Wildlife Adaptation Menu with Example Tactics

This is a draft version of the Wildlife Adaptation Menu. Please do not distribute. Visit www.forestadaptation.org/focus/wildlife to learn more about the project, and contact Stephen Handler (sdhandler@fs.fed.us) for more information. Authors of this menu include: Olivia LeDee (USGS Northeast Climate Adaptation Science Center), Ben Zuckerberg (University of Wisconsin), Chris Hoving (Michigan Dept. of Natural Resources), Stephen Handler (USDA Forest Service and Northern Institute of Applied Climate Science), and Chris Swanston (USDA Forest Service and Northern Institute of Applied Climate Science).

Adaptation Strategies for Population Management

1. Maintain and enhance genetic diversity

Approaches

1.1. Increase genetic exchange between populations

1.1.1. Establish corridors of interior hardwood forest between existing populations of scarlet tanagers

1.1.2. Relocate timber rattlesnakes from one population to another to enhance genetic exchange

1.2. Protect genetic admixture (interbreeding) zones in order to facilitate adaptive genetic exchange

1.2.1. Place reserves at the convergence of different prairie chicken population areas.

1.2.2. Allow new admixture zones where changing climate conditions may draw previously isolated dragonfly populations together.

1.2.3. Identify areas of potential hybridization between species, such as blue-winged and golden-winged warblers or southern and northern flying squirrels.

1.3. Limit genetic exchange to protect isolated populations

1.3.1. Ensure that mainland individuals are not inadvertently transported to island wildlife populations, such as mainland red squirrels being transported to Isle Royale National Park.

1.3.2. Create dispersal barriers to limit genetic exchange between populations

1.4. Protect trailing edge or leading edge populations

1.4.1. Identify and protect "trailing edge" or southerly populations of boreal species such as snowshoe hare, in case they develop different color-shift phenology that allows them to persist in changing conditions.

1.4.2. Promote or invest in "leading edge" populations of Carolina wren in New York and Massachusetts in order to promote future-adapted traits

1.5. Protect populations in disturbed environments because they may contain adaptive traits

1.5.1. Identify wildlife populations that thrive in recently burned areas that may be suited to future conditions with more frequent wildfire (areas of pyrodiversity)

1.5.2. Favor wildlife populations that have survived mega drought events and may be suited to future conditions with more drought stress.

1.6. Protect areas of high phylogenetic or phenotypic diversity or endemism

1.6.1. Establish new protected areas in areas of high phylogenetic diversity

1.6.2. Prioritize phylogenetic diversity hotspots when designing fuel breaks for wildfire protection.

1.6.3. Conserve and protect areas with high likelihood of polymorphism, such as snowshoe hare populations with high degree of coat color polymorphs

1.7. Import individuals with climate-adaptive genetic traits (translocation)

1.7.1. Import southern black bears that may be physiologically adapted to shorter periods of torpor during the winter.

1.7.2. Import individuals that may have physiological traits that allow them to tolerate greater heat stress during the summer.

1.8. Preserve genetic material (gene banks)

1.8.1. Collect tissue samples of critically endangered wildlife for frozen storage, following the example of the Australian Frozen Zoo and other gene banks.

1.8.2. Identify captive populations or museum specimens of critically endangered wildlife and preserve samples of their tissue, such as Karner blue butterfly specimens from Indiana Dunes National Lakeshore

1.9. Restore genetic diversity in isolated or inbred populations (genetic rescue)

1.9.1. Import wolves from the mainland from different populations to restore genetic diversity in an inbred island population.

1.9.2. Use individual eastern Massasauga rattlesnakes from zoos to restore genetic diversity in wild populations through captive breeding programs

2. Maintain metapopulation processes

Approaches

2.1. Translocate individuals or populations to formerly occupied habitat within the existing range (reintroduction)

2.1.1. Capture bison from a thriving population and reintroduce them into unoccupied suitable grassland habitat in the former range.

2.1.2. Move Karner blue butterflies from stable populations into suitable habitat within the historic range in northwest Ohio where they have been extirpated

2.1.3. Establish a population of elk in the historic, but unoccupied range in northeastern Minnesota

2.2. Identify and protect source populations

2.2.1. Protect the source population of cougars in the Dakotas to allow for continued emigration to suitable habitat in the Midwest region.

2.2.2. Protect source American marten populations in New Hampshire to facilitate dispersal to Vermont

2.3. Establish and maintain connectivity between populations through corridors or stepping stones

2.3.1. Establish corridors of interior hardwood forest between existing populations of scarlet tanagers

2.3.2. Identify and protect stepping stone areas nearby and between existing populations, such as creating islands of savanna habitat with lupine in close proximity to occupied Karner blue butterfly areas.

2.3.3. Construct amphibian tunnels to permit movement across roads

3. Facilitate shifts in the geographic range of the species in anticipation of future conditions

Approaches

3.1. Establish corridors and minimize barriers to movement to new suitable habitats

3.1.1. Create highway crossing structures that span barriers to northward movement.

3.1.2. Connect mature northern or boreal forest habitats that are oriented north-south across the landscape to facilitate northward migration of northern flying squirrels.

3.1.3. Concentrate pollinator projects in linear, north-south oriented priority areas to create private land stepping stones through rural and urban landscapes.

3.1.4. Buffer natural cover along north-south trails, like the Iron Belle Trail, through acquisitions, easements, or private land programs.

3.2. Prepare suitable habitat in anticipation of future introduction, reintroduction, or natural range shift of a species

3.2.1. Plant lupine and other nectar sources used by oak savanna butterflies, such as the Karner blue butterfly, in oak pine barrens in northern Michigan.

3.2.2. Provide technical assistance to private landowners to encourage private landowners to create grassland habitat for quail and other grassland birds.

3.2.3. Identify and improve anticipated future stopover or wintering habitat for migratory birds

3.3. Move and release individuals into a population where conditions are now suitable and are expected to improve

3.3.1. Move eastern tiger salamanders from populations in south-central Minnesota to populations north-central Minnesota, where conditions may be more suitable as the prairie-forest border shifts to the northeast.

3.3.2. Release wild turkeys from mid-Atlantic states into New England

3.4. Reintroduce species where climate is expected to remain suitable.

3.4.1. Capture bison from a thriving population and reintroduce them into areas that are expected to be suitable grassland habitat.

3.4.2. Capture copperbelly water snakes from populations that are not listed, and introduce them in wetland complexes in northern Indiana, Ohio, and Michigan that are geographically isolated from extant endangered populations.

3.5. Conserve leading-edge populations (high altitude, northern, etc.)

3.5.1. Identify and protect "leading edge" or northerly populations of temperate species, such as red-bellied woodpeckers, in case they are more suited to take advantage of newly available habitat

3.5.2. Identify and protect high-elevation populations, especially along north-south oriented mountain ranges

3.6. Introduce species to new areas with suitable current and future climate

3.6.1. Release Karner blue butterfly individuals into established savanna habitat in northern locations in the Lower Peninsula of Michigan, beyond where they would be expected to migrate on their own.

3.6.2. Release quail in agricultural landscapes with suitable food, cover, and structure at both local and landscape scales.

4. Sustain positive and reduce negative interspecific and biotic interactions

Approaches

4.1. Increase or protect existing biodiversity.

4.1.1. Restore areas of tallgrass prairie habitat in landscapes dominated by row crops.

4.1.2. Identify vernal pools in upland forests and protect these areas from disturbance during forest management operations.

4.1.3. Identify viable assemblages of Species of Greatest Conservation Need

4.1.4. Manage for functional and or phylogenetic diversity (as opposed to species diversity)

4.2. Manage native competitor species to allow other species to persist or thrive

4.2.1. Trap and relocate fishers out of areas where pine marten populations are struggling to establish.

4.2.2. Remove barred owls to facilitate spotted owl population persistence.

4.3. Detect and remove non-native invasive species

4.3.1. Invest in eradication efforts (trapping, hunting, etc.) to remove non-native feral hogs from protected areas.

4.3.2. Monitor for the presence of non-native constrictor snakes such as Burmese pythons in areas adjacent to known occurrences and remove them.

4.4. Manage predator populations

4.4.1. Manage for higher predator populations to control white-tailed deer populations.

4.4.2. Trap and remove nest predators in turtle recovery areas.

4.5. Restore historic trophic linkages

4.5.1. Reintroduce apex predators such as wolves or lynx in areas where they have been eradicated.

4.5.2. Restore food sources such as wild rice to benefit waterfowl populations.

4.6. Protect functional groups or keystone species that help sustain ecosystem functions

4.6.1. Protect large grazers such as bison in order to sustain savanna and grassland habitats.

4.6.2. Protect prairie dogs in order to provide a prey source and burrows for other species.

4.6.3. Protect non-native flowering species that are sustaining native insects, such as non-native milkweed being used by monarch butterflies

4.7. Reintroduce extirpated species or functional groups

4.7.1. Reintroduce apex predators such as cougars where they have been extirpated

4.7.2. Resurrect extinct/extirpated species that fulfill a critical functional role, such as resurrecting the passenger pigeon in eastern North America.

4.8. Manage extant and emerging diseases

4.8.1. Vaccinate vulnerable individuals or populations against disease, such as vaccinating prairie dogs and black-footed ferrets against the plague bacterium.

4.8.2. Partner with research labs to increase capacity for surveillance, outreach, and management of diseases.

4.8.3. Limit interspecific interactions that can spread disease, such as regulating hunting to reduce white-tailed deer in remnant moose habitats to protect moose from brainworms typically carried by white-tailed deer.

4.8.4. Protect individuals that exhibit natural immunity and resistance.

5. Maintain a sustainable population size by managing reproduction, survival, and migration

Approaches

5.1. Move and release individuals to augment an existing population

5.1.1. Capture sharp-tailed grouse from a large, stable population in northern Minnesota and release them into a smaller existing population in northern Wisconsin.

5.1.2. Augment declining Canada lynx populations in Colorado with individuals from Alaska

5.1.3. Capture moose from an expanding population on Isle Royale National Park and release them into suitable habitat areas in the mainland of Minnesota, Wisconsin, and Michigan.

5.1.4. Move turkeys from southern Michigan to northern Michigan in order to satisfy hunting demand.

5.2. Increase reproduction and survival rates

5.2.1. Install artificial nests or denning sites, such as nest boxes for northern flying squirrels or wood ducks on unoccupied lakes

5.2.2.Provide supplemental food to improve survival for songbirds in winter

5.2.3. Create nesting platforms for black terns to reduce nest loss

5.2.4.Encourage "put and take harvests" toward the northern or upslope range limits for species like pheasants or quail to establish reproductive adults.

5.2.5. Head-starting juvenile individuals to increase survival, for example capturing and raising juvenile Blanding's turtles in captivity for a short period before releasing them into the wild.

5.3. Use captive breeding programs to increase populations of declining or rare species

5.3.1. Captive breeding programs to increase reproduction of highly threatened species such as black-footed ferrets.

5.3.2. Use salvage captive rearing to increase productivity of Great Lakes piping plover

5.4. Manage natural predation to increase populations of declining or rare species

5.4.1. Trap and remove nest predators in turtle recovery areas.

5.4.2. Install predator guards on nest boxes to protect eggs and juveniles from owls, raccoons, cats, and snakes.

5.4.3. Reduce populations of feral cats to protect songbird populations

5.5. Control take, harvest, and illegal harvest.

5.5.1. Implement no-wake zones on lakes around active loon nests.

5.5.2. Enforce regulations against illegal harvest of wildlife species.

6. Manage harvest regulations to manipulate populations of harvestable species

Approaches

6.1. Regulate hunting to increase population size for declining species or species anticipated to be impacted by climate change

6.1.1. Decrease harvest (through season length, bag limits, refuge, etc) to encourage dispersal by surplus individuals along northern or high elevation range limits

6.1.2. Reduce bag limits for declining furbearer species

6.1.3. Set harvest regulations more conservatively (relative to theoretical optimal harvest levels) to allow for direct and indirect impacts of climate change to harvestable surpluses.

6.1.4. Adjust harvest levels for waterfowl species anticipated to decline, such as redhead ducks

6.2. Regulate hunting to decrease population size

6.2.1. Increase hunting limits on white-tailed deer in moose habitat areas to reduce the transmission of brainworm from deer to moose.

6.2.2. Cull populations to prevent the spread of diseases, such as reducing white-tailed deer densities to reduce the spread of chronic wasting disease

6.3. Regulate hunting to facilitate shifting phenology or species ranges

6.3.1. Revise wildlife harvest regulations to track changes in timing, such as changing migration dates for waterfowl.

6.3.2. Set population goals high enough to encourage evolution or dispersal, such as setting high population goals for reintroduced elk in Wisconsin to allow for gradual dispersal to new areas.

7. Plan for and reduce human disturbance and human-wildlife conflict

Approaches

7.1. Anticipate and manage conflict from increasing populations and range expansions

7.1.1. Implement chemical or hormonal contraception in white-tailed deer to reduce populations in urban areas.

7.1.2. Increase trapping on orchards to reduce crop damage from expanding opossum populations in northern states

7.2. Manage conflict associated with societal adaptations to climate change (coastline hardening, land-use changes, etc.)

7.2.1. Avoid the conversion of natural ecosystems to agricultural uses in forested landscapes as land-use pressure increases.

7.2.2. Locate utility corridors around critical habitats and use wildlife-friendly options when possible, such as planting native pollinator species in powerline right-of-ways.

7.3. Reduce or limit access to sensitive habitats or environments

7.3.1. Route recreational trails around or away from occupied Karner blue butterfly habitat.

7.3.2. Alter timing of forest management operations or recreational activities to avoid compacting below-the-snow environments.

7.4. Reduce or remove human disturbance stress during sensitive time periods

7.4.1. Limit recreational trail access to areas that might be critical for nesting birds.

7.4.2. Implement temporary road closures to restrict access to elk populations during calving season.

7.4.3. Restrict dog access on beaches to reduce disturbance and stress to beach-nesting birds.

7.5. Implement nonlethal behavioral control methods (barriers and deterrents)

7.5.1. Use trained animals such as dogs to "haze" large carnivores away from livestock, crops, and other areas that may attract them.

Adaptation Strategies for Habitat Management

8. Protect, restore, and maintain sources of food, water, and cover as components of habitat.

Approaches

8.1. Manage for plant species diversity and complexity

8.1.1. Promote a diversity of species and age classes with forest management, such as implementing variable-density thinning in a red pine plantation to create diverse canopy cover and light environments for tree regeneration.

8.1.2. Seed a diversity of aquatic vegetation in wetland restoration projects to create a variety of food sources at different times for migratory waterfowl.

8.2. Promote plant genetic diversity

8.2.1. Use seed from multiple seed zones during grassland restoration efforts

8.2.2. Use seed from southerly populations or areas that have experienced drought in recent past.

8.3. Prioritize native vegetation for habitat management and restoration

8.3.1. Use native tree species to reforest old agricultural land.

8.3.2. Use seed mixtures with native drought-tolerant species in grassland restoration projects

8.4. Protect and create a diversity of microhabitats and microclimates

8.4.1. Protect and create small vernal pools in mesic forests.

8.4.2. Implement forest management actions that promote diverse canopy cover, light environments, down woody habitat, and diversity of tree sizes.

8.5. Enhance primary food sources for specialist climate-sensitive species

8.5.1. Promote lupine species for Karner blue butterfly habitat.

8.5.2. Protect milkweed along roadsides, utility corridors, and grasslands for monarch butterfly habitat.

8.6. Provide supplemental food sources

8.6.1. Promote a diversity of mast-producing species through forest management, such as planting soft mast species to supplement hard mast species in oak forests.

8.6.2. Provide supplemental forage for a reintroduced elk herd during especially harsh winters.

8.6.3. Create mixed plantings of forbs, legumes and grasses to produce insects at critical periods for birds.

8.7. Create or maintain replicated sources of food, water, and cover in a variety of locations across the landscape

8.7.1. Manage for early-successional aspen forests in multiple locations adjacent to winter deer yards.

8.7.2. Restore pothole wetlands and riparian oxbows in agricultural landscapes to provide redundant waterfowl habitats.

8.8. Maintain or mimic natural disturbance regimes to enhance habitat quality

8.8.1. Restore fire to fire-adapted ecosystems through prescribed burning

8.8.2. Design management practices that mimic natural disturbance in terms of size, shape, timing, and intensity, such as creating small harvest gaps in northern hardwoods forests to mimic a small windthrow event.

8.8.3. Match historic variability in size, shape, timing, and intensity of disturbances

8.8.4. Use water control infrastructure to replicate flooding regimes in wetlands

9. Adjust management of food, water, and cover to align with expected future conditions.

Approaches

9.1. Use non-local, future-adapted genotypes in habitat management

9.1.1. In habitat restoration projects, select seed sources based on anticipated future climate conditions, such as selecting seed zones from central or southern Minnesota when planting in northern Minnesota.

9.1.2. Establish grain food plots with cultivars that are expected to be tolerant of future climate conditions.

9.2. Create new sources of food, water, and cover in anticipation of future conditions

9.2.1. Promote a new suite of conifer species such as eastern white pine to provide thermal cover in order to replace declining boreal conifers.

9.2.2. Encourage hickory species as a new source of hard mast in northern states.

9.2.3. Plant secondary nectar sources for threatened butterfly species.

9.2.4. Invest in water control structures to allow for controlled wetland management in new areas.

9.3. Identify temporary water storage during times of high water

9.3.1. Restore historic floodplains and oxbows to retain floodwaters.

9.3.2. Divert excess water into temporary holding structures during floods.

9.4. Manage for sources of food, water, and cover across the annual cycle and different life stages in response to changing phenology

9.4.1. Pump water to accessible tanks for ungulates and other species during droughts.

9.4.2. Restore permanent wetlands by removing drain tile in agricultural landscapes

9.4.3. Create scrapes to retain potential water sources for amphibians

9.5. Establish green infrastructure or hard defenses to protect habitat from anticipated climate impacts

9.5.1. Plant flowering species that provide nectar for pollinators during early, middle, and late phases of the growing season to account for unpredictable phenology.

9.5.2. In northern areas, restore wetlands with diverse aquatic vegetation to provide food sources for ducks that may reside for longer periods or eventually remain over winter.

9.5.3. Increase forest structure to provide cover for snowshoe hare

10. Establish and enhance protected areas or habitat reserves

Approaches

10.1. Create large, intact, or aggregated protected areas

10.1.1. Establish conservation easements adjacent to protected Federal or State lands.

10.1.2. Pursue land swaps to consolidate protected lands into larger consolidated blocks.

10.2. Increase the number of small protected areas

10.2.1. Establish municipal or community-owned forests that are protected as public land

10.2.2. Encourage private conservation easements through favorable tax incentives or agricultural set-aside programs.

10.3. Increase representation and replication of protected species and habitats

10.3.1. Establish protected areas along multiple stretches of Great Lakes shoreline.
10.3.2. Ensure that protected areas account for a minimum percentage of all native ecosystem types.
10.3.3. Prioritize acquisitions of protected lands in under-represented settings, such as fertile soils, low elevations, or level ground.
10.3.4. Use landscape protection analyses, such as USGS's GAP or TNC's Conserving Nature's Stage analysis, to strategically prioritize future conservation acquisitions

10.4. Select reserves that maximize biodiversity protection for a suite of species
10.4.1. Protect prairie remnants with high diversity of grasses and forbs.
10.4.2. Protect forested areas that also contain an intact, native ground flora.
10.4.3. Focus land acquisition for hunting or fishing on lands that provide habitat to multiple Species of Greatest Conservation Need or other climate-vulnerable species

10.5. Orient suites of protected areas in ways that span gradients in climate
10.5.1. Design protected areas to run north-south to allow for species movement, such as northerly-shifting white-throated sparrows.
10.5.2. Design protected areas to run perpendicular to coastlines where maritime or lake effect create narrow growing zones
10.5.3. Design protected areas to run up and down slope to cut across narrow climate zones associated with elevation
10.5.4. Prioritize protected area conservation where elevation, latitude, and lake/maritime effects work synergistically, such as the Appalachian Mountains.

10.6. Create durable protected areas that maximize topographic and geologic variety
10.6.1. Create protected areas that contain numerous wetlands in an otherwise uniform landscape.
10.6.2. Use landscape analyses and associated maps, such as TNC Conserving Nature's Stage analysis, to identify areas with relatively high topographic (slope, aspect, elevation) and geologic variety

10.7. Protect areas at high risk of change due to climate or land use change
10.7.1. Protect peatland ecosystems in southern Minnesota for declining bird communities.
10.7.2. Restore high-elevation spruce-fir forests in the Allegheny Mountains of West Virginia.

10.8. Protect climate refugia across the landscape
10.8.1. Design protected areas to include cool spots on the landscape that may be slower to change.
10.8.2. Protect areas that contain disjunct or relict ecosystems, because they have withstood previous periods of environmental change.

10.9. Protect sites that are expected to provide future suitable habitat
10.9.1. Identify and protect areas with expected future climate conditions that are similar to local current conditions.
10.9.2. Protect areas that are geophysically similar (soils, hydrology, pH, etc) to areas to the south or lower elevation that have habitats valued in that region
10.9.3. Work with partners to change levels of protection on public land as valued wildlife species move in our out of an area (e.g., critical habitat for endangered species)

10.10. Protect stepping stones, adjacent reserves, and corridors
10.10.1. Identify and protect stepping stone areas to connect existing populations with future suitable habitat, such as creating islands of savanna habitat with lupine northward of occupied Karner blue butterfly areas.
10.10.2. Establish long recreational trails in a north-south orientation and buffer them with natural cover to facilitate dispersal
10.10.3. Establish trails or other linear conservation areas that run perpendicular to coastlines to facilitate movement across lake/marine climate zones or retreat from sea-level rise

10.11. Create temporary or dynamic reserves
10.11.1. Establish "rolling" conservation easements perpendicular to shorelines that are anticipated to experience increased inundation.
10.11.2. Revise land acquisition plans to acquire/divest of lands as species shift out of protected lands and into unprotected lands

10.12. Protect habitat across the annual cycle and life stages
10.12.1. Protect winter habitat complexes for white-tailed deer as well as spring foraging areas in adjacent uplands.
10.12.2. Protect both breeding and wintering habitat for Kirtland's warbler in the upper Great Lakes and Bahamas

10.13. Protect current safe havens for climate vulnerable populations to ensure those populations are available for future conservation efforts
10.13.1. Protect critical habitat for threatened or endangered species, such as groundwater-fed wetlands with adjacent uplands for eastern Massasauga rattlesnakes.
10.13.2. Protect important stopover habitat for migratory birds in the western Lake Erie watershed.

10.14. Protect sufficient habitat for viable populations to be self-sustaining and of sufficient quality to create surplus dispersers
10.14.1. Create large complexes of interior forest habitat for birds like scarlet tanagers.
10.14.2. Increase habitat quality along northern or high elevation edges of a species' geographic range

11. Promote wildlife habitat conservation on lands outside of protected areas

Approaches

11.1. Identify and restore degraded landscapes with high potential habitat quality
11.1.1. Remove marginal agricultural land from production and restore to native vegetation
11.1.2. Implement prescribed fire in longleaf pine stands to restore open habitats and reduce encroachment of woody species to improve habitat for red-cockaded woodpeckers

11.2. Reduce or limit barriers to wildlife movement across private land
11.2.1. Promote wildlife-friendly fencing, such as incorporating gaps or "lay-down" areas when livestock are not present.
11.2.2. Restore wetlands on private lands to provide stopover areas for migratory waterfowl
11.2.3. Develop wildlife crossing structures across major impediments like highways

11.3. Manage private lands near and between public lands (buffer zones)

11.3.1. Manage for young forest cover on private land next to protected conifer swamps to provide a continuous complex for deer forage.
11.3.2. Manage for mature forest characteristics on private land next to protected old-growth forests

11.4. Enhance green infrastructure in urban or developed landscapes
11.4.1. Plant a diversity of pollinator species in urban and developed landscapes
11.4.2. Connect urban parks and other open spaces to provide greenways for wildlife movement

11.5. Manage agricultural land to provide compatible wildlife use
11.5.1. Establish or maintain grazing rates on public grasslands that also allow for wildlife use
11.5.2. Establish prairie vegetation strips in the midst or on the perimeter of row crop fields to provide pollinator habitat.

11.6. Manage forest land to provide compatible wildlife use
11.6.1. Retain and encourage increased large woody habitat in managed forest land (standing snags and downed logs)
11.6.2. Manage forests to provide young regeneration of browse species adjacent to deer wintering complexes

11.7. Influence land use to prevent habitat loss on private land (legal, financial, regulation)
11.7.1. Establish incentives to promote in-fill development in metropolitan areas rather than suburban and exurban development.
11.7.2. Promote conservation easements through tax incentive programs

Additional Adaptation Strategies

12. Intentionally choose to take no action

Approaches

12.1. Take no action in some situations as part of an overall triage strategy
12.1.1. Elect to focus resources on threatened, but viable SGCN populations
12.1.2. Divert resources from high-cost, low conservation value wildlife management areas or reserves
12.1.3. Elect not to pursue high-cost, socially unacceptable conservation measures such as assisted migration in order to focus on more viable actions.

12.2. Designate "no action" areas as a control to compare with management interventions
12.2.1. Select areas to monitor bird species in managed versus unmanaged forests
12.2.2. Compare reproduction for waterfowl where shallow lakes are managed differently

12.3. Allow for autonomous adaptation, or unassisted adaptation to climate change
12.3.1. Monitor changes in arrival dates and productivity of short-distance migratory birds in response to changing temperature and food sources
12.3.2. Plant diverse suites of grassland plants and monitor changes in phenotype and genotype in response to changing climate

13. Engage human communities in wildlife conservation

Approaches

13.1. Develop outreach and technical assistance programs for the public

13.1.1. Work with stakeholders ahead of time to communicate why climate change will result in noticeable change that adaptation actions may not be able to address, such as with declining moose populations in Minnesota.

13.1.2. Facilitate the expected expansion of bighorn sheep in Colorado by establishing technical assistance programs for private landowners to construct wildlife-friendly fencing and enhance open, fire-dependent habitat.

13.1.3. Target outreach programs to reach diverse audiences, including urban and underserved communities.

13.2. Provide access for wildlife-dependent recreation

13.2.1. Diversify use categories in protected areas to allow for compatible forms of recreation

13.2.2. Develop recreational opportunities outside of protected areas, such as birdwatching tours in metro parks or agricultural landscapes

13.3. Increase local community involvement in wildlife management

13.3.1. Develop citizen-science programs to monitor wildlife use or changing phenology in protected areas

13.3.2. Respectfully solicit input from local indigenous communities regarding the management of wildlife and wildlife habitat in protected areas or ceded territories

13.3.3. Work with stakeholders ahead of time when climate adaptation will result in noticeable change, such as "no action" responses to climate change.

13.4. Promote community-managed conservation lands

13.4.1. Identify private forest lands adjacent to rural communities that may be viable candidates for municipal ownership and funding through the USDA Forest Service Community Forest Program

13.4.2. Establish cooperative agreements among ranchers to restore and manage wildlife habitat for nature-based tourism and hunting opportunities.

13.4.3. Create endowments for management of community-managed reserves or private lands

13.5. Respect and incorporate landscape values of indigenous communities in management decisions

13.5.1. Consult with Tribal Historic Preservation Officers, elders, and other knowledge holders to learn about the historical and present community relationships with an area.

13.5.2. Design management actions that also enhance and sustain indigenous community values, such as coordinating prescribed fires in areas and during seasons that will enhance blueberry-picking opportunities.

13.6. Pay for ecosystem services or provide subsidies for income losses

13.6.1. Subsidize farmers and ranchers for lost income due to wildlife predation or harassment of livestock

13.6.2. Subsidize the cost of wildfire mitigation actions upstream from municipal water sources through payments from the water utility, based on the avoided cost of water treatment from maintaining a forested watershed.

13.7. Coordinate across agencies and scales to make sure programs are complementary

13.7.1. Coordinate with upstream and downstream land owners and agencies while designing habitat restoration projects along river corridors.

13.7.2. Work with local agencies and local communities to plan supporting management actions and outreach programs when planning species movements such as translocations or range expansions.

13.7.3. Identify "boundary organizations" that can facilitate collaboration across organizations and help with landscape-scale adaptation projects.

13.8. Promote sustainable urbanization

13.8.1. Establish incentives to promote infill development in metropolitan areas rather than suburban and exurban development.

13.8.2. Connect urban parks and other open spaces to provide greenways for wildlife movement