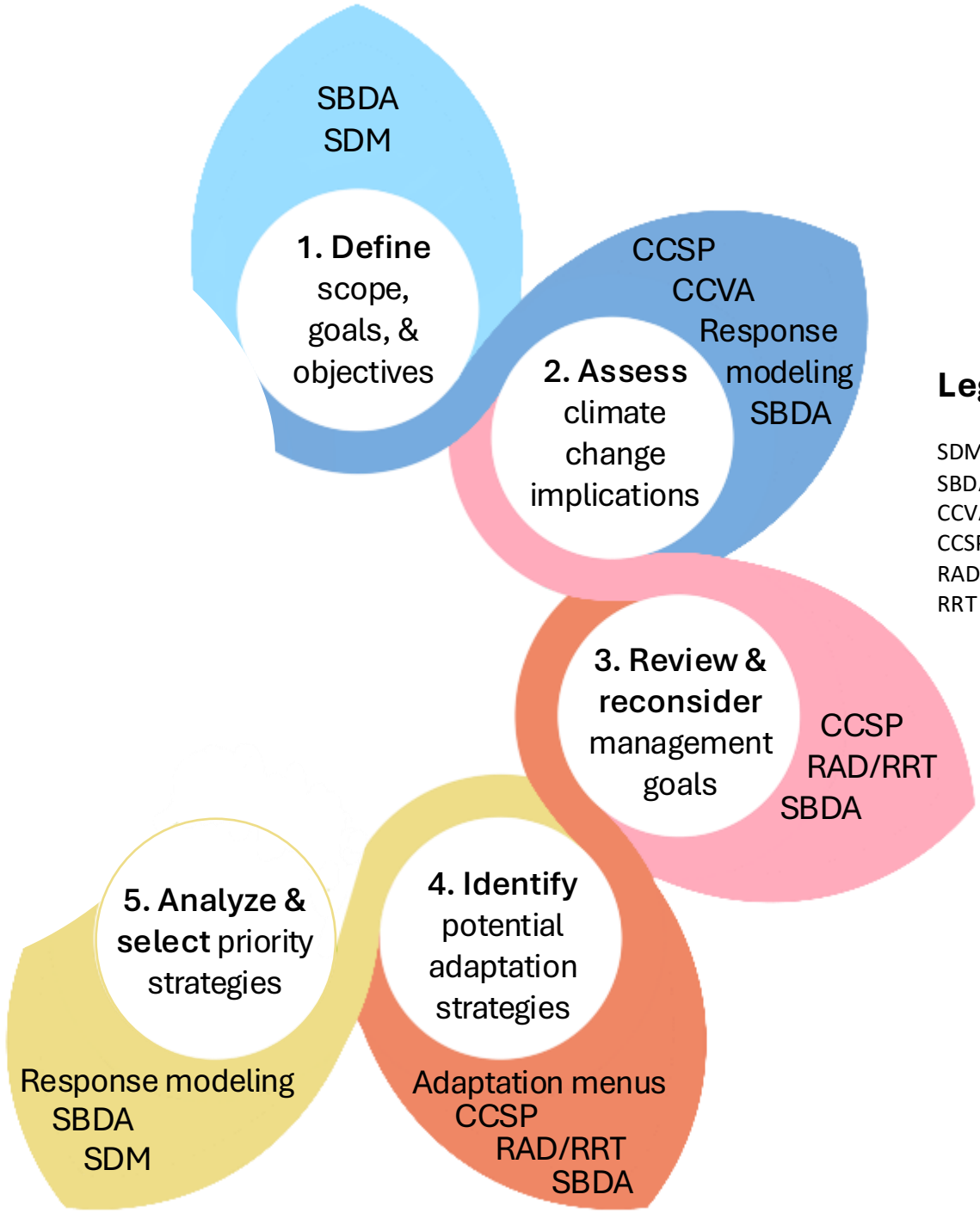
Photo: https://www.istockphoto.com/photo/phillips-and-flat-head-screwdrivers-gm104870348-13452891

Sister Frameworks: RRT & RAD

- Similar terms
  - Resistance = Resist
    - Actions to maintain <u>historical</u> conditions
  - Transition = Direct
    - Actions to foster or steer change towards preferred <u>new</u> conditions
- Unique terms
  - Accept (allow change to proceed autonomously)
    - Useful in contexts where no management intervention is an important and common choice
  - Resilience (actions that help the system adapt to changing climatic conditions)
    - Blurs distinction between managing for persistence vs. for change







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Objective	Attribute	Direction	Units	Status Quo	Preservation	Commercial	Terminal Benefits	Spread the Pain 1	Spread the Pain 2	Max Rebuilding	Spread the Pain 3	Sports Compromise
Conservation	% meeting Rec Plan Objective 1	H	%	73%	76%	82%	80%	72%	80%	84%	79%	81%
Conservation	% meeting Rec Plan Objective 2	H	%	32%	33%	33%	34%	31%	35%	34%	33%	34%
Conservation	No of returns in 2010	H	# 000	6.3	7.8	12.5	8.7	6.5	8.6	13.2	8.0	8.9
Conservation	No of returns in 2016-2019 (ave)	H	# 000	16.9	24.3	47.7	31.1	16.8	30.1	53.8	28.7	35.7
Conservation	Probability of extinction	L	%	2.4%	1.1%	0.0%	0.3%	3.4%	0.2%	0.0%	0.4%	0.2%
Conservation	% Enhanced fish 2010	L	%	27%	21%	56%	34%	26%	35%	52%	37%	46%
Conservation	% Enhanced ave fish 2016-2019	L	%	33%	29%	45%	41%	32%	42%	41%	45%	46%
Costs	Total Costs	L	(Yr As Ave $M)	$ 171	$ 389	$ 588	$ 488	$ 171	$ 523	$ 588	$ 328	$ 500
Catch	Total Downstream	H	# 000	1,925	384	6,601	3,391	3,391	4,642	1,925	4,618	4,642
Catch	Total Upstream	H	# 000	637	2,884	564	2,365	2,365	2,335	3,854	2,131	2,335
Catch	Total First Nations	H	# 000	777	739	769	796	796	768	797	768	768
Jobs	Total FTEs	H	# FTEs	1.60	2.80	4.10	3.70	1.60	3.30	4.10	2.50	4.10

Gregory R, Long G. 2009. Using structured decision making to help implement a precautionary approach to endangered species management. Risk Analysis 29:518-532.

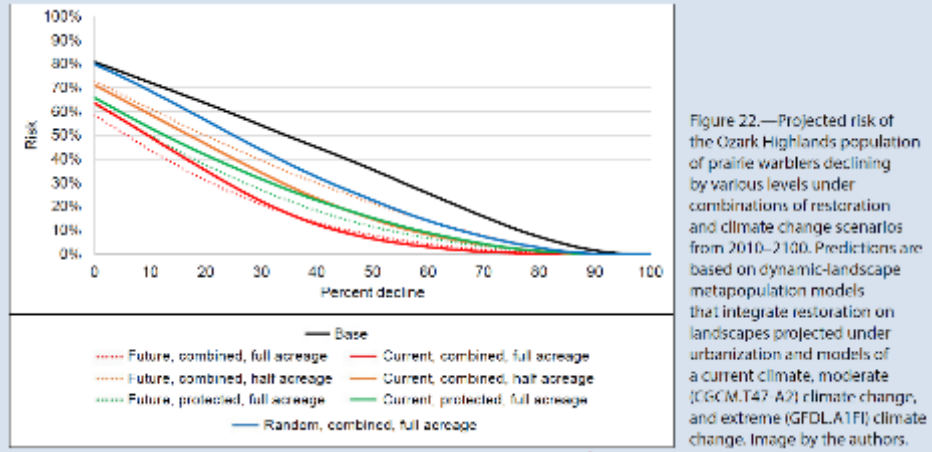
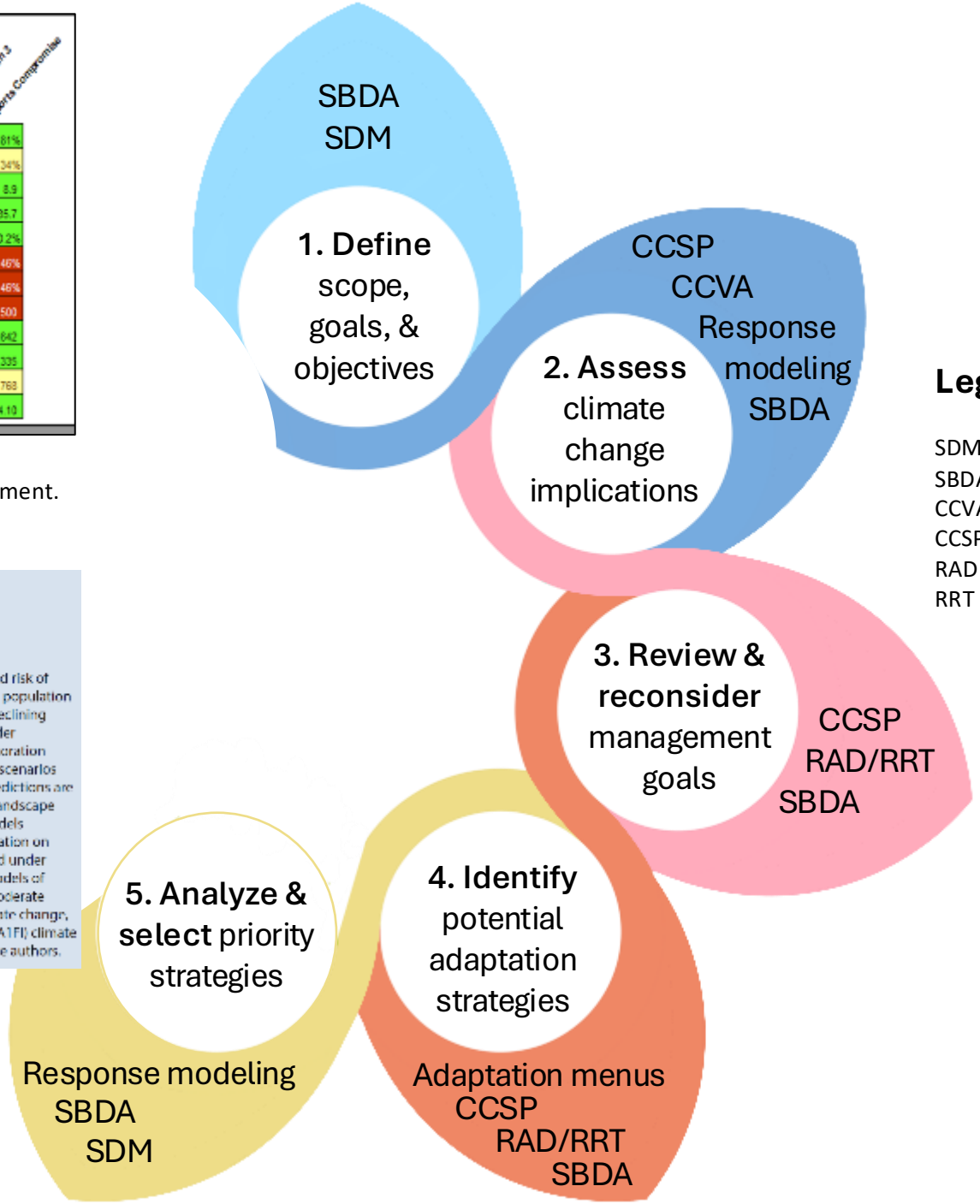


Figure 22.—Projected risk of the Ozark Highlands population of prairie warblers declining by various levels under combinations of restoration and climate change scenarios from 2010–2100. Predictions are based on dynamic-landscape metapopulation models that integrate restoration on landscapes projected under urbanization and models of a current climate, moderate (CGCM.T47.A2) climate change, and extreme (GFDL.A1FI) climate change. Image by the authors.

Bonnot et al. 2019. Developing a decision-support process for landscape conservation design. USFS GTR NRS-190.



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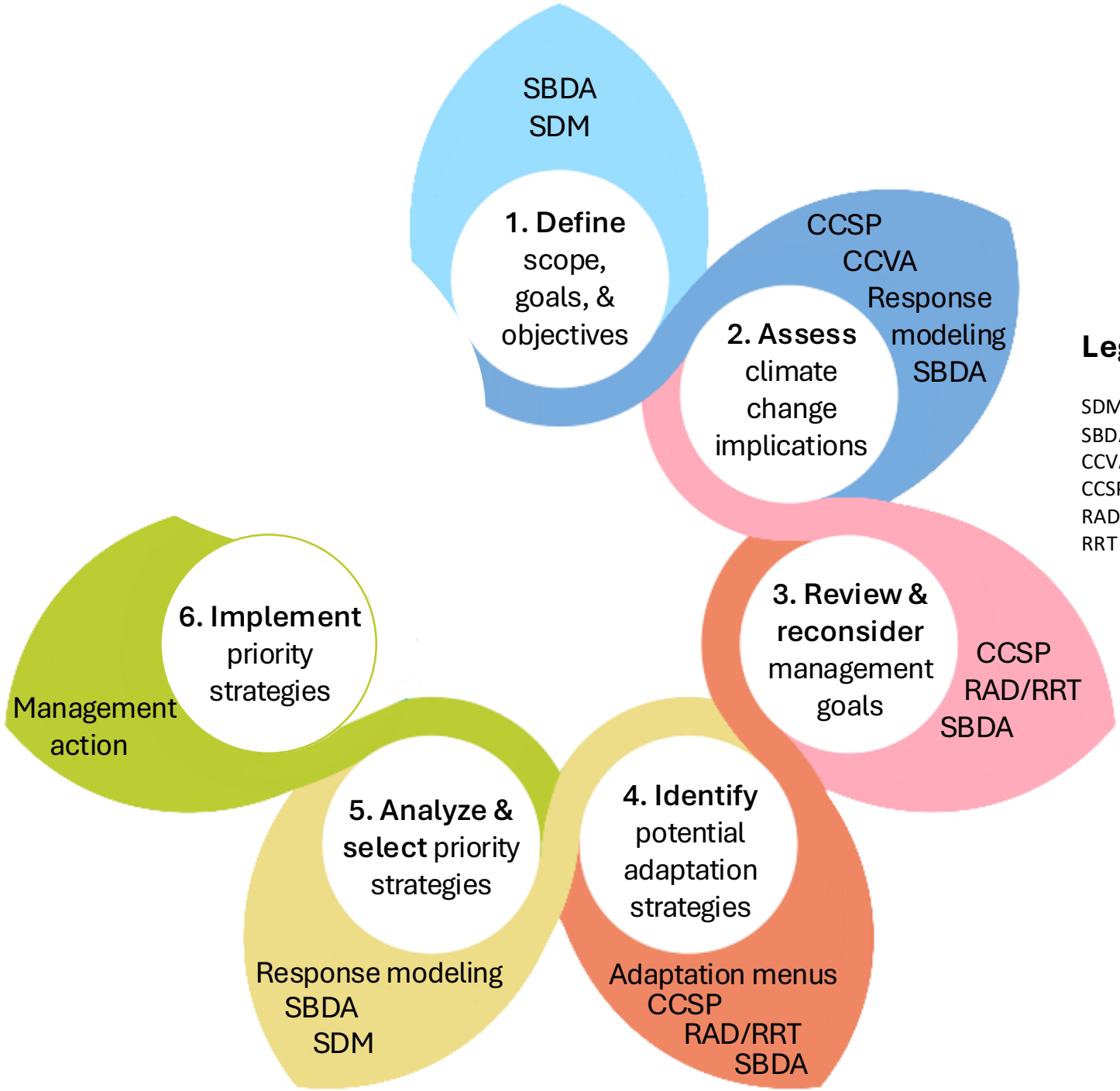

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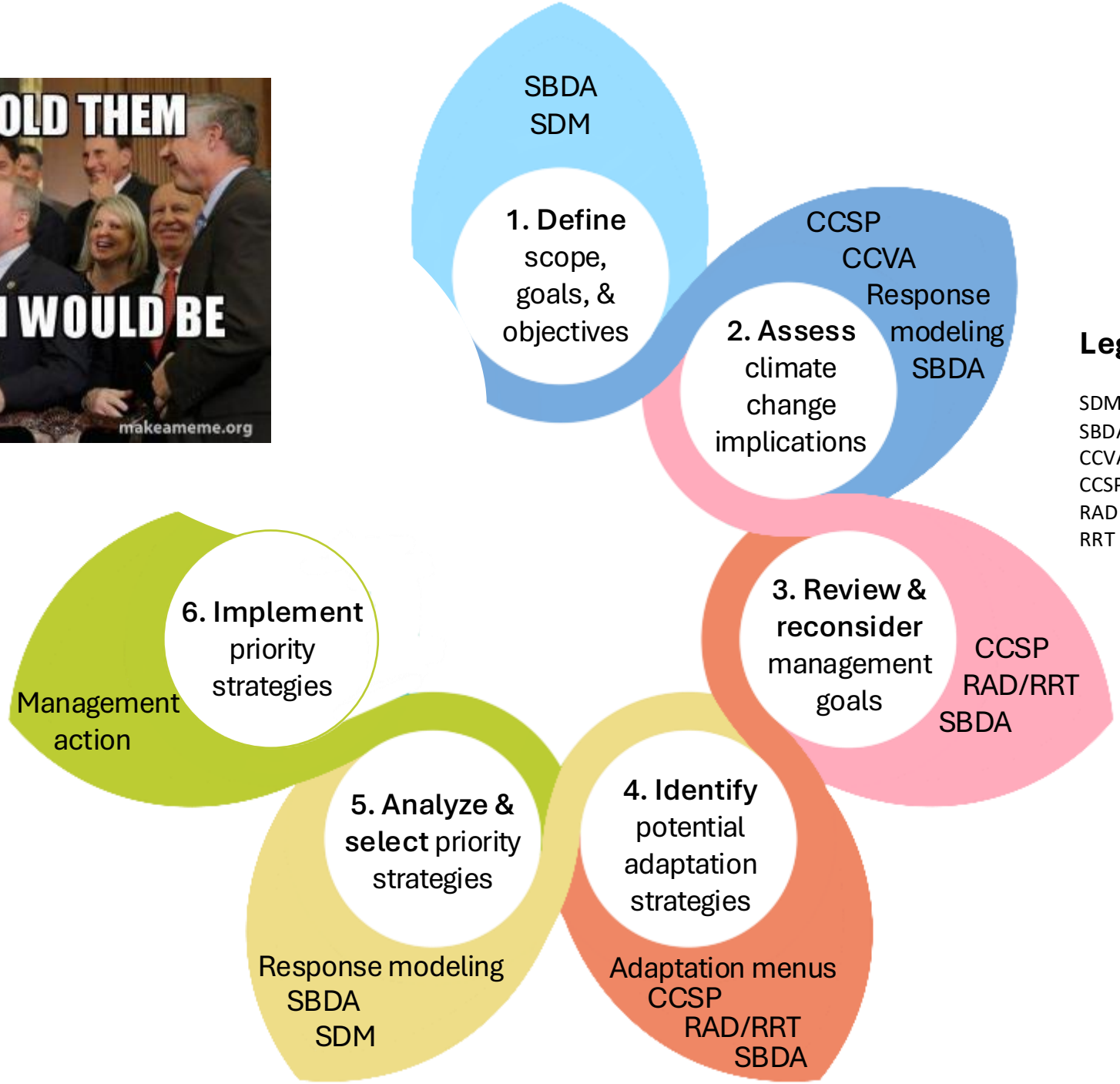

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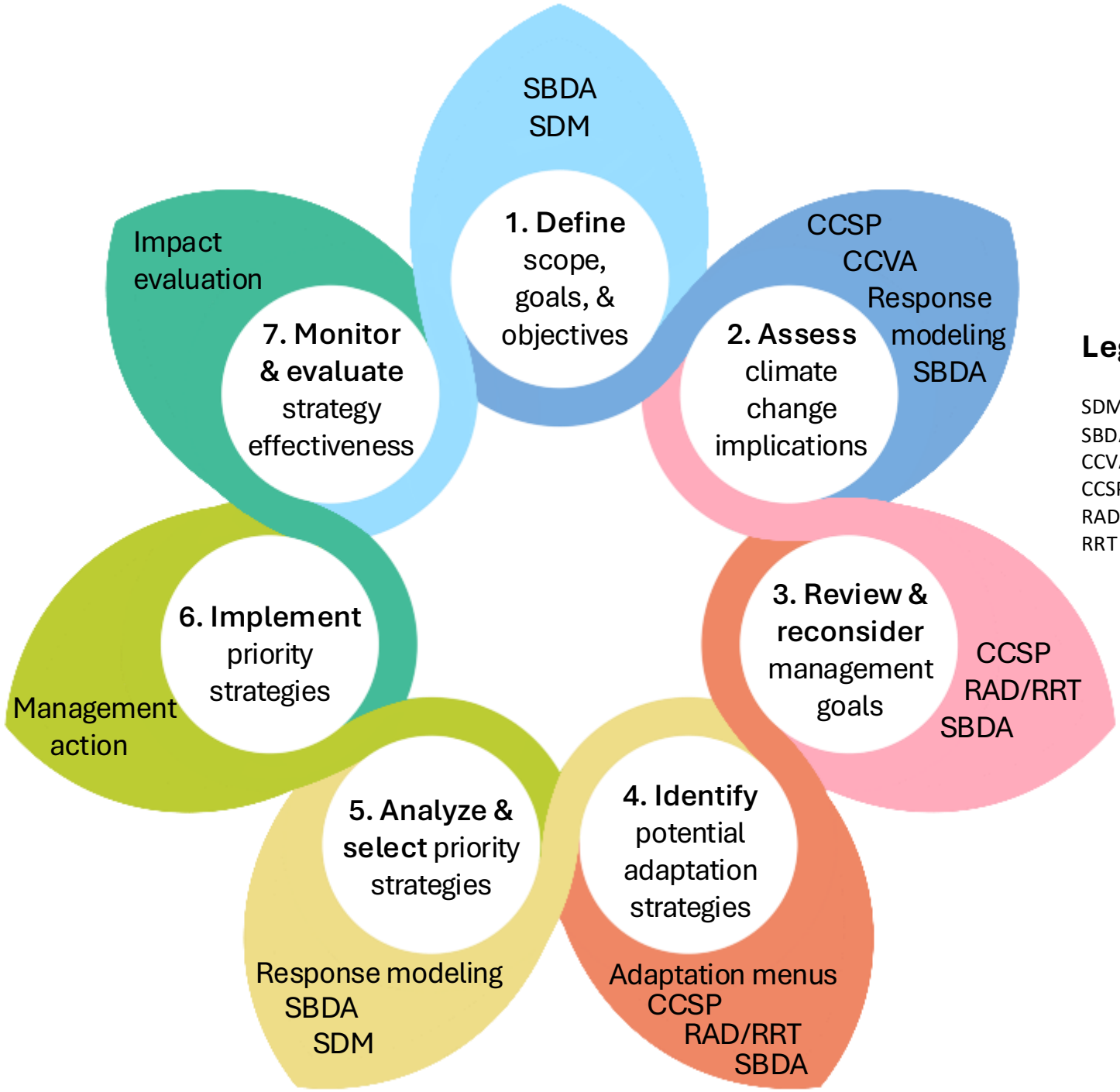

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  - Consistency of the processes we've helped develop suggests practitioners are coalescing around key features of adaptation planning.
  - Common key features allow for clear communication across adaptation roles and jurisdictions.

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  - Common key features allow for clear communication across adaptation roles and jurisdictions.
- Don't Get Wrapped Around the Axle
  - Practitioners need to be cognizant of differences between Approaches, Processes, and Tools
  - Established tools have their place(s) in the adaptation planning process and are complementary or even interchangeable.

Practical Applications of Miller et al. 2025

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  - Lots of “pre-work” before engaging in any adaptation process
  - Time, Talent, Treasure & Trust

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  - In an application that crosses agencies, consider starting our comparison & perhaps using the 7 steps we outline.
- Match Tools to the Step in the Process
  - Regardless of which Adaptation Process you choose, consider starting with the vetted tools we cover to execute each step.
  - Again, the tools are complementary or even interchangeable, so let your audience guide the choice.

A Few Related Application Concepts

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  - Not every process will need a deep dive on every step

Climate Change Response Program

MENU OF SCENARIO-BASED ASSISTANCE OFFERED TO PARKS

	EXPLORATION-ORIENTED (LOOSELY TIED TO PARK DECISION)	DECISION-ORIENTED (CLOSELY TIED TO PARK DECISION)
BROAD SCOPE OF ISSUES ADDRESSED	**Broad Scope-Exploratory** *Recommended Process:* ***Facilitated Exploration Workshop*** • *2 day workshop, CCRP/contractor led + park planning team* • *Output: Workshop summary report identifying potential management options*	**Broad Scope-Decision Oriented** *Recommended Process:* ***Multi-resource Decision Support*** • *Series of meetings (6-12 months), CCRP led + park planning team* • *Output: Spreadsheets/report with resource-specific vulnerability assessments and prioritized adaptation actions*
NARROW SCOPE OF ISSUES ADDRESSED	**Narrow Scope-Exploratory** *Recommended Process:* ***Self-guided Workbook*** • *4-6 hours, park staff led with minimal CCRP support* • *Output: Completed workbook identifying priority adaptation actions*	**Narrow Scope-Decision Oriented** *Recommended Process:* ***Ecological Response Modeling*** • *Series of meetings (3-6 months), CCRP led + park experts* • *Output: Technical report detailing climate impacts on specific resource/asset*

A Few Related Application Concepts

- Rapid Prototyping
  - Every process is unique & the steps are inter-related. Getting around the wheel quickly can be useful for identifying connections & trouble spots.
  - Ensures Step 7 is addressed appropriately
- Right-sizing the Process
  - Not every process will need a deep dive on every step
- Flexible Order of Events
  - Steps 1-4 don't necessarily need to be done sequentially

Questions?

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Todd Jones-Farrand, david_jones-farrand@fws.gov