How to Respond to Changing Ecosystems:

Resist, Accept, or Direct?

Ecosystem Transformation Workshop
November 14–16, 2018
Seattle, WA

The American Fisheries Society (AFS) and The Wildlife Society's (TWS) Climate Change and Wildlife Working Group identified ecosystem transformation as a top priority topic to address the emerging climate change issues in natural resource management. A nominated team of experts participated in this workshop on the topic that will result in two synthesis publications. The outcomes of this effort will inform TWS and AFS policy strategies and be used to engage the broader membership of both societies, as well as policy makers and the public.

Framing the issue of ecosystem transformation

Ecosystems are transforming under climate change, with shifts in important ecological functions and services occurring at unprecedented rates. As systems approach socio-economic and ecological thresholds, our current management toolbox has proved to be incomplete for maintaining critical ecosystem services, including fisheries production and the provision of wildlife habitat. Multiple approaches are therefore needed to address the varying uncertainties we face. Three major alternatives can be envisioned, depending on the circumstances: resist, accept, or direct change.

RESIST

Some changes can be resisted. Managers will work to maintain ecosystem processes, function, and composition without experiencing dramatic, threshold-crossing changes.

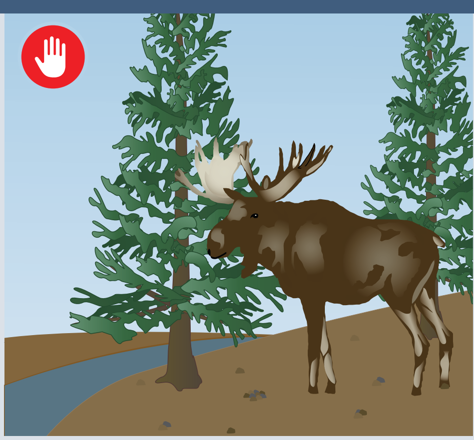
ACCEPT

Many changes can be accepted, perhaps because they cannot feasibly be resisted or because they are acceptable to—or even desirable by—society. Managers will work to ease the transition.

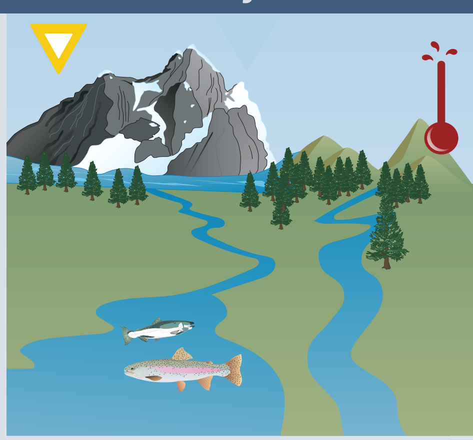
DIRECT

A few changes can be directed toward a different state, either because resistance is unrealistic or there is an opportunity to direct the change to a more desirable future state. Managers will face a new frontier in overseeing this process.

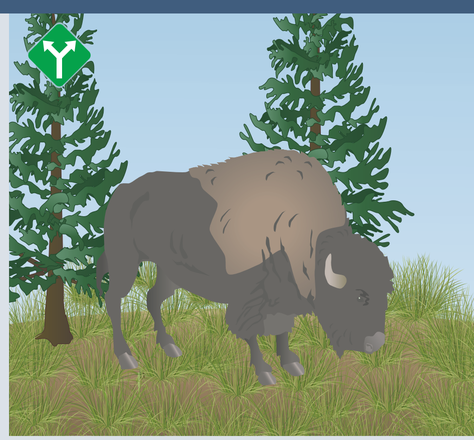
Kenai Peninsula, Alaska: A Case Study



Stream banks are restored, the most feasible and deleterious invasive species are eradicated, fire is managed progressively, and landscape connectivity is maintained through fish and wildlife passages under or over highways. Non-native species are monitored for escapement as climate changes.



Glaciers are melting, non-glacial streams are warming, tree line is rising, and wetlands are drying. Many invasives are not managed either due to a lack of feasibility or perceived threat. Society has accepted the changes in fish and wildlife communities, even with higher costs to ecosystem services.



A spruce bark beetle epidemic and human-caused fire have shifted white spruce forests into a novel grassland ecosystem. Non-native trees from neighboring regions are being planted, and the introduction of large grazers is being considered to stabilize the new grasslands and related communities.

A need to respond to widespread eco

Ecosystems change naturally and they've changed a lot in the past—even without the influence of humans. Resource managers need to adapt their outlook to respond to environmental change.

Tracking Alaska's shifting fish communities. Alaska's commercial fisheries support over 50,000 jobs and produce more fish than any other U.S. state. However, increasing ocean temperatures are changing the abundance and distribution of commercially important fish populations such as Alaskan pollock and Pacific cod, thereby putting commercial fisheries and coastal communities at risk. National Oceanic and Atmospheric Administration (NOAA) fisheries scientists are currently developing models to improve assessments and projections to better inform future management decisions.

Walleye pollock and flatfish catch in the Bering Sea. NOAA.

Resisting the drought-induced changes of Southwest US forests.
Prolonged drought with record-high temperatures is leading to wildfire and bark-beetle mortality at an unprecedented scale in coniferous forests of the Southwest. In many areas, the forests are not regenerating after disturbance, but rather, are being replaced by persistent woodlands and shrublands of oak, piñon, and locust, leading to changes in snowpack, hydrology, and wildlife habitat. Forest managers are resisting these changes with forest thinning and controlled burns to reduce disturbance extent and severity.

Controlled burn in Yosemite National Park. Rennett Stowe / CC BY 2.0.

Managing invasive shrubs in Southwest streamside forests.
Streamside forests dominated by native cottonwoods and willows have been changing since the introduction of salt cedar. These forest transformations are contributing to lower water tables and are degrading critical habitats that support native fish and wildlife populations, which in turn support outdoor recreation economies. As these processes continue, investing now in understanding how to best resist or direct such forest change is necessary for the protection of fish and wildlife resources in the coming decades.

Tamarisk in Las Vegas Wash. US Fish & Wildlife Service.

system changes across the nation

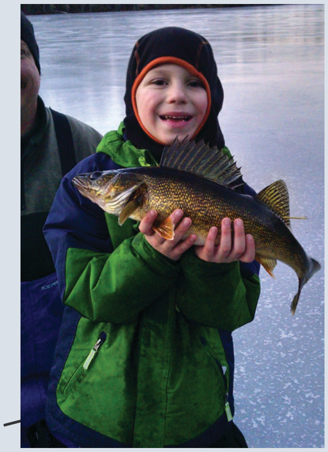
However, change is now happening more profoundly and more quickly than ever before.

Restoring Carter Lake. Urbanization accelerated the accumulation of nutrient and polluted runoff. This caused frequent harmful algal blooms and fish kills, severely reducing the use and value of this popular metropolitan lake. Conflicts between user groups prevented collaboration until a community-based planning process brought together all twenty two entities with legal authority at Carter Lake, incorporating viewpoints into a $6 million project to implement watershed-wide best management practices and restore the health of the lake. The success and longevity of this directed change will rely on active adaptive management and continued collaboration into the future.

Carter Lake before (inset, Carter Lake Preservation Society) and after restoration (main, Eric Fowler).

Santa Cruz River, Arizona. National Park Service / A. W. Biel.

Managing river flows for native fishes in the Southwestern United States. Climate change is reducing surface water availability and increasing the length and severity of droughts. Southwestern rivers are experiencing transformations to intermittent stream flows and shifts from native species to non-native, drought-tolerant species. However, adaptive flow management provides opportunities to resist these shifts by mimicking natural flow regimes to benefit native and discourage non-native species.



Wisconsin walleye fishing. Gregory Sass.

Stocking to sustain Wisconsin fisheries. Walleye angling generates over $33 million for Wisconsin, annually, and is a source of cultural identity for the state. Yet, climate change is impacting temperate lakes, altering the ability of these ecosystems to support walleye populations. Fisheries managers can augment natural walleye populations with hatchery-released fish to ensure the long-term recreational, economic, and cultural value of these sportfish resources.

Native lake trout are making a comeback in Lake Huron. USFWS Midwest Region / CC BY 2.0.

Recovering Lake Huron's native food webs. The Great Lakes commercial, recreational, and tribal fisheries are collectively valued at more than $7 billion annually and support more than 75,000 jobs. The collapse of non-native prey species and transformation of food webs in Lake Huron threaten this economically and culturally important industry. Management is responding to this change by actively fostering the transition back to native fish predators and prey.

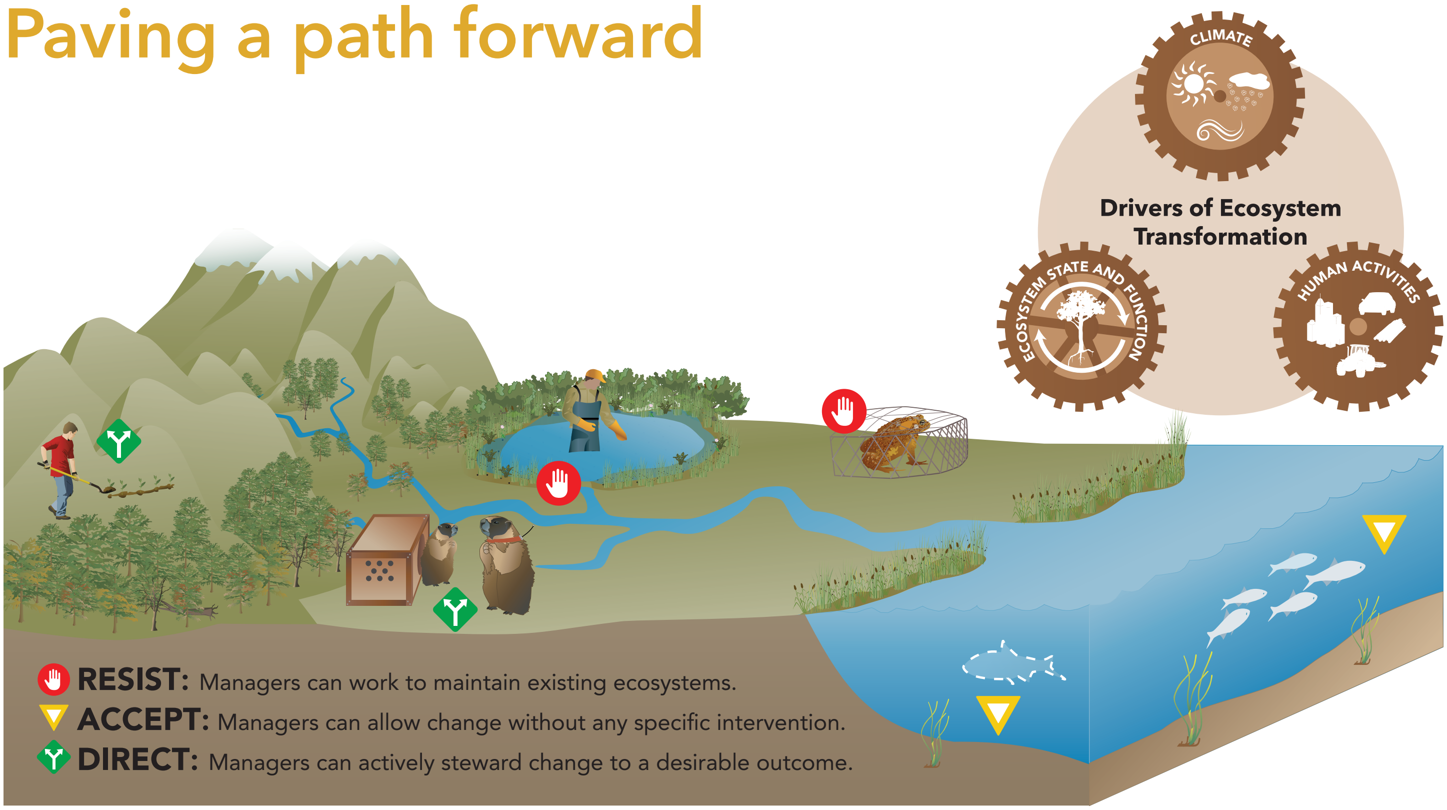
South Texas cattle grazing. AgriLife Today / CC BY-NC-ND 2.0.

Adjusting Southern grazing practices. Due to long-term changes in temperature and water availability that influence patterns of forage availability, ranchers and permittees are changing when, where, and how many animals they graze in a given year. In some cases, combinations of weather and uncharacteristic stocking rates can lead to changes that diminish options for future productivity. Changing grazing can dramatically alter which fish and wildlife species increase or decrease on different parts of landscapes.

Coastal marsh in Louisiana. Tim Carruthers.

Preserving Gulf Coast marshes. In the early 2000s, Gulf Coast marshes experienced an unprecedented 250,000 acre die-off, likely as a result of severe drought. This rapid loss may foreshadow future transformation of these marshes, in many cases to open water. Such losses result from the combined effects of sea-level rise, acute and chronic drought, subsidence, and other stressors. River diversions are being implemented to provide salt marshes with needed sediments.

Paving a path forward



We face a pivotal decision-making point in charting the future path for natural resource management. Managers have multiple non-mutually exclusive strategies available within an adaptive management decision framework. To resist changes and maintain historical conditions, managers can consider options, such as lakeshore restoration to minimize runoff or removal of invasive species to encourage native species interactions. To accept changes and cope with new outcomes, managers can maintain trophic interactions by allowing new species to enter ecosystems while other species may disappear. To direct changes towards a new desirable ecosystem structure and function, managers can consider options like translocating small burrowing mammals to promote healthy soils or assisted colonization of plants to increase carbon sequestration.

From left to right, top to bottom: a shift in seasonality leaves winter snowshoe hares more vulnerable to predation (Frostnip907 / CC BY-NC-SA 2.0); rising temperatures and spreading pathogens threaten the survival of spotted salamanders (Peter Paplanus / CC BY 2.0); sea level rise and intensifying coastal development diminish remaining habitat for piping plovers (Putneypics / CC BY-NC 2.0); and melting sea ice habitat forces walruses to crowd ashore (US Fish & Wildlife Service, Alaska).

Taking action in the face of change

In sustaining essential ecosystem functions and services, adapting to ecosystem transformation benefits all people. Still, there is great uncertainty in the changes to come and the path forward is unclear. The scientific community can help decision-makers by increasing its understanding of how ecosystems will transform. After identifying both the desirable and unacceptable outcomes, managers can develop appropriate actions, all the while remaining flexible in their approach as they learn more. Today's leadership and decision making can improve our ability to respond to ecosystem transformation by supporting efforts to understand the trajectories of change, the efficacy of current management approaches, and the best design practices for resisting and directing transformation in order to achieve desired ecosystem goals.

US Fish & Wildlife Service biologists releasing salmon after data collection in Andreafsky River, Alaska. US Fish & Wildlife Service.

Anticipating ecosystem transformation

- Define clear objectives for ecosystems with **stakeholder involvement**.
- Assess health of ecosystems and **measure ongoing change** by collating available knowledge and identifying gaps to fill.
- **Identify barriers** that prevent planning and decision making from achieving ecosystem objectives.
- Design actions to achieve objectives **using multiple approaches** while avoiding decisions that reduce future flexibility.

US Fish & Wildlife Service removing invasive riparian vegetation in Condor Canyon, Nevada. US Fish & Wildlife Service.

Managing for ecosystem transformation

- Regularly address objectives for ecosystems with **stakeholder input**.
- Use pilot interventions that **examine key uncertainties** in how ecosystems respond both to ongoing change and to different management actions.
- Conduct **experimental research** to reduce uncertainty in ecological responses to different climate trajectories.
- **Manage iteratively**, learning from management success and failure.
- Expect more frequent surprises as ecosystem transformations accelerate and **make course corrections** as needed.

Participants at the Ecosystem Transformation Workshop held in Seattle, Washington on November 14-16th, 2018.

Cover photo: Coconino National Forest / CC BY-SA 2.0.

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