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The Art of the Possible: Adaptation Options for Persistence and Change

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*The views expressed in this presentation are those of the authors and do not represent official policy of the US EPA.

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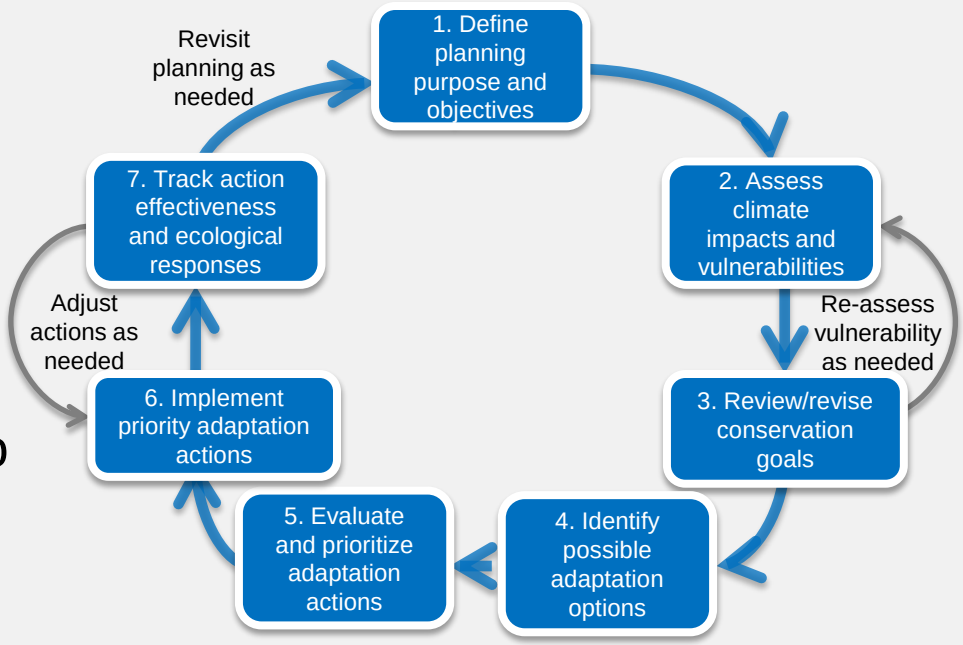
Overview

- Climate smart adaptation requires thinking along two pathways: for persistence and change
- Managing for persistence aims to prevent systems from crossing thresholds of major change



- Managing for change involves anticipating unavoidable thresholds and preparing for/guiding the transition to a different state
- Moving forward, the success of climate adaptation will require cycling between managing for persistence and change

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Adaptation Approaches

Reduce Non-Climate Stresses	Minimize localized human stressors that hinder the ability of species or ecosystems to withstand or adjust to climatic events
Protect Key Ecosystem Features	Focus management on structural characteristics, organisms, or areas that represent important “underpinnings” or “keystones” of the current or future system of interest
Ensure Connectivity	Protect, restore, and create landscape features that facilitate movement of organisms (and gene flow) among resource patches
Restore Structure and Function	Rebuild, modify or transform ecosystems that have been lost or compromised, in order to restore desired structures and functions

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Adaptation Approaches Cont'd

Support Evolutionary Potential	Protect a variety of species, populations and ecosystems in multiple places to bet-hedge against losses from climate disturbances, and where possible manage these systems to assist positive evolutionary change
Protect Refugia	Protect areas less affected by climate change as sources of "seed" for recovery or as destinations for climate-sensitive migrants
Relocate Organisms	Engage in human-facilitated transplanting of organisms from one location to another in order to bypass a barrier

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Managing For Persistence

- Initial work on adaptation has focused on managing for persistence of existing species and ecosystems under current goals
- Managing for persistence remains a viable goal where there is (1) potential for long term success or (2) a high priority placed on "buying time"
- Climate smart management = understanding the specifics of the system and identifying actions designed explicitly to address climate change impacts in combination with other stressors

Example: U.S. Central Flyway

Conservation target level: Network of protected areas	Adaptation approach	Example of specific management options	Key climate-smart questions
Central Flyway  <u>Conservation goal:</u> Ensure appropriate feeding habitats to sustain migratory waterfowl <u>Key climate-related vulnerabilities</u>: • Changes in precip. - Altered flows - Increased runoff - Reduced extent and number of wetlands and lakes • Increases in temp	Reduce non-climate stressors	Work with farmers to reduce agricultural runoff into wetland feeding habitats to improve water quality, groundwater recharge, and hydrologic function	How will climate change affect runoff of non-point source pollution from agricultural lands into feeding habitats? What are the best options (e.g., riparian buffers, improved irrigation scheduling) for reducing runoff of pollutants into water bodies, and when and where should they be implemented?
	Protect key ecosystem features	Maintain disturbance regimes (e.g., controlled burns, pasture rotation, periodic flooding) to augment natural processes and mimic natural patterns	How will climate change, in combination with other human activities, alter historic disturbance regimes (e.g., distribution, frequency, area disturbed) that shape ecosystems providing feeding habitat for waterfowl? How, when and where can human-assisted practices be used to best mimic natural patterns?
	Ensure Connectivity	Conserve corridors and transitional habitats between ecosystem types through land exchanges, conservation easements and other approaches	How will climate change affect species with special connectivity needs (e.g., area-, resource-, dispersal -limited)? Where will the connectivity gaps in the landscape be, and how can priority areas be conserved to maintain transitional habitats and corridors, considering ecosystem functions and physical barriers?
	Restore Structure and Function	Restore or enhance areas that will provide essential feeding habitat and ecosystem services during ecosystem transitions under a changing climate	How will climate change affect ecosystems that have been identified as providing key food resources for migratory waterfowl under the current climate? What areas, if restored, will provide the necessary feeding habitat to sustain waterfowl species as ecosystems change, and where and when should they be restored?
	Support Evolutionary Potential	Conserve areas representing the full range of geophysical settings (e.g., bedrock geology, soils) to maximize future biodiversity	How will climate change affect the full range of habitats and associated land cover and geophysical settings that support migratory waterfowl species? What areas need to be conserved that will maintain that full range under climate change?
Relocate Organisms	Assist in the translocation of limited-dispersal species to repositioned habitats		How will climate change affect food sources such as fish and submerged aquatic vegetation, and are their dispersal capabilities sufficient for them to adjust? Which species should be moved, and to which sites according to projections of favorable future conditions?

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Important Considerations

- Looking across options, which options are complementary, interdependent or synergistic in a positive way?

- Looking across options, which combination(s) might produce conflicting outcomes, and are there ways to mitigate or avoid the conflicts?

Example: U.S. Central Flyway

Conservation target	Adaptation	Example of specific	Key climate-smart questions
Reduce non-climate stressors	Work with farmers to reduce agricultural runoff into wetland feeding habitats to improve water quality, groundwater recharge, and hydrologic function		How will climate change affect runoff of non-point source pollution from agricultural lands into feeding habitats? What are the best options (e.g., riparian buffers, improved irrigation scheduling) for reducing runoff of pollutants into water bodies, and when and where should they be implemented?
		natural processes and mimic natural patterns	when and where can human-assisted practices be used to best mimic natural patterns?
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wetlands and lakes • Increases in temp. - Species distribution shifts - Asynchronous phenological changes and shifts in resource availability	Potential	(e.g., bedrock geology, soils) to maximize future biodiversity	species? What areas need to be conserved that will maintain that full range under climate change?
	Protect refugia	Identify/protect wetland habitats that will serve as refugia, i.e., where precipitation is projected to stay the same or increase	How will climate change affect wetland water levels and extent? Which wetland areas in or near feeding habitats are projected to persist or increase in size? What should the placement and size of buffer strips be to maintain/protect these areas from development?
	Relocate Organisms	Assist in the translocation of limited-dispersal species to repositioned habitats	How will climate change affect food sources such as fish and submerged aquatic vegetation, and are their dispersal capabilities sufficient for them to adjust? Which species should be moved, and to which sites according to projections of favorable future conditions (see refugia discussion above)?

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Managing For Change

- Managing for change will become increasingly necessary as ecosystems experience regime shifts due to climate change
- To date we have mostly reacted to regime shifts after they have occurred or while they are occurring
- More recently researchers have been working on ways to affect trajectories toward more favorable future states as climate changes
- The same adaptation approaches are used, but under different management contexts and objectives

Example: Alligator River NWR

Target: Multi-Ecosystem Mosaic	Adaptation approach	Example of specific management options	Key climate-smart questions
Bogs, fresh/ brackish marshes, hardwood/ white cedar swamps 	Reduce non-climate stressors	(Persistence) Mitigate runoff of sediments and pollutants from surrounding croplands by preventing further losses (and/or replacing) bottomland hardwood forests	How will climate change related shifts in precipitation patterns and hydrology affect overland runoff of sediments and pollutants? In what locations should priority management of forests be focused to minimize runoff?
	Protect key ecosystem features	(Persistence) Mimic natural hydrology by installing water control structures to reduce the impact of saltwater intrusion	How will sea level rise and changes in the intensity and frequency of large storms affect coastal hydrology? What are the implications for the number, placement and viability of water control structures to mimic natural hydrology?
Protect and preserve wetland	Restore Structure and Function	(Change) Restore structures for coastal soil stabilization by planting flood-tolerant tree species on cleared land	What cleared areas along the coastal edge are most impacted by erosion from sea level rise and storm surge? Which tree species (e.g., black gum, bald cypress) would be most effective as well as least sensitive to climate change?
- Erosion - Saltwater intrusion - Inundation - Increased sediment runoff • Altered hydrology - Rising water table	Refugia	potential sites within the path of connected Refuges (see above) that provide future refugia for endangered species	changes in vegetation and predator-prey relationships shift endangered species habitat along the refuge corridor? What number, location and size of sites is needed for continued provision of habitat?
	Relocate Organisms	(Change) If corridors between refuges do not yet exist/are not possible, manually transport species with limited dispersal capabilities to destination habitats	See climate-smart questions for refugia. Relocate species to appropriate locations identified/ protected.

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More Examples

- Fish: Manage habitat for transition from cold to warm water species
- Forests: “Assisted succession” to new forest type
- Corals: “Inoculation” with more temperature-tolerant symbionts
- Wildlife: Create corridors to connect current habitat to future refugia
- Wetlands: Acquire areas up-watershed to allow for inland retreat

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Cycling Between Persistence and Change

- Moving forward, adaptation will require alternating between managing for persistence, to managing through a change, to managing for persistence of a new system

- While managing for persistence and change can be distinct activities, it is more likely that both types of planning and action will be needed at the same time

- Planning processes must address both short and long term ecological changes, and may even require shifting management goals to accommodate change