



NCA4: Climate Impacts on Tourism & Recreation

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East-West Center
NOAA One Seminar Series
August 14, 2019



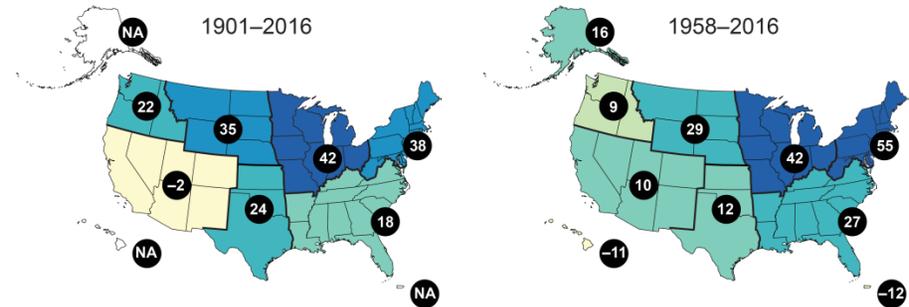
A changing climate is affecting and will continue to affect recreation and tourism (T&R)

- Economies of some regions and sectors are more dependent on tourism and recreation than others, but all are impacted
 - Some will have loss of revenue and identity, but also new opportunities
- Climate change affects recreation through three pathways (Ch22 NGP):
 1. Direct impacts to the ecosystems and wildlife or fish populations of interest
 2. Changes in environmental conditions that directly affect recreationists or tourism
 3. Effects of adaptation policies on habitat quality or recreational enjoyment (for example, energy policies that result in higher fuel costs, making distant trips more expensive) – *speculative*
- Impacts are highly interdependent and compounding
- Proactive management strategies, such as the use of projected stream temperatures to set priorities for fish conservation, can help reduce disruptions to tourist economies and recreation.

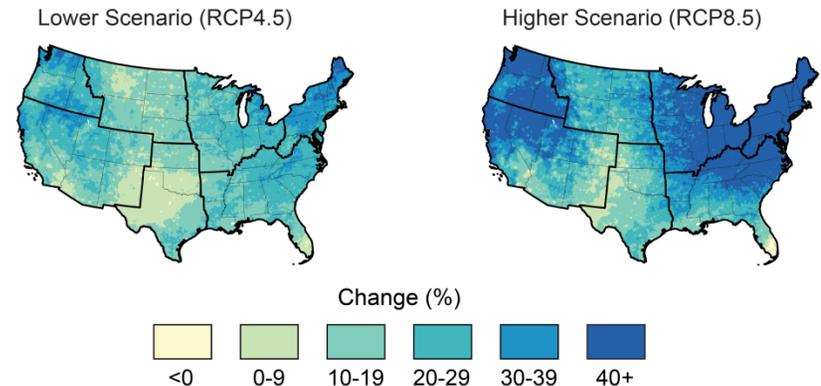
Climate Variables [NCA4 V1, and V2 Ch.2]

- Heat waves
- Extreme precipitation and flooding
- Frequency and intensity of storms and hurricanes
- Pervasive and severe drought
- Reduced snowpack and sea ice
- Increased wildfire activity
- Sea level rise
- Ocean warming and acidification

Observed Change in Total Annual Precipitation
Falling in the Heaviest 1% of Events



Projected Change in Total Annual Precipitation
Falling in the Heaviest 1% of Events by Late 21st Century



Vol 1, Figure 2.6: Heavy precipitation is becoming more intense and more frequent across most of the United States, and these trends are projected to continue in the future.

Tourism & Recreation Impacts

- Biodiversity & Ecosystems
- Coral Reefs
- Coastal & Marine Systems
- National & State Parks
- Recreational Waters
- Wildfire & Air Quality
- Livelihoods of Indigenous Peoples



Figure 1.13: Razor clamming draws crowds on the coast of Washington State. This popular recreation activity is expected to decline due to ocean acidification, harmful algal blooms, warmer temperatures, and habitat degradation.

From Figure 24.7, Ch. 24: Northwest (Photo courtesy of Vera Trainer, NOAA).

Biodiversity & Ecosystems

- Landscapes are essential to regional identities and tourism industries
 - Climate change influences plant and animal species' physiology, growth, mortality, distribution, and reproduction
- Autumn foliage tourism in the Northeast contributes billions of dollars to the regional economy (Ch18 NE)
- Species such as moose, which drive a multimillion-dollar tourism industry, are already experiencing increased parasite infections and deaths from ticks (Ch18 NE)
- Warmer spring temperatures are associated with earlier arrivals of migratory songbirds.
- Some birds are not expected to migrate as far south in response to milder winters, which could affect birding and hunting recreational opportunities. (Ch19 SE)



Cascading Impacts – North Great Plains

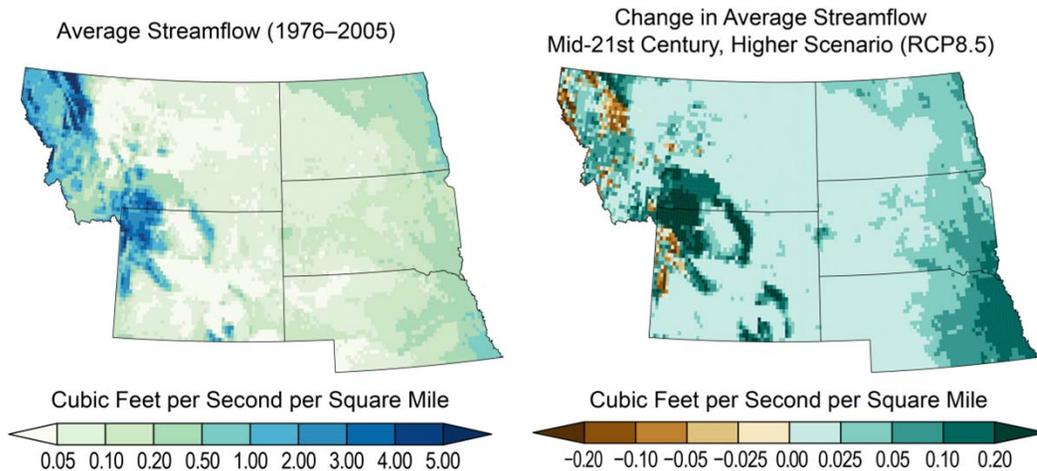


Figure 22.3: Annual streamflows are expected to increase across much of the eastern part of the region, with isolated but important decreases in the western highlands.

Sources: NOAA NCEI and CICS-NC.

- Shifts in habitat suitability in favor of warmwater fish projected to reduce coldwater fishing in the Northern Great Plains by \$25 mil/year (RCP4.5) and \$66 mil/year (RCP8.5) by 2100
- Changes in snowpack, spring snowmelt, and runoff resulted in more rapid melting earlier peak runoff due to rapid springtime warming
 - Lower streamflows, especially in late summer
 - Combined with warmer air temperatures, stream temperatures rise
 - Accelerated hybridization and genetic dilution of native trout species with non-natives

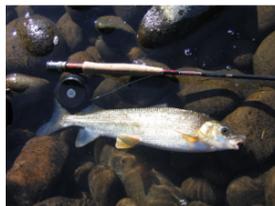
- Increased vulnerability of coldwater fish to disease
- Proliferative kidney disease (PKD) killed thousands of native mountain whitefish in Montana in 2016
- Month-long closure of 180 miles of the Yellowstone River to water-based recreation
- Economic impacts to local communities ranged from \$363,600 to \$529,240

A lengthy stretch of the Yellowstone River is closing after 20,000 or more fish suddenly died



Ruffin Prevost, Reuters Aug. 19, 2016, 8:23 PM

(Reuters) — Montana wildlife officials have closed a lengthy stretch of the Yellowstone River to all recreational activities at the height of the summer tourist season following the deaths of thousands of fish this week from a rare but virulent microbial parasite.



The wildlife agency found more than 2,000 mountain whitefish dead.
Wikimedia Commons

The drastic move, announced on Friday, was aimed at preventing the parasite's spread to other waters in a state where fly fishing is a cherished pastime for residents and a key draw for visiting anglers

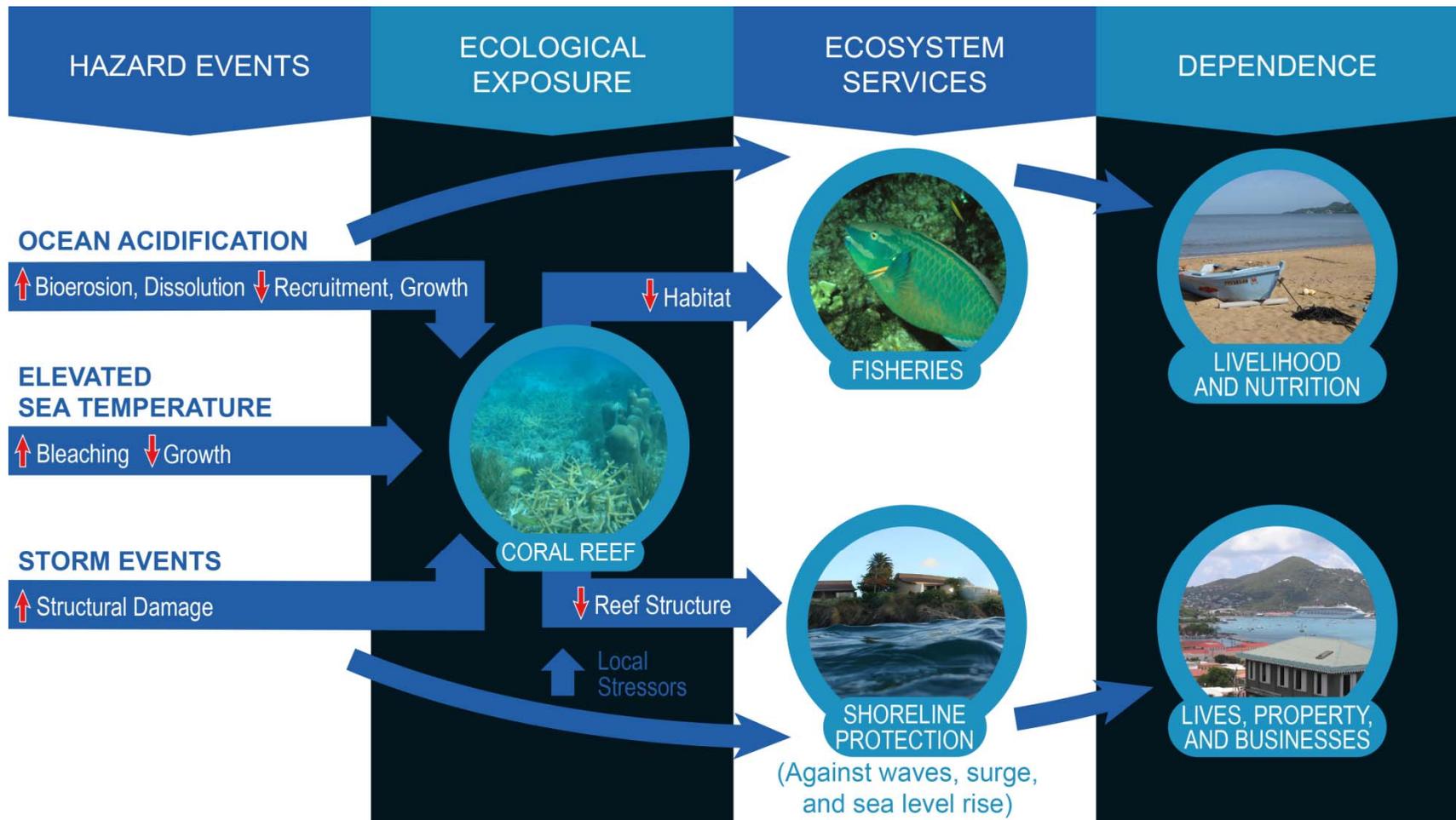
“Governor Steve Bullock called the fish kill ‘a threat to Montana’s entire outdoor economy and the tens of thousands of jobs it sustains.’

Outdoor recreation supports more than 64,000 Montana jobs and brings in almost \$6 billion annually, Bullock said.”

<https://www.businessinsider.com/r-deadly-fish-parasite-forces-yellowstone-river-closure-in-montana-2016-8>

Coral Reefs – HI&USAPI, Caribbean, SE

Figure 20.10 Connections between climate-related impacts, responses of marine habitats and species to these impacts, and, ultimately, the effects to ecosystem services and the human community. (Photos: NOAA)



Reef ecosystem services will decline

- Loss of coral reef structure results in a decline in fish abundance and biodiversity, negatively impacting tourism, fisheries, and coastal protection
- Loss of reef recreational benefits in the US is ~\$140 billion by 2100 (RCP8.5) (Ch9 Oceans)
 - Potential losses of up to 90% of the reef recreation value in Puerto Rico by 2100 (Ch20 Caribbean)
 - Fajardo/Culebra/Vieques generated ~\$217 mil/year for T&R and \$1 mil/yr in coastal protection
 - In Hawai'i under RCP8.5: economic loss of \$1.3 bil/year by 2050 and \$1.9 bil/year by 2090 (Ch27 HI&PI)
- Warming reductions in the 2015 Paris Agreement are projected to delay the onset of annual severe bleaching by an average of 11 years (Ch27)



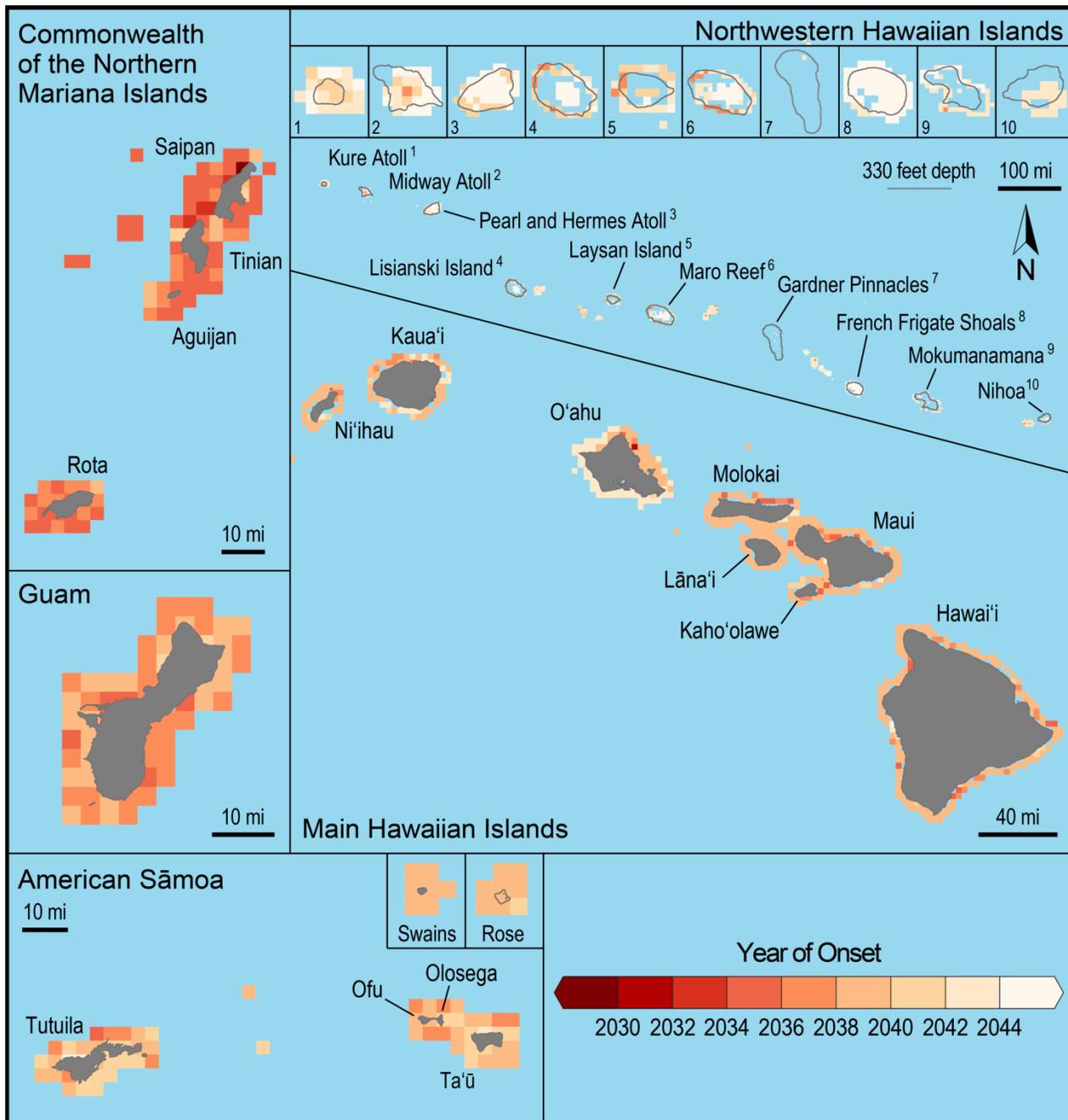


Figure 27.10: The figure shows the years when severe coral bleaching is projected to occur annually in the Hawai'i and U.S.-Affiliated Pacific Islands under a higher scenario (RCP8.5). Darker colors indicate earlier projected onset of coral bleaching. Under projected warming of approximately 0.5°F per decade, all nearshore coral reefs in the region will experience annual bleaching before 2050.

Source: NOAA.

Coastal & Marine Systems

- Diverse ecosystems - beaches, intertidal zones, reefs, seagrasses, salt marshes, estuaries, and deltas that support fisheries, recreation, and coastal storm protection
 - Property and infrastructure, cultural landscapes, historic structures, recreational structures

- Seasonal ocean temperature changes shifted phytoplankton blooms (Ch18 NE)
 - Timing of fish and invertebrate reproduction
 - Marine fisheries and spawning
- >74% of beaches in upper Texas coast affected by SLR, beach erosion averages ~10 ft/year (Ch23 SGP)
- ~60% of beach transects studied in Puerto Rico experienced erosion (1970-2010) (Ch20 Car)
 - 5% suffered very high erosion, with a beach loss of 3.97 feet to 6.56 ft/year

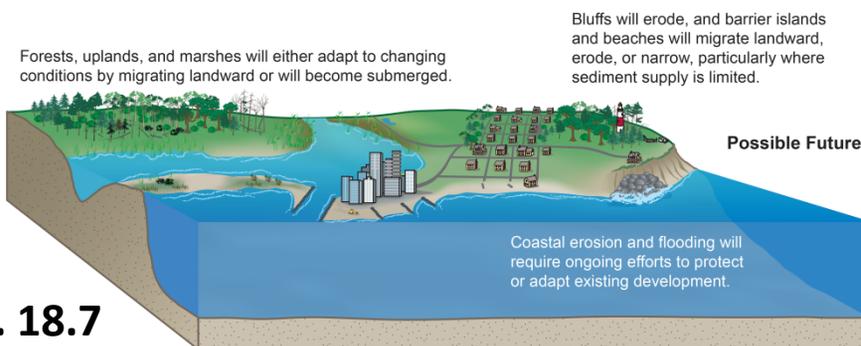
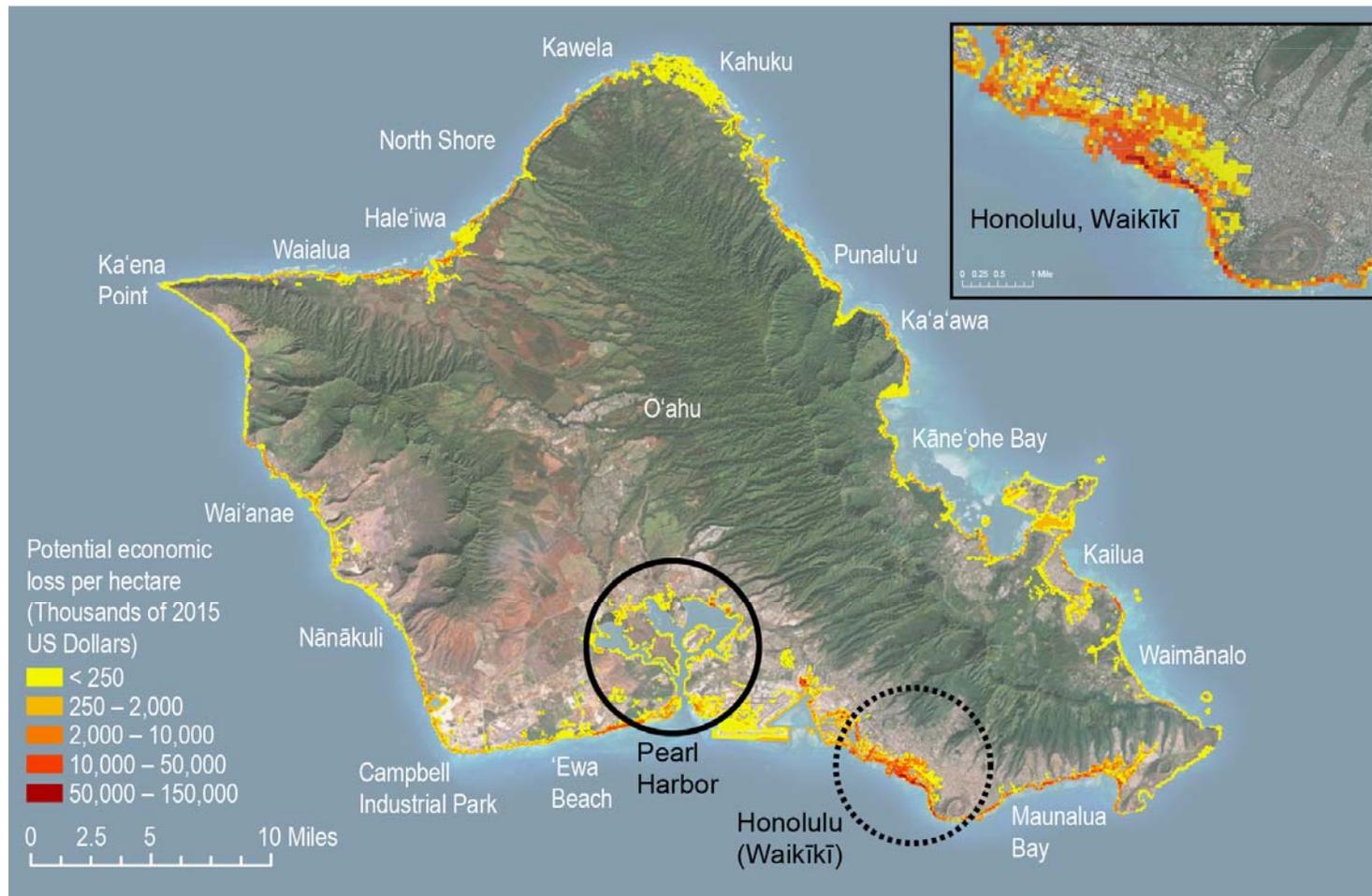


Fig. 18.7

Figure 27.9: This map highlights potential economic losses in the exposure area associated with 3.2 feet of sea level rise on the island of O‘ahu, Hawai‘i. Potential economic losses are estimated from impacts to land and residential and commercial infrastructure. Highly impacted areas include the U.S. Pacific Command in Pearl Harbor (black circle) and the vulnerable tourist areas surrounding Waikīkī (dashed black circle).

Source: adapted by Tetra Tech Inc. from the Hawai‘i Climate Change Mitigation and Adaptation Commission 2017



Flooding in Charleston, SC (Ch19 SE)

- Historical coastal cities built just above the current MHHW level
 - Gravity-driven drainage sends rainwater into tidal estuaries
- SLR in the last one hundred years means the storm water systems in these areas are no longer able to perform as designed
- Charleston experienced 38 and 50 days of high tide flood events in 2015 and 2016
 - By 2045, projected up to 180 events a year
- Each event cost ~\$12.4 million (in 2009 dollars)
 - Over past 50 years, gross damage and lost wages >\$1.53 billion (dollar year not specified)
- The city has developed a Sea Level Rise Strategy that plans for 50 years out based on moderate sea level rise scenarios
- As of 2016, the City has spent or set aside \$235 million for drainage improvement projects



Figure 19.9: (left) U.S. Highway 17 in Charleston during a flood event. Floodwaters can get deep enough to stall vehicles. (right) Market Street drainage tunnel being constructed as part of a drainage improvement project. This tunnel crosses downtown Charleston 140 feet underground and is designed to rapidly convey storm water to the nearby Ashley River. Photo credit: City of Charleston 2015.

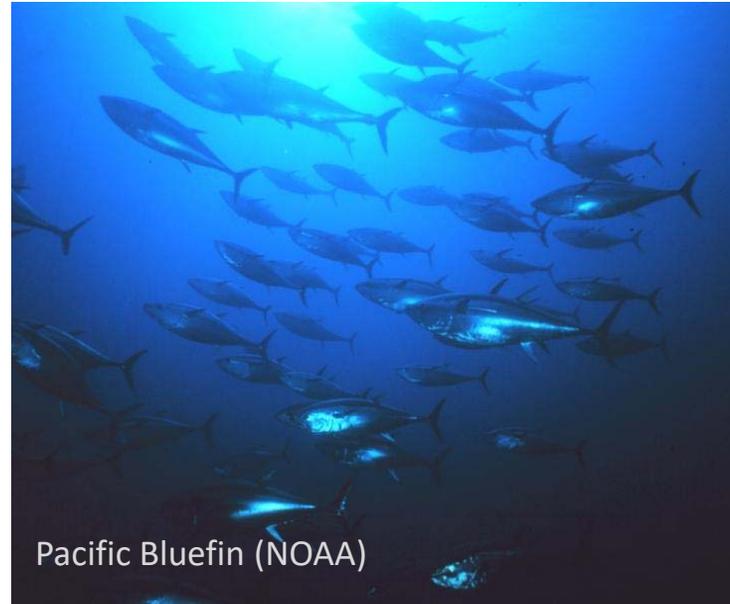
Recreational Waters

- The quality and quantity of water available for recreational use are being affected by climate change, increasing risks and costs
- Under RCP8.5, increasing water temperatures and low DO will extend toxic algal blooms by 1 month (Ch14)
 - Algal bloom August 2014 in Lake Erie, introduced cyanobacteria into drinking and recreational water sources, restricting use (Ch21)
 - The warming of bay waters on the Texas coast has been documented for at least 35 years
 - Drought in 2011 > record high salinities in Texas estuaries > “red tide” algal bloom (Ch23)
 - Fish mortality ~4.4 million. Commercial oyster season closed. Total economic loss estimated at \$7.5 mil (dollar year not reported)



Commercial & recreational fishing and aquaculture

- Fresh and ocean fisheries will be increasingly impacted by warming, seasonal shifts, invasives, and drought
- The landings from the pelagic longline fisheries in Hawaii is worth over \$100 million annually (2012–2013 dollars) (Ch27)
 - 50% decline in maximum catch potential under RCP8.5 projected by 2100 for EEZs of islands in the central and western Pacific



Pacific Bluefin (NOAA)



Oyster harvesting (NOAA)

Outdoor Recreation & Snowpack

- Winter recreation industry is significant in many regions
 - Projected declines in snowpack in the west
 - More rain than snow in the central and eastern US
- **Northeast.** Supports rural areas, ~44,500 jobs, generates \$2.6–\$2.7 billion/yr (Ch18)
 - RCP4.5 Projects decline in visits and ski delays by mid-century
 - RCP8.5 Natural snow/ice cover economically viable in only far northern area by 2100
- **Northwest.** Low-elevation ski areas struggled to stay open during the 2014–2015 season (Ch24)
- Outdoor rec generates \$51 billion in consumer spending each year, ~451,000 jobs
 - From 1999 to 2009, a low-snowfall year had 2,100 fewer employees and \$189 mil less in ski resort revenues compared to high-snowfall
- **NGP.** Cross-country skiing and snowmobiling in northwestern Wyoming and western Montana (Ch 22)
 - RCP4.5 decline 20-60% by 2090
 - RCP8.5 decline 60-100%



Mount Hood in warm weather. Photo: Ken Lund / Flickr

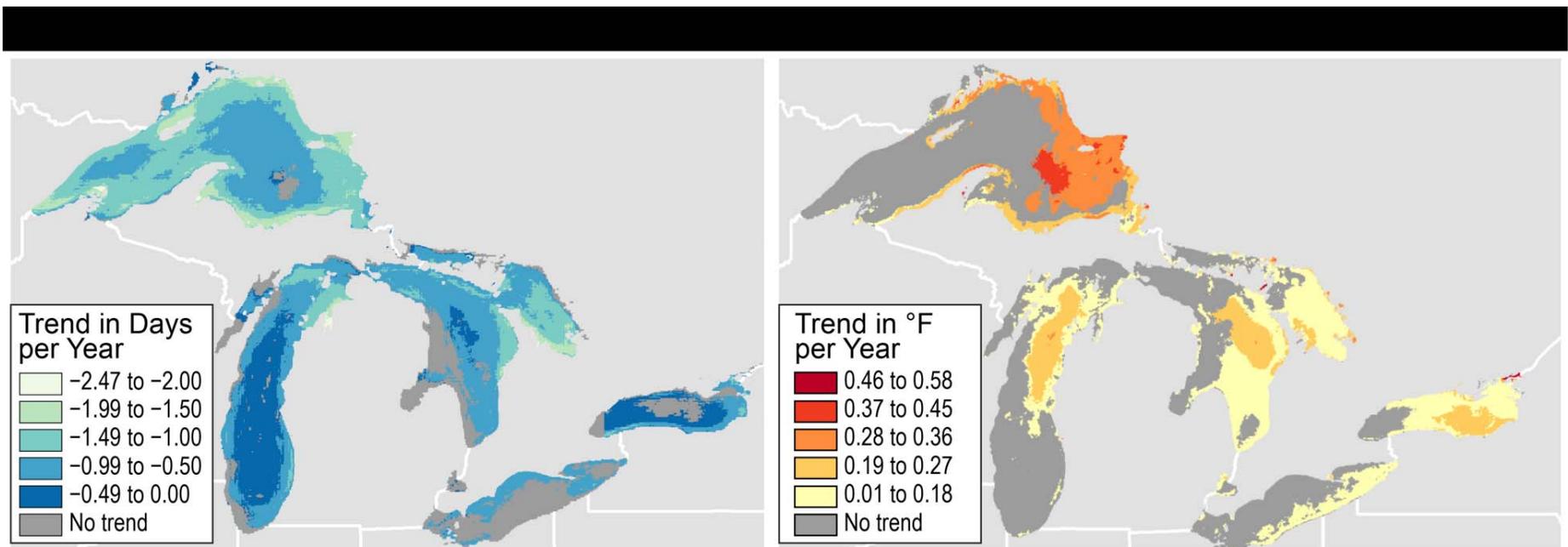
Figure 18.2: This map of the Northeast shows consistently earlier snowmelt-related streamflow timing for rivers from 1960 to 2014. Each symbol represents the change for an individual river over the entire period. Changes in the timing of snowmelt potentially interfere with the reproduction of many aquatic species and impact water-supply reservoir management because of higher winter flows and lower spring flows. The average winter–spring air temperature increase of 1.67°F in the Northeast from 1940 to 2014 is thought to be the cause of average earlier streamflow timing of 7.7 days.

Source: adapted from Dudley et al. 2017; Digital Elevation Model CGIAR–CSI (CGIAR Consortium for Spatial Information). Reprinted with permission from Elsevier.



Figure 21.8: The duration of seasonal ice cover decreased in most areas of the Great Lakes between 1973 and 2013, while summer surface water temperature (SWT) increased in most areas between 1994 and 2013. (a) The map shows the rate of change in ice cover duration. The greatest rate of decrease in seasonal ice cover duration is seen near shorelines, with smaller rates occurring in the deeper central parts of Lakes Michigan and Ontario, which rarely have ice cover. (b) The map shows the rate of change in summer SWT. The greatest rates of increase in summer SWT occurred in deeper water, with smaller increases occurring near shorelines.

Source: adapted from Mason et al. 2016. *Used with permission from Springer.*



National & State Parks

- Superstorm Sandy damaged NY parks - Gateway National Recreation Area and Statue of Liberty National Monument (Ch8 NE)
- Yosemite NP, forest shifted into subalpine meadows from 1880 to 2002, and small mammals shifted 1,600 feet upslope from 1914 to 2006
 - Climate change outweighed other factors as cause (Ch25 SW)
- Potential habitat shift of Joshua trees out of much of Joshua Tree NP (Ch25 SW)
- 18 of 29 native species within Hawai'i Volcanoes NP are projected to lose range
 - Most high-priority areas managed to protect biodiversity are projected to lose a majority of the native species (Ch27 HI&PI)



Figure 19.18: Burmese pythons are apex predators (not preyed upon by other animals) that are sensitive to cold temperatures and are expected to be favored by warming winters. This photo is from Everglades National Park, where unintentionally introduced pythons have expanded and reduced native mammal populations.

Photo credit: U.S. Geological Survey.



Wildfire & Air Quality

- Increasing wildfire frequency is projected to reduce the ability of U.S. forests to support recreation as well as economic and subsistence activities (Ch1)
 - Tourism businesses may experience short-term losses as visitors avoid recently burned areas
- More frequent wildfire smoke increases health risks and decreases outdoor activity time (Ch13 Air Quality)
- Increasing incidence of wildfire near inhabited areas leads to a wide array of costs (Ch26 AK)
 - Firefighting, health and safety impacts, property damage, insurance losses, and higher costs of fire insurance
 - Wildfire suppression costs of \$25 million more per year (in 2015 dollars, 3% discount rate) under RCP4.5 above the 2002–2013 annual average by the end of the century

Figure 1.5: Wildfires are increasingly encroaching on American communities, posing threats to lives, critical infrastructure, and property. In October 2017, more than a dozen fires burned through northern California, killing dozens of people and leaving thousands more homeless. Communities distant from the fires were affected by poor air quality. (left) A NASA satellite image shows active fires on October 9, 2017. (right) The Tubbs Fire, which burned parts of Napa, Sonoma, and Lake counties, was the most destructive in California's history. It caused an estimated \$1.2 billion in damages and destroyed over 5,000 structures, including 5% of the housing stock in the city of Santa Rosa.

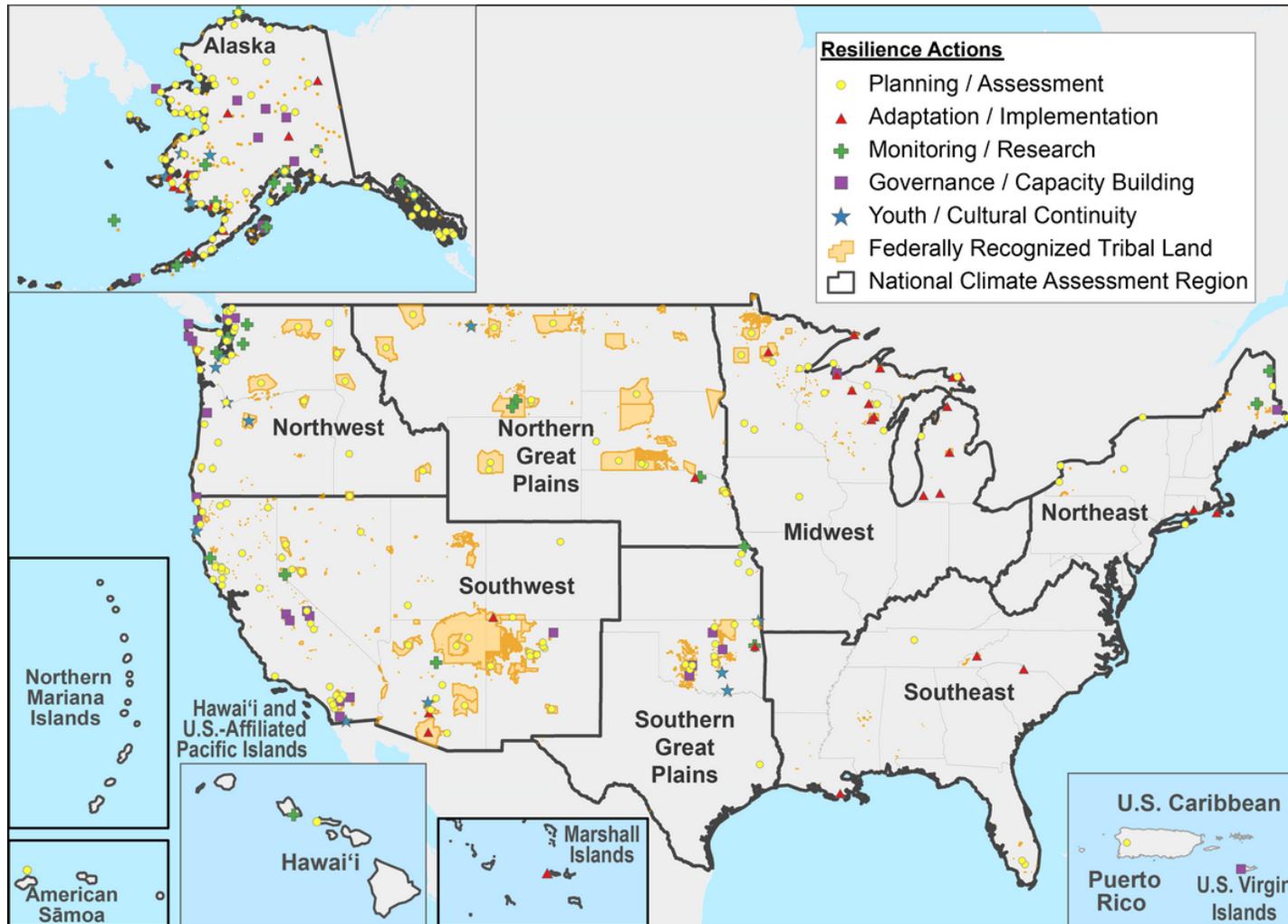
Image credits: (left) NASA; (right) Master Sgt. David Loeffler, U.S. Air National Guard.



Indigenous Peoples

- Climate impacts are expected to increasingly disrupt Indigenous peoples' livelihoods and economies, including agriculture and agroforestry, fishing, recreation, and tourism
 - Communities face institutional barriers to self-determined management of water, land, other natural resources, and infrastructure that will be increasingly impacted (Ch15 Tribes)
- **Subsistence.** Portions of Michigan, Wisconsin, and Minnesota contain ceded territory of many tribes, and these are used for hunting, fishing, and gathering native plants, all of which play vital roles in maintaining cultural heritage (Ch21 MW)
- **Indigenous tourism enterprises.** Alaska Natives utilize skins, furs, and walrus tusks for local subsistence economies and for clothing and crafts for local tourism (Ch15 Tribes)
 - Retreat of arctic sea ice changes fish and wildlife habitat important for subsistence, tourism, and recreation
- **Modern livelihoods.** Ocean acidification and drought, in combination with pollution and development, are negatively affecting fisheries and ecosystems (which are drivers of tourism), directly impacting the livelihood security of Pacific communities (Ch27 HI&PI)
 - In Pacific island countries and territories, industrial tuna fisheries account for half of all exports, 25,000 jobs, and 11% of economic production
 - In Hawai'i, between 2011 and 2015, 37,386 Native Hawaiians worked in tourism-intensive industries annually (~12.5% of the Native Hawaiian population residing in Hawai'i)
- **Cultural sites.** 550 Hawaiian cultural sites would be threatened by 2100 under 3.2 ft SLR (Ch27 HI&PI)

Figure 15.1: Many Indigenous peoples are taking steps to adapt to climate change impacts. You can use the interactive version of this map available at <https://biamaps.doi.gov/nca/> to search by activity type, region, and sector and to find more information and links to each project.



The Need for Adaptation

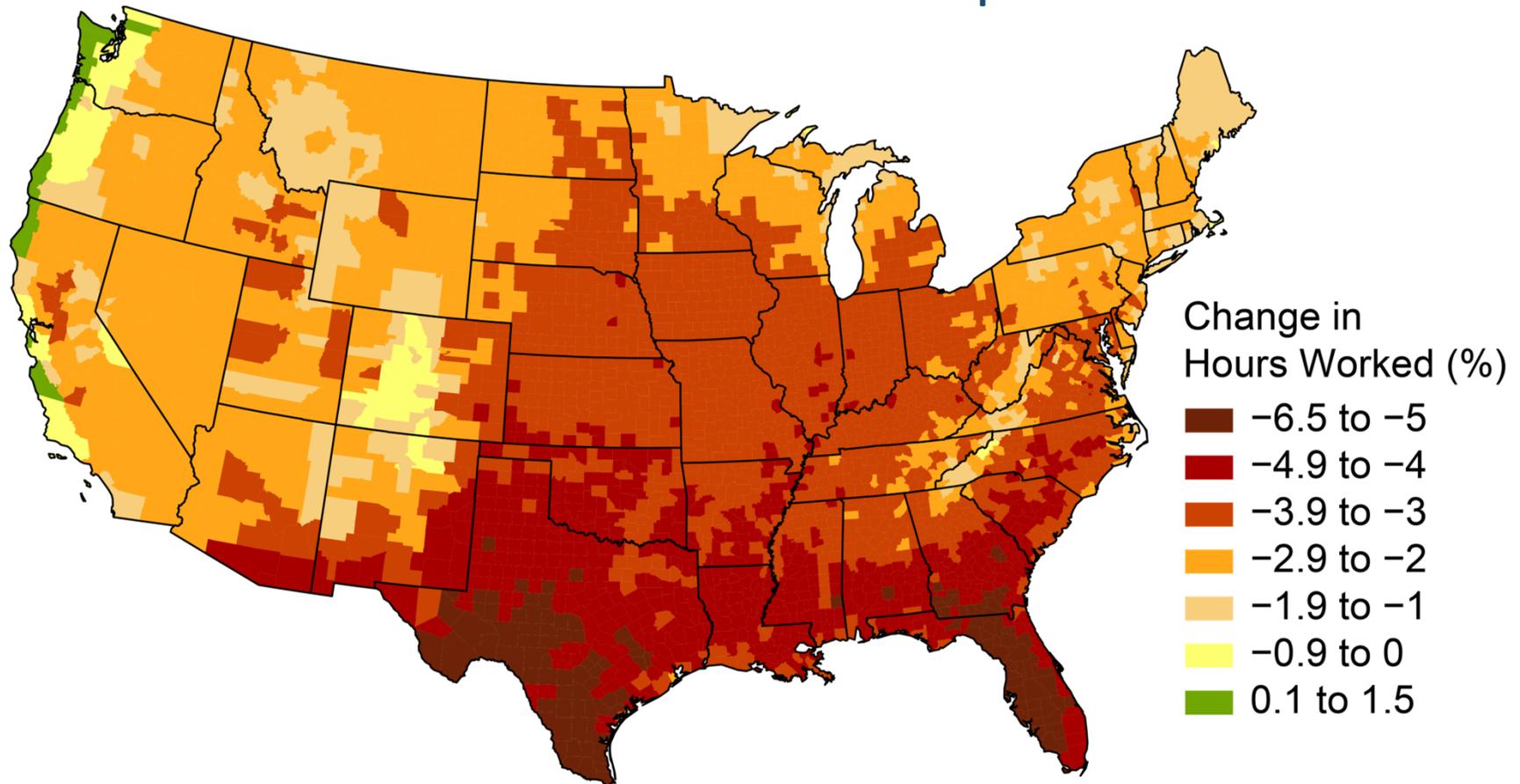


Figure 19.21: This map shows the estimated percent change in hours worked in 2090 under RCP8.5. Projections indicate an annual average of 570 million labor hours lost per year in the Southeast by 2090. Estimates represent a change in hours worked as compared to a 2003–2007 average baseline for high-risk industries only. These industries are defined as agriculture, forestry, and fishing; hunting, mining, and construction; manufacturing, transportation, and utilities.

Source: adapted from EPA 2017.

Building Coral Reef Resilience

- Reduce potential impacts of climate change on the coral population through propagation (coral farming) is a strategy meant to improve the reef community and ecosystem function, including for fish species that use this ecosystem
- The selection and propagation of fragments and samples from coral colonies that have survived stressors such as bleaching events are emphasized

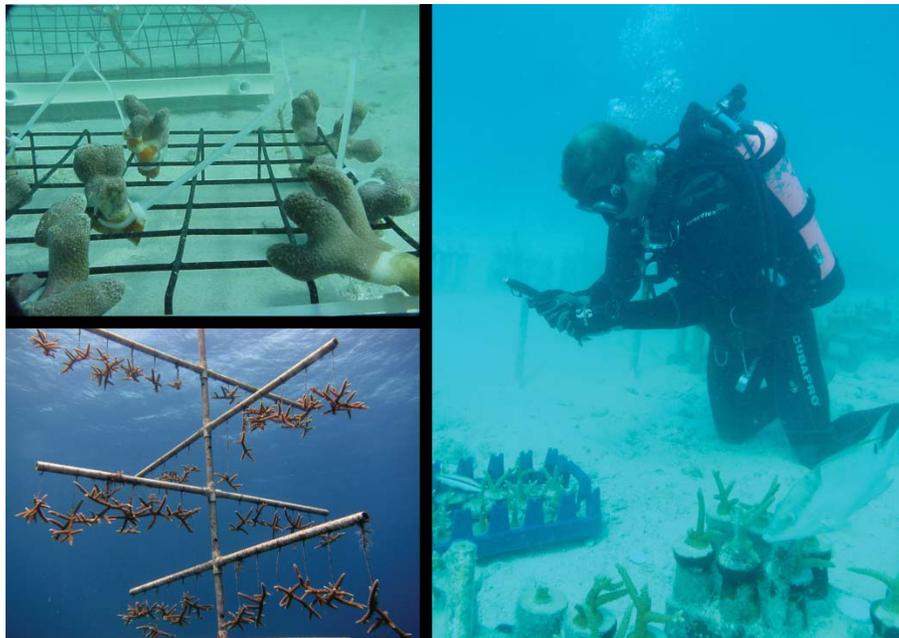


Figure 20.11: Examples of coral farming in the U.S. Caribbean and Florida demonstrate different types of structures used for growing fragments from branching corals.

Photo credits: (top left) Carlos Pacheco, USFWS; (bottom left) NOAA; (right) Florida Fish and Wildlife ([CC BY-ND 2.0](#)).

Integrated Adaptation in the Southwest

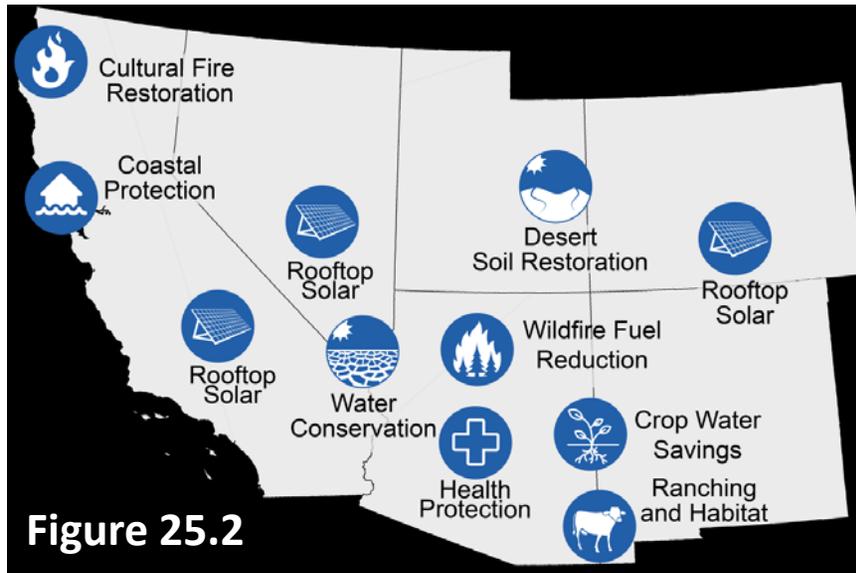


Figure 25.2

- **Coastal protection:** San Francisco - In response to SLR and storm surge, voters approved funds to restore coastal habitats and levees
- **Crop water savings:** Gila River Basin - local gov. lined 15 miles of irrigation canals to reduce seepage, saving enough to irrigate 8,500 acres of alfalfa and food crops each year
- **Cultural fire restoration:** Reintroduction of cultural burning by the Yurok Tribe in California reduces wildfire risks
- **Desert soil restoration:** Utah - transplanting native and microbial communities improves soil fertility and guards against erosion
- **Health protection:** To reduce heat-associated injury and deaths on trails, the City of Phoenix and tourism organizations developed a campaign reminding hikers to bring water, stay hydrated, and stay aware of environmental conditions
- **Ranching and habitat:** Malpai Borderlands Group in Arizona and New Mexico integrates native plant and wildlife conservation into private ranching
- **Rooftop solar:** The state gov. of California, Colorado, and Nevada have enacted policies that support rooftop solar on homes
- **Water conservation:** Drought in the Colorado River Basin reduced the volume of water in Lakes Mead and Powell by over half. The United States, Mexico, and state governments have mobilized users to conserve water, keeping the lake above a critical level
- **Wildfire fuel reduction:** In response to severe wildfires, the City of Flagstaff, Arizona, enacted a bond to fund reduction of fire fuels in forests around the town.

Source: National Park Service.

Shifting Recreational Norms

- Winter Rec. Investing in artificial snowmaking, opening higher-elevation trails, shifting north (NW, NE)
- Business diversification by creating more summer recreation opportunities, so that ski areas revenue depends less on snow-related recreation (NW)
- Monitoring PSP shellfish toxins at noncommercial locations used for fishing and recreation (AK)
- Design and construction of greenway spaces to control flooding and add parkland (Dubuque, Iowa - Bee Branch Creek) (Ch11)



Bee Branch Creek Fig. 11.8



More difficult to adapt....

- Regional and cultural identities associated with specific natural resources or pastimes
- Ecotourism centered around fundamentally altered ecosystems



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