Vol. 16 No. 4

SPECIAL FOCUS + CLIMATE ADAPTATION

July/August 2022

THE WILDLIFE PROFESSIONAL

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THE WILDLIFE PROFESSIONAL

July/August 2022 Vol. 16 No. 4

The Wildlife Professional is the flagship publication of The Wildlife Society and a benefit of membership. The magazine —published six times annually—presents timely research, news and analysis of trends in the wildlife profession.

ABOUT

The Wildlife Society, founded in 1937, is an international nonprofit scientific and educational association dedicated to excellence in wildlife stewardship through science and education. Our mission is to inspire, empower and enable wildlife professionals to sustain wildlife populations and their habitat through science-based management and conservation. We encourage professional growth through certification, peer-reviewed publications, conferences and working groups. For more information, visit us at www.wildlife.org.

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U.S. Geological Survey biologist Stephanie Walden holds an emaciated horned puffin (*Fratercula corniculata*) that washed up on a beach off the coast of mainland Alaska.

Credit: Andy Johnson/Cornell Lab of Ornithology

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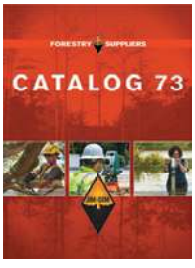

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THE WILDLIFE PROFESSIONAL

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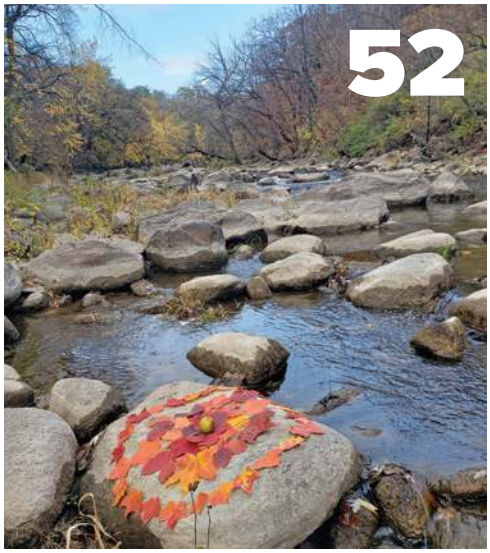

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Seabirds and Climate

I remember seeing my first puffin. Just a couple of years ago, my wife and I made a trip to the Oregon coastline specifically to find them. We watched as a handful of tufted puffins (*Fratercula cirrhata*) flew around Haystack Rock, where they were nesting alongside several hundred common murres (*Uria aalge*) and a few other species of sea and coastal birds. It was a wonderful sight and a great day of birdwatching on the beach.

Our cover story for this issue takes a look at a mysterious uptick in the number of die-off events for this guild of seafaring birds. Die-offs of seabirds have been occurring in greater frequencies over larger areas than ever before. From puffins to murres to auklets, thousands of dead birds have been found along the Pacific coastline of North America in several distinct die-off events over the past several years—raising questions about the conservation implications for these species and the health of the marine ecosystem.

While exact causes remain elusive to determine, one of the contributing factors to these die-off events is likely climate change. The changes in climatic patterns have warmed water temperatures and affected these birds' forage resources.

This issue's special focus highlights climate change and our profession's work—and requisite need—to address it. A couple of articles discuss a particular framework our profession can use to think about climate change and how to best tackle the challenges it poses. The "Resist-Accept-Direct" (RAD) framework presents an opportunity for our profession to adaptively manage wildlife resources and wildlife habitat in the face of a changing climate.

Another article with a climatic focus highlights ongoing research in the Arctic on polar bears (*Ursus maritimus*), a classic climate change focal species. We also have an article that discusses an approach the Oregon Department of Fish and Wildlife is using to integrate a climate adaptation policy into its everyday work of conservation and management.

The Wildlife Society and our members play a leading role in addressing climate change. An article by TWS' Climate Change and Sustainability Advisory Committee emphasizes the importance of facing this challenge and offers opportunities for members to get involved.

But climate change and other ecological challenges aren't always easy to face day in and day out. Progress can be hard to see, and it can often feel hopeless for us to even attempt anything. Our special focus concludes with a discussion on these feelings and how you can manage 'ecogrief'—a persistent mental challenge across our profession.

I hope the articles contributed by your fellow wildlife professionals and TWS staff in this issue make you feel inspired, empowered and enabled to continue your important work of wildlife conservation and management. As always, your feedback and input on *The Wildlife Professional* are welcome and encouraged. ■

Keith Norris, AWB® (he/him)
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& Communications
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By Gordon R. Batcheller

On Spokane

It's pronounced "Spo-CAN," not "Spo-CANE." The Wildlife Society's upcoming Annual Conference will be there from Nov. 6-10. I look forward to seeing you! You are coming, right?

This region—the Pacific Northwest—has a rich history. I don't just mean the history that started when Lewis and Clark dipped their toes in the Pacific Ocean at the mouth of the Columbia River on Nov. 15, 1805. I am referring to the rich history of the Indigenous peoples who call—and have long called—this region their home.

I am working to ensure that our conference celebrates the accomplishments and contributions of Tribes in this diverse ecosystem, specifically those of the Upper Columbia River, so TWS can honor their culture and heritage and recognize their contributions to wildlife conservation and management.

I encourage you to learn of the life and work of Tribes and Native peoples in this region by reading about the Upper Columbia United Tribes. This organization connects five member Tribes in their shared vision to restore damaged ecosystems of the Upper Columbia River Basin. While each Tribe is sovereign, their leaders recognize that collaboration is the key to addressing complexity. In Spokane, we will honor the collaborative work of the Coeur d'Alene Tribe, the Confederated Tribes of the Colville Reservation, the Kalispel Tribe, the Kootenai Tribe of Idaho and the Spokane Tribe.

The Spokane River, a very short walk from the conference, is a powerful reminder of the enormous importance of moving water and the life within. Unfortunately, the Upper Columbia River system, which includes the Spokane, is degraded due to a legacy of abuse of its natural functions. For thousands of years, chinook, coho, sockeye and steelhead salmon were central to the health, culture and life of Indigenous communities in this region—and to the health of the ecosystem, providing food to wildlife and following spawning, pouring vast volumes of nutrients back into the land and water. The construction of hydroelectric dams wrecked this system and destroyed the ecological and cultural roles of salmon.

In 2015, a joint paper of the Columbia Basin Tribes and First Nations described how anadromous salmon can be reintroduced to the Columbia River Basin. It will be my great honor to bring tribal representatives to the opening plenary session of our conference to share their vision for restoring salmon to their proper place in the ecosystem.

In my first column in *The Wildlife Professional*, I stated that one of my goals during my presidency was to strengthen collaboration with Indigenous fish and wildlife professionals. I am pleased that The Wildlife Society is advancing that goal. For example, we commented on a White House policy on the incorporation of traditional knowledge in federal decision making. Our Publications Committee is developing policy related to the peer review process associated with manuscripts based on traditional knowledge. TWS' elected leaders are regularly attending meetings of the Native American Fish and Wildlife Society. And our Native Peoples' Wildlife Management Working Group is one of our most active and impactful.

The importance of Indian Country is clearly recognized at the highest level in the U.S. government. Deb Haaland, the first Native American to serve as the U.S. Secretary of the Interior, has stated that one of her top priorities is "Strengthening Indian Country … while acknowledging the past and working toward a better future …" I have invited Secretary Haaland to be our featured speaker at the Spokane conference. I hope she comes. As The Wildlife Society becomes increasingly effective at influencing policy, I want the secretary to see your enthusiasm and commitment to wildlife conservation to benefit all peoples.

We expect to have 2,000 people celebrating at this year's conference. As we return to an in-person event, we will learn from each other. Your skills will grow. You will leave Spokane a stronger wildlife professional. As we gather, our conference will be known as a time and space where diverse voices and opinions are heard and respected. The Wildlife Society has established guidelines for professional behavior. We take these very seriously, and for this reason, for the first time, Council has brought on a professional ombudsperson to serve as a resource if anyone feels disrespected or discriminated against. Let's be sure that the ombudsperson is idle. See you soon. ■

Gordon R. Batcheller, CWB®, was chief wildlife biologist in New York before retiring in 2015, and he now serves as executive secretary for the Northeast Association of Fish and Wildlife Agencies. He is a TWS Fellow and president of The Wildlife Society.

Recent papers from wildlife conservation and management journals

Stewardship practices boost purple martin occupancy

Eastern purple martins rely almost completely on human-made nest boxes. As their numbers decline, the conditions of these nest boxes become increasingly important.

"This is a really unique species because they rely on humans so much, and human-provided housing has a big impact on that group of birds," said TWS member Glen Hvenegaard, professor of environmental science and geography at the University of Alberta's Augustana Campus.

In a study published in the *Wildlife Society Bulletin*, he and co-author Braeden Kelly found that in Alberta, cleaning eastern purple martin (*Progne subis subis*) nests and removing blowfly larvae—which can suck young chicks' blood—were the most important actions to increase martin occupancy.

The researchers hope these findings can help make hosting purple martins easier. While the species is reliant on humans, Kelly said, people also benefit. "It can lead to this lifelong bond," he said. "I think it's a really important species in that way."

▼ **Purple martins rely on human-provided nest boxes.**

Credit: Glen Hvenegaard

Credit: Ivan Filion

▲ **The Burwash elk herd has moved away from the area where crossing structures were built.**

Elk dodge highway mitigation measures in Ontario

Measures to decrease vehicle collisions with elk on an expanded highway in central Ontario may be coming up short.

The Ontario Ministry of Transportation finished widening a 10-kilometer portion of a two-lane highway between Sudbury and Perry Sound in 2012, expanding the road to four lanes near the Burwash elk herd. The provincial agency built a number of overpasses and underpasses as well as fencing and one-way gates to reduce car collisions with elk (*Cervus canadensis*) and other wildlife.

But the herd recently shifted farther north, away from the nearest structure, complicating efforts, according to a study published recently in the *Journal of Wildlife Management*.

Study author David Lieske, an associate professor in geography and environment at Mount Allison University in New Brunswick, and his colleagues examined collision data and tracked elk using GPS collars. They found that elk mortality from collisions increased 2.5 times after the project.

The study shows the importance of continued wildlife monitoring after mitigation measures are put in place, Lieske said, since wildlife don't always behave in predictable ways. Funding should be built into new projects to ensure continued safety for wildlife and drivers, he said. In this case, that could include extending the fencing closer to the elk herd today.

"It makes the case for an adaptive management policy," he said.

For Gunnison sage-grouse, translocations are tricky

To bolster threatened Gunnison sage-grouse numbers, managers rely on translocating birds from their main population in western Colorado's Gunnison Basin to far-flung satellite populations. Researchers wanted to better understand the translocated birds' survival rates to guide these efforts.

"They're kind of a conservation-reliant species," said Tony Apa, an avian researcher with Colorado Parks and Wildlife and the lead author of the study published in the *Wildlife Society Bulletin*.

After years of translocating a few Gunnison sage-grouse (*Centrocercus minimus*) at a time, biologists found that females survive better than males and subadults better than adults. The researchers urged managers to target younger birds and pay attention to habitat conditions at satellite locations to maximize translocated grouse survival.

But with dwindling numbers in the source population, they found, translocations may not be enough. "I think we need to start thinking about captive rearing as a tool in the toolbox to augment these populations," Apa said.

▼ **Translocations have been key to maintaining Gunnison sage-grouse populations.**

Credit: Bob Gress

Bison promote wetlands diversity

Bison reintroduction may benefit native songbirds and deer in wetlands.

Biologists originally wondered how reintroduced bison (*Bison bison*) affected other wildlife in the Montana grasslands. Bison's year-round grazing, some thought, might negatively affect ecosystems compared to domestic cattle's seasonal grazing.

Past research found that bison grazing didn't affect grasslands bird diversity compared to cattle, but scientists wondered about the effects on wetlands species in riparian areas.

In a study published in *Frontiers in Ecology and Evolution*, Andy Boyce, an ecologist with the Smithsonian Conservation Biology Institute, and his co-authors used land satellite data to determine how vegetation cover in wetlands with cattle grazing compared to areas where bison had been reintroduced. They found that there was more native and diverse vegetation in areas with bison.

That likely has more to do with what bison aren't doing than what they are doing. "They're spending less time in these stream and riparian areas," Boyce said. "We think they don't have the same preferences for feeding on young woody shrubs as cattle."

Credit: U.S. Fish and Wildlife Service

▲ **Wetlands and riparian areas with bison in Montana have more diverse native vegetation.**

Bird point counts and modeling revealed wetlands where bison were reintroduced also had higher native songbird diversity compared to areas with seasonal domestic cattle grazing. These vegetation changes corresponded with frequent white-tailed deer (*Odocoileus virginianus*) presence.

"Bison reintroduction might act as passive riparian restoration," Boyce said.

Credit: Arizona Game and Fish Department

▲ **Black bears continued to use the area burned by the Wallow Fire.**

Intense Arizona wildfire hasn't displaced black bears

Black bears living in the path of Arizona's largest wildfire stuck around but avoided the areas with the most severe blazes.

"What this tells us is large wildfires might not be bad for some wildlife species," said TWS member Andrew Jones, a terrestrial research program manager for the Arizona Game and Fish Department.

Jones co-authored a study published in the *Journal of Wildlife Management* looking at black bear movements during, before and after the Wallow Fire, which scorched more than 2,000 square kilometers in Arizona. He and his colleagues found that the bears stayed in the general area of the blaze but avoided spots with high-severity burns. "There was enough of a mosaic remaining within the Wallow Fire footprint, and they were still making a living there," he said.

The bears also didn't expand their home ranges to avoid the fire. That's good news, Jones said, since moving to other areas might make them more susceptible to human conflict.

Disentangling a sea turtle threat

Promptly and properly disentangling leatherback sea turtles from fishing gear can give them a good chance of long-term survival.

Biologists with the nonprofit Center for Coastal Studies have been responding to calls about turtle bycatch events since 2005. They remove the ropes and record data on the turtles.

"At the beginning, there wasn't much information," said Kara Dodge, a research scientist with the New England Aquarium. "There were few photos, since people had no cameras on their phone." But as the years went on, scientists compiled more comprehensive data and images to look for patterns.

In a study published in *Endangered Species Research*, Dodge and her colleagues found that of almost 300 entanglement events, 272 involved leatherback sea turtles (*Dermochelys coriacea*). Recreational boaters reported more than 60% of the events.

Credit: Center for Coastal Studies; disentanglement authorized under 50 CFR 222.310

▲ **A leatherback sea turtle is entangled in fishing gear in Cape Cod Bay.**

Some entangled turtles were monitored with satellite and acoustic tags after release, and others were identified through subsequent entanglements or strandings. Researchers found that 88% of the turtles completely freed from entanglement had low or intermediate risk of death in the days following. Some tagged turtles were alive even years after their disentanglement.

Even though the study provides some hope for turtles found alive, 17% of the turtles were dead in fishing gear, she said. Mitigation for this can include emerging technologies like ropeless fishing gear or reducing the number of buoy lines in the water.

"We are very much about the balanced use of the ocean," she said. "That means coexistence of fisheries and species." ■

Contributed by David Frey, Dana Kobilinsky and Joshua Rapp Learn

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004	148.3649	P BLOOM ♂ TUVU #5703	Banded 08-09-19 Irvine Lake Dam Air Band #L2
005	148.3999	P BLOOM ♂ TUVU #5704	Banded 08-10-19 Irvine Lake Dam Air Band #L3
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SOUTHWEST

New plan considers humans' role in Mexican wolf deaths

Credit: Jim Clark/USFWS

▲ **The U.S. Fish and Wildlife Service has drafted a new update to the 2017 recovery plan for Mexican wolves.**

The U.S. Fish and Wildlife Service has bolstered its draft Mexican wolf recovery plan with measures confronting poaching, vehicle strikes and other human-caused wolf deaths. In 2020, the USFWS reported 14 federally endangered Mexican wolves (*Canis lupus baileyi*) died from poaching and another six from vehicle strikes. The U.S. District Court of Arizona ordered the USFWS to update its 2017 Mexican wolf recovery plan by addressing human-caused deaths. A new draft added money for public education, safe road crossing and livestock conflict avoidance measures. This new plan estimates that downlisting the wolves in 16 to 20 years and removing them from the endangered species list altogether in 25 to 35 years would cost a total of about $178.4 million, including funds used by governmental and nongovernmental organizations in both the U.S. and Mexico. "Our recovery strategy for the Mexican wolf is to establish and maintain a minimum of two resilient, genetically diverse Mexican wolf populations distributed across ecologically and geographically diverse areas in the subspecies' range in the United States and Mexico," the draft plan states. The agency is seeking comments from stakeholders, agencies, Tribes and the public on the new draft plan until Oct. 14.

NORTHWEST

Oregon hires poaching prosecutor

To address a recent rise in poaching cases, the Oregon Department of Justice hired a new prosecutor dedicated to investigating and bringing charges against poachers. Jay Hall, who previously worked as an Oregon district attorney using state Racketeering Influenced and Corrupt Organizations (RICO) statutes against poaching rings, now serves as an assistant attorney general. "The Wildlife Anti-Poaching Resource Prosecutor will help give a voice to the voiceless," said Yvonne Shaw, a Stop Poaching Campaign Coordinator with the Oregon Department of Fish and Wildlife. "Crimes against animals can be difficult to prosecute because there are no statements from victims to present to the courts." The new position may also encourage other prosecutors to take on poaching cases. Hall's hiring comes as part of a larger effort that started in 2019 to deal with poaching in Oregon. Other measures have included hiring additional law enforcement officers focused on fish and wildlife crime and a campaign to improve public awareness about poaching.

CENTRAL MOUNTAINS & PLAINS

COVID-19 pandemic changes Nebraska turkey hunting

When the COVID-19 pandemic began to ramp up in March 2020, something else was also starting in Nebraska—spring turkey hunting season. "It's a popular activity not just for residents. It attracts people from all over the country," said TWS member Christopher Chizinski, an associate professor of human dimensions of wildlife at the University of Nebraska-Lincoln. When the state responded to COVID by barring permit sales to nonresident hunters, Chizinski and his colleagues wondered how it would impact turkey (*Meleagris gallopavo*) hunting in the state. Chizinski led a study published in the *Journal of Wildlife Management* that found that nonresident sales dipped to 1,000 permits, down from around 9,000 in previous years. But resident sales jumped from around 12,000 to over 17,000. Much of the increase was driven by hunters who hadn't hunted in three years or more. Surveys suggested the reason for more residents hunting was because they perceived it as a safe activity when many others were shut down. They also believed there was less competition

Courtesy of the Oregon Department of Fish and Wildlife

◀ **Jay Hall receives the Prosecutor of the Year award in 2010 from then-Oregon State Police Fish and Wildlife Division Captain Jeff Samuels, along with Steve Marx, the ODFW's former South Willamette watershed manager.**

Credit: Nebraska Land Magazine/Nebraska Game and Parks Commission

Turkey hunting by Nebraska residents increased during the pandemic.

with fewer nonresidents around. Even with these changes, turkey populations appeared to be relatively unaffected. "This was a natural experiment to see what happens when we get some sort of major thing that disrupts people's participation," Chizinski said. "Something like this can come in and disrupt license sales and permit sales. Nebraska Game and Parks lost $1 million just over the period of a month in license sales. In my lab, we're building ways to forecast license and permit sales, which can give us some ability to make projections."

NORTH CENTRAL

Donation adds to Michigan park

Michigan's most remote park has grown by nearly 1,300 acres after a gift from the Upper Peninsula Land Conservancy. The conservancy offered three parcels, which made up the Peshekee Headwaters Nature Preserve, an area that includes much of the headwaters of the West Branch of the Peshekee River. The conservancy said it was donating the land to protect the property from degradation and to maintain public access. The Upper Peninsula land is home to diverse wildlife, including moose (*Alces alces*), black bears (*Ursus americanus*), white-tailed deer (*Odocoileus virginianus*), gray wolves (*Canis lupus*) and loons *(Gavia immer*). "This property augments the remarkable remote landscape at Craig Lake State Park," said Doug Rich, western Upper Peninsula district supervisor for the Michigan Department of Natural Resources' Parks and Recreation Division, in a press release. "The acquisition also helps achieve department goals and supports strategies and plans involving trails, public lands and protecting natural resources for the future."

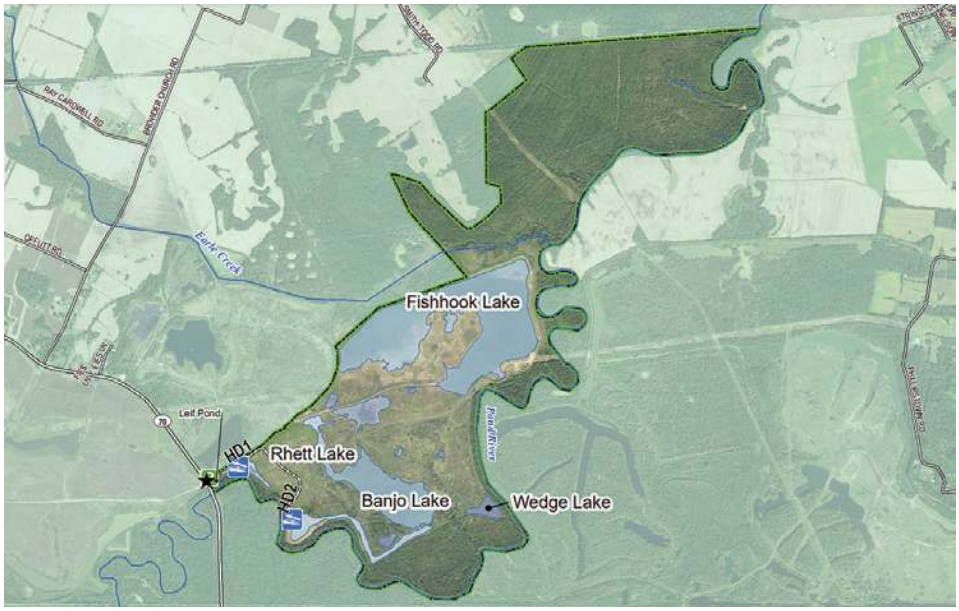
Credit: ryangs

Craig Lake State Park is Michigan's most remote park.

SOUTHEAST

Kentucky opens new wildlife management area

Kentucky has opened a new wildlife management area after receiving a pair of land donations totaling 1,800 acres. The Kentucky Department of Fish and Wildlife Resources is conducting restoration work on the new Harris-Dickerson Wildlife Management Area to improve the site's grasslands, forests and wetlands. "The wetland restoration work in the northern portion of the property has been a tremendous success and will provide excellent bottomland hardwood habitat as the forest continues to grow," Eric Williams, local public lands biologist with Kentucky Fish and Wildlife, said in a press release. "Wildlife viewing will also be good due to the variety of habitats found here." The property includes two tracts. The 700-acre northern tract is comprised largely of hardwood trees planted as part of a wetland restoration project. The 1,100-acre southern tract primarily encompasses



Credit: Kentucky Department of Fish and Wildlife Resources

▲ **The Harris-Dickerson Wildlife Management Area comprises two tracts donated by a mining company to satisfy federal wetland conservation requirements.**

reclaimed surface-mined lands. Mining company Andalex Resources donated the two parcels as part of an agreement with the U.S. Army Corps of Engineers to satisfy wetland conservation requirements under the U.S. Clean Water Act.

WEST

Condors return to Northern California

Endangered California condors have returned to the skies in Northern California after the Yurok Tribe and Redwood National and State Parks coordinated the release of three condors in May. They are the first California condors (*Gymnogyps californianus*) to occupy that portion of their range since 1892. The releases are part of a management plan to return condors to Yurok land. "For countless generations, the Yurok people have upheld a sacred responsibility to maintain balance in the natural world," Joseph James, chairman of the Yurok Tribe, said in a press release. "Condor reintroduction is a real-life manifestation of our cultural commitment to restore and protect the planet for future generations." Two male condors were released in early May. A female was released in late May. Another male was expected to be released later. The Northern California Condor Restoration Program, comprised of Yurok and park biologists and technicians, plans to manage the flock from a new release facility near the Klamath River. The Northern California flock will be considered a nonessential, experimental population under the federal Endangered Species Act.

Credit: Yurok Tribe

◀ **A pair of California condors awaits release in Northern California.**

NORTHEAST

Climate affects tern prey availability in Gulf of Maine

A warming climate is changing the foraging patterns of three tern species in the Gulf of Maine during a critical period before they breed. In a study published recently in *Avian Conservation and Ecology*, researchers examined stable isotopes in eggshell tissues of Arctic terns (*Sterna paradisaea*), common terns (*S. hirundo*) and the federally endangered roseate terns (*S. dougallii*) collected on seven islands in the Gulf of Maine from 2016 to 2018 to determine what the birds were eating in the period leading up to breeding and egg laying. Migratory birds that arrive in the Gulf during the spring need to bulk up on food before breeding and fledging chicks, and these two years were some of the warmest springs in recent history. Lead author Rachel Bratton, a master's student at the University of Massachusetts Boston,

Credit: Kirk Rogers/U.S. Fish and Wildlife Service

▲ **Arctic terns are changing their foraging patterns in the Gulf of Maine.**

and her colleagues found that warmer conditions may be affecting prey availability in the Gulf of Maine for these species. "Warming elevates risk of trophic mismatch, where the arrival of migratory seabirds misaligns with prey availability," she said. "Our results reveal highly localized foraging habits for each species, suggesting that management of habitat and prey resources will need to be considered on a population-by-population basis."

CANADA

Banff closes areas to protect wildlife corridors

Banff National Park is closing hiking trails and wilderness areas around Lake Louise this summer to protect important wildlife corridors. The areas will remain off limits until Oct. 15 in an effort to reduce conflicts with grizzly bears (*Ursus arctos horribilis*) and other wildlife. "This area is part of the Fairview wildlife corridor which is used by a variety of wildlife including grizzly bears," Parks Canada said in a statement. The agency said the affected areas are "hot spots for summer bear activity." The park is expecting unusually heavy visitation this summer after travel restrictions during the COVID-19 pandemic reduced visitor numbers in previous years. "These new measures will further reduce disruptions to wildlife and improve human safety," Parks Canada said.

Credit: María Fernanda Checa

Park rangers in Ecuador use a large slingshot to place strings in trees for bait traps to retrieve butterflies.

INTERNATIONAL

Park rangers in Ecuador help monitor butterflies

Park rangers in Ecuador are helping researchers understand more about insect trends in the country. As part of a program at Yasuní National Park, rangers collect butterflies, identify them and mark them during bimonthly monitoring events and share the information with researchers. "The idea is that park rangers will ultimately have the tools and ability to write up their own research papers, rather than turning to people outside," said Keith Willmott, a curator and director of the Florida Museum's McGuire Center for Lepidoptera and Biodiversity. After nearly 30 years working in Ecuador, Willmott, like other lepidopterists, noticed butterflies could be abundant one year and scarce the next. While a growing body of evidence shows insect declines throughout the globe, those studies "are mostly restricted to temperate or industrialized regions," he said. He and his colleagues created the Yasuní project to close that gap. With lead author María Fernanda Checa, Willmott co-authored a paper published in *Insect Conservation and Diversity* describing the program. Three park rangers served as co-authors. Willmott hopes the data collected can help answer questions about insect diversity, especially since butterflies are seen as indicator species of how other insects are faring. "Our long-term goal is to build a permanent monitoring program so that in 10, 15, 20 years, it might help us answer the questions we have at the moment but don't have the data for," he said. ■

Credit: Y Nakanishi

Banff National Park is expecting high visitor numbers this summer.

Contributed by David Frey, Dana Kobilinsky and Joshua Rapp Learn

Bridging the urban-wildlife gap

JESSICA MERKLING BRINGS A GENERALIST BACKGROUND TO WILDLIFE BIOLOGY

By Dana Kobilinsky

Growing up in rural Indiana, Jessica Merkling never expected her career would be dealing with wildlife in the city. But as an urban wildlife biologist in the north region for the Indiana Department of Natural Resources, Merkling plays a key role in helping landowners coexist with wildlife from the heart of Indianapolis to the northeast corner of the state.

Courtesy Jessica Merkling

▲ **Jessica Merkling collects water from a crayfish burrow to test for eDNA as part of her master's research on massasauga rattlesnakes.**

"Jessica embodies where our field is going," said Geriann Albers, a furbearer biologist with the Indiana DNR. "She is someone who is super passionate about our resources." She didn't come from a traditional educational path, Albers said, but she has found an important place in wildlife management.

Merkling grew up in a wooded area near Fort Wayne, where being in nature was a part of life, learning to hunt was a rite of passage and deer hunting became a birthday tradition. "For me, it's always been a family-oriented thing," she said.

But wildlife wasn't what she set out to study. As an undergrad at the University of Indianapolis, Merkling started out majoring in exercise science for physical therapy, but her adviser suggested biology would be a better fit. The school didn't have a wildlife concentration, so she studied general biology.

"I hear a lot of people who went to great, amazing schools with great wildlife programs, but that's not how I got here," she said. "I kind of fumbled along and fell into this, even though this is what I have always liked."

A different path

After a semester at graduate school and a couple jobs that had nothing to do with her biology degree, Merkling sharpened her focus on wildlife biology. In 2014, she was hired as a fisheries aide at the Indiana DNR and decided to go back to school in 2015 for her master's degree at Purdue University Fort Wayne. The degree was also in general biology, but her master's project involved collecting eDNA to learn more about eastern massasauga rattlesnakes (*Sistrurus catenatus*). Two years later, she began her position as an urban wildlife biologist.

The general biology degree paid off. In a field where many wildlifers are laser-focused on the species they're studying, Merkling stood out because of her broader background. It has allowed her to be more open minded, said Patrick Mayer, the north region private lands supervisor who hired her for the position.

"She picked up the things she needed to pick up and learn, and having that generalist background makes her stronger," he said.

The work brings her close to home, although not the rural landscape she was used to. "I've learned a lot of things about how to interact with people in urban cities versus in a more rural setting," she said.

Working with landowners

Part of her position involves talking to private landowners to develop, improve or acquire habitat in urban areas. She spends much of her time working with landowners on pollinator gardens, dealing with conflicts between people and wildlife and providing permits for Canada goose (*Branta canadensis*) management. She feels most productive when landowners choose to take a step in the direction that she suggests. One landowner, she recalls, had over six acres of a crop field they weren't going to use anymore. She urged them to plant flowers for pollinators. "When we planted it

the first year, there was ragweed taller than me," she said. "I thought internally, what did I just tell this landowner to do?"

But the work paid off. "It looks gorgeous now every time it's in bloom. That's the stuff that's really cool."

Patience and personality

Having patience, Merkling said, is the most challenging virtue in her position. But her colleagues say that is one of her best assets. "What has always impressed me about Jessica, and I don't think she'd acknowledge this about herself, is her patience," said TWS member Albers.

"A lot of her job is going to meetings and just listening and waiting for [landowners] to be ready to take action," Albers said. "It takes patience on her part to understand their needs and help them efficiently."

Merkling also wouldn't be so successful in her field without her friendly personality. "She's very outgoing and welcoming, and so people gravitate to her," said TWS member Erin Basiger, who used to work alongside Merkling at the IN DNR.

Those traits have helped Merkling get partners with different agendas to find common ground, Mayer said. "There have been multiple times where she's had to work with a number of people, and those people have walked away happy," he said. "That's the biggest thing."

A changing field

As the state DNR wrestles with remaining relevant to a changing constituency, Merkling has found herself at the center of those changes, and she's been a driving force in moving them forward. "She's not scared to get out there and make her presence known," Mayer said. "I'm really happy to have her as a biologist." The agency has worked to target efforts at people not involved in hunting and fishing, and colleagues say Merkling's vision has always been a step ahead, creating unique outreach events, like promoting bee boxes to attract native bees.

"That was the coolest idea ever," Basiger said. "She's one of those people that's very up to date. She was a fantastic person to work with. You can throw ideas at her, and she's willing to play ball."

Courtesy Jessica Merkling

▲ **Jessica Merkling staffs a booth at an event in Elkhart, Indiana, to discuss how the Indiana DNR works with urban wildlife.**

As the field evolves, Merkling hopes to continue working with landowners to achieve the best outcomes for wildlife.

"The biggest thing I want is for people to feel confident in doing their own thing with their habitat," she said. "Even if they live in an area with a teeny tiny yard, there are ways to be involved, and it's valuable." ■

Dana Kobilinsky is the associate editor for The Wildlife Society.

A Wave of Die-offs

WHAT'S KILLING PACIFIC SEABIRDS?

By Joshua Rapp Learn

Massive die-offs have killed seabirds, like this thick-billed murre, throughout the North Pacific. Some die-offs appear to be related to rising ocean temperatures associated with climate change. For others, the causes are less clear.

Credit: Andy Johnson/Cornell Lab of Ornithology

Citizen scientists were the first to tune into the unfolding tragedy. Combing the beaches in the San Francisco Bay area in November 2014, they spotted a few dead seabirds that had washed up on shore. By the next month, droves of dead Cassin's auklets littered the beach. This wasn't just happening around the San Francisco Bay. Biologists soon realized that thousands of dead birds were washing up along the Pacific Coast in California, Oregon and Washington.

For the volunteers who monitor beaches from Northern California to Alaska as part of the Coastal Observation and Seabird Survey Team (COASST), dead seabirds along the shore aren't necessarily shocking. Every few decades, large storms along migration routes can kill hundreds of birds, which sometimes wash onto the world's beaches. Given the natural boom and bust of prey availability, some years can be particularly deadly for seabirds even without foul weather.

But this Cassin's auklet (*Ptychoramphus aleuticus*) die-off was different. These birds normally spend their winters feeding far out in the Pacific Ocean, hundreds of kilometers from the coast. It was odd to see so many carcasses wash up. From the cliff-lined beaches of California to the temperate rainforest-lined shores of Washington state, volunteers documented upwards of 7,500 emaciated carcasses across nearly 1,000 kilometers of coast. Scientists estimated the actual death toll was probably orders of magnitude higher—as much as 350,000 or 400,000—raising concerning questions for a species whose entire global population is estimated at roughly 3.5 million to 4.5 million. What had brought these birds so close to land? And what had killed them?

"Something in the natural history of that bird had changed," said Julia Parrish, executive director of COASST and a professor at the University of Washington's School of Aquatic and Fishery Sciences.

After a few months, the sightings tapered off, but the auklet die-off turned out to be just the beginning of an even larger phenomenon. A series of similar events unfolded in subsequent years, involving hundreds of thousands of seabirds from a half dozen species—including sooty shearwaters

Credit: Coastal Observation and Seabird Survey Team

▲ **A Cassin's auklet takes flight off the coast of Monterey, California. A die-off in 2014 killed as many as one in 10 of these birds in the Pacific.**

(*Ardenna grisea*) and tufted puffins (*Fratercula cirrhata*)—that washed up along the West Coast of North America. Researchers estimate millions more sank or were eaten by scavengers.

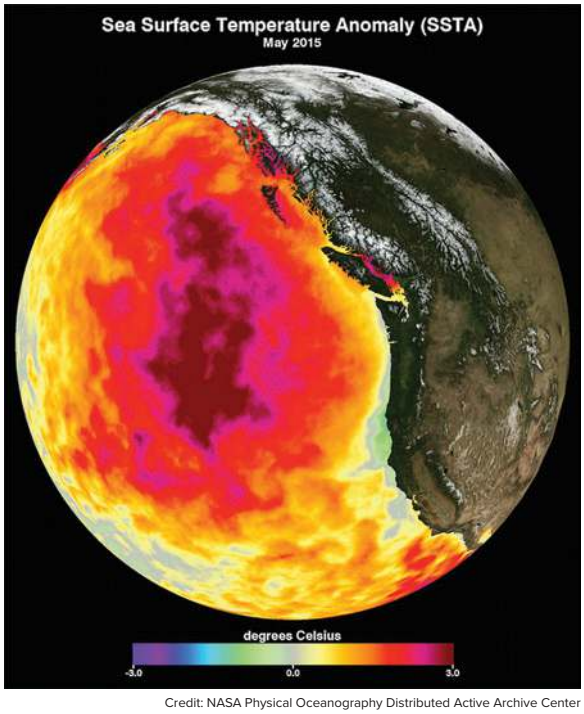
To understand what's causing these die-offs, researchers are turning to climate and oceanographic information, but in many cases, the answers remain elusive.

Blame it on the Blob

One of the backdrops to these die-offs was an intense warming in an area of the northern Pacific Ocean, which began right around the time of the Cassin's auklet event. Surface waters warmed several degrees Celsius—an increase that could affect productivity at the very base of oceanic life.

Warmer waters can cause the phytoplankton community to change dramatically, which, in turn, can reduce zooplankton like the krill that Cassin's auklets eat. Declines in zooplankton numbers or diversity can also mean less food for forage fish—smaller sardine-sized species like capelin, which murres and puffins consume.

The commercial fishing industry tracks forage fish, since they are important sources of food for commercially harvested species like cod and pollock, and their numbers didn't look good when the ocean began to warm. "The major forage fish had all taken nosedives in 2015," said John Piatt, a research scientist with the U.S. Geological Survey's Alaska Science Center. "In my whole career, working 40 years on this stuff, I've never seen anything like this scale."



Credit: NASA Physical Oceanography Distributed Active Archive Center

Between 2013 and 2016, a large mass of unusually warm ocean water—nicknamed the Blob—dominated the North Pacific, with temperatures as much as 3 degrees Celsius higher than average.

Piatt helped create the method scientists use to estimate seabird die-offs. After the 1989 Exxon Valdez oil tanker spill in Alaska's Prince William Sound, officials wanted to be able to place a cost on the damage, but that proved difficult since—as with the recent die-off events—the number of birds on shore may be just a fraction of the birds that died in deeper waters. Piatt came up with a novel approach. From the thousands of carcasses washed ashore, he and his team collected 100 of the freshest ones, marked them for identification and dumped them back in the ocean, up-current from the spill. After a few weeks, only three of them washed back up—on the same beach where they'd appeared in the first place.

The following year, researcher Glenn Ford and his team repeated Piatt's experiment, this time using radio-tagged carcasses. Again, they retrieved 3%. In another experiment, Ford dropped birds directly where the spill occurred, and 40% of the carcasses returned. As a rough average, Piatt and Ford later estimated that only about 10% of birds would likely wash up from a major die-off at sea. Knowledge of ocean currents has improved since then, but researchers still use modified forms of Piatt's models, and Piatt continues to track seabird mortalities.

Nothing in his career, however, prepared him for what he saw in the North Pacific—a three-year-long heatwave that some termed "the Blob," related to global climate change. When forage fish numbers plunged, ramifications spread throughout the ocean ecosystem. Competition increased among seabirds, and they had to compete with cod and pollock for the same diminished food resource. Since fish vastly outnumber seabirds they had stiff competition.

"This warming up thing is a big freaking deal," Piatt said. "It was the biggest warming event that's been documented to date, and it lasted longer than any other heatwave to date."

Unprecedented losses

As massive as it was, the auklet die-off paled in comparison—both in numbers and in geographic extent—to the deaths of common murres (*Uria aalge*) that began the following winter in the midst of the Blob.

Robb Kaler, a seabird specialist in Alaska with the U.S. Fish and Wildlife Service, first began receiving calls about the event as early as May 2015. By the following January, scientists counted nearly 7,000 dead murres at the western edge of Passage Canal in Prince William Sound. "That's unprecedented," Piatt said. The area was in the midst of the Blob's warm waters. The murres appeared to have starved to death.

The die-off reached its greatest intensity in January and February before it came to an end 11 months after it began. "That's a longer die-off than anything we've ever recorded," Parrish said. Carcasses appeared on beaches from the San Francisco Bay to the Bering Sea. Estimating the losses over such a massive expanse proved difficult, but scientists believe more than 1 million out of a global population of 7.5 million murres may have died.

A rare generalist die-off

Forage fish weren't the only type of seabird prey the Blob affected. During the winter of 2016-2017, the warming event coincided with a lack of prey that affected even birds that seemed like they should be able to weather the changing conditions. Around St. Paul Island in the Pribilof Archipelago, off Alaska's west coast, tufted puffins began dying off.

"Puffin die-offs are pretty rare because they are such generalists," said Marc Romano, a wildlife biologist at the Alaska Maritime National Wildlife Refuge. "That was really shocking."

Credit: Coastal Observation and Seabird Survey Team

▲ **COASST Surveyor Marc Bates prepares to record a dead pelagic cormorant (*Phalacrocorax pelagicus*) that washed up on the coast of Oregon near Cannon Beach.**

Lauren Divine, director for the Ecosystem Conservation Office for the Tribal Government of St. Paul, happened to be on the island when community members brought her the first few dead puffins from the Bering Sea in late 2016. Over the ensuing months, researchers estimated a total of 3,150 to 8,800 puffins and crested auklets (*Aethia cristatella*) died (Jones et al. 2019).

It was small and isolated compared to previous events. But the effects of the puffin die-off—fueled by a lack of prey at a time the birds were molting and in a weakened condition—were significant. The number of dead puffins exceeded the roughly 6,500 estimated in the colony on the Pribilof islands—researchers believe most came from colonies to the east and north of the archipelago.

Not letting up

Seabird die-offs didn't stop after that, but they did change patterns. While catastrophic events like the murre die-off haven't returned, wildlife managers have noted more consistent, yet smaller, yearly die-offs, often farther north than the ones centered in and around the Blob in earlier years.

"We have not had a break," Romano said. "It's getting to the point where it's tiring."

These more recent die-offs have occurred in the Chukchi and Bering seas. They happened not in the winter, as with past die-offs, but in the summer, with species like northern fulmars (*Fulmarus glacialis*), short-tailed shearwaters (*Ardenna tenuirostris*) and sooty shearwaters. These birds migrate across the globe from breeding grounds in the southern hemisphere around New Zealand and the southern coast of Australia every year.

These die-offs are a little less understood, in part because the birds often wash up on remote parts of the coast that aren't always monitored—if at all. The die-offs started in June 2017 just a few months after the puffin die-off and continued every summer for the next few years. Fulmars, shearwaters, black-legged kittiwakes (*Rissa tridactyla*) and thick-billed murres (*Uria lomvia*) washed up, many clearly starved. But with no Blob to point a

▼ Crested and least auklets (*Aethia pusilla*) appear at a breeding colony on St. Matthew Island, off the coast of Alaska.

Credit: Andy Johnson/Cornell Lab of Ornithology

Credit: Andy Johnson/Cornell Lab of Ornithology

Researcher Bryce Robinson holds an emaciated horned puffin (*Fratercula corniculata*) on St. Matthew Island in the Pribilof Archipelago, off the coast of Alaska.

finger at this time, it has proved more difficult for scientists to hypothesize about the causes.

Romano suspects it has to do with changing sea ice cover patterns in these northern waters due to climate change. Phytoplankton live and thrive on the underside of sea ice, and they feed other organisms higher up in the food web. As ice melts earlier, waters warm (Duffy-Anderson et al. 2019) and may become more suitable for cod or pollock to come into the area and eat the forage fish that shearwaters and fulmars prefer (Eisner et al. 2020).

Atlantic mysteries

The Pacific isn't the only area that has seen massive seabird deaths. Seabirds have also experienced problems in the North Atlantic. Starting in March 2022, hundreds of thick-billed murres (*Uria lomvia*) began washing up on the shores of Labrador.

Bill Montevecchi, a research professor at the Memorial University of Newfoundland who studies seabird behavior and ecology, said it isn't clear why these birds died, but just as in the Pacific, it could be a series of suboptimal conditions including ice shifts, wind stress and warming temperatures affecting food resources.

"Maybe the whole probability—the whole Russian roulette of those interactions—has shifted," Montevecchi said.

Common murres, razorbills (*Alca torda*) and Atlantic puffins (*Fratercula arctica*) also began washing up on the shores of Iceland, Norway, Denmark, Germany and Great Britain months earlier, and while it's not clear if they're related, Montevecchi said it's at least a curious coincidence. "It's almost as if there have been die-offs moving from east to west across the Atlantic," he said.

"We're seeing fundamental changes in the Bering Sea that I don't think are going away any time soon," Romano said.

Biologists worry about these shifting trends, especially among the shearwaters and fulmars, which typically would be spending time in the northern end of their range bulking up for their next breeding season. "They should be up here putting on mass," Romano said.

Credit: Paul Melovidov/Ecosystem Conservation Office of the Aleut Community of St. Paul Island

▲ **Aaron Lestenkof, an environmental sentinel with the Ecosystem Conservation Office of the Aleut Community of St. Paul Island, examines dead crested auklets during coastal monitoring on St. Paul Island.**

Climate's changes

In addition to its role in starvation, climate change may play other roles in these die-offs. While monitoring black-legged kittiwakes at Middleton Island in the Gulf of Alaska in July and August 2021, researchers documented several dozen that died within a few days of appearing sick and lethargic. Disease testing by scientists at the University of Alaska Fairbanks and the National Wildlife Health Center concluded several birds had died of avian botulism. These numbers didn't represent a huge proportion of die-offs that summer, but this was the first documented case of avian botulism in Alaska. Temperature plays a critical role in the multiplication of bacteria, including those that cause avian botulism, and the warmer climate might be allowing diseases to persist in formerly inhospitable areas and contribute to the overall deaths, Kaler said.

In another case, hundreds of rhinoceros auklets (*Cerorhinca monocerata*) washed up dead on the shores of Washington state and Vancouver Island in British Columbia in 2016. Many of the ones analyzed in the lab were emaciated and had succumbed to massive bacterial infections. Parrish believes disease may have been exacerbated by warmer ocean conditions.

Northern fulmar carcasses found in a 2017 die-off in the Bering and Chukchi seas contained saxitoxin, a neurotoxin produced by harmful algal blooms. These blooms are predicted to worsen as a result of climate change, in part due to higher ocean temperatures that facilitate their growth. "Other bird die-offs in Alaska and elsewhere have been linked to harmful algal blooms, so this is clearly an issue of concern for seabirds," said TWS member Caroline Van Hemert, a research wildlife biologist at the USGS Alaska Science Center, who studies these blooms. Van Hemert and her colleagues didn't find direct evidence that saxitoxin killed birds during the 2017 die-off (Van Hemert et al. 2021), but "the concentrations in the birds were high enough that we flagged it as a possible contributing factor," she said. An ongoing study of a localized mortality event at an Arctic tern (*Sterna paradisaea*) colony near Juneau, Alaska, in 2019 identified saxitoxin as a likely cause of bird deaths.

Fire and water

To some degree, smaller die-offs may be part of the natural ebb and flow of populations. It may seem

macabre to beachgoers, but these die-offs can give periodic boosts to seafloor marine communities and scavengers of the sea and shore, researchers say. Like a wildfire rejuvenating an aging forest, less extensive seabird die-offs may contribute to a healthier ecosystem in the long run.

However, just as climate change has led to more intense wildfires, seabird die-offs seem to be on the rise, increasing in frequency and abundance. Nearly every year has seen a significant die-off since the Cassin's auklet event in 2014. "[Die-offs] are not new, and they happened pre-industrial pollution and pre-global warming," Piatt said. "But there is no indication they were this big."

Working with zooarchaeologists, Parrish and her colleagues have examined seabird presence dating back hundreds of years. It's difficult to understand how big past die-offs may have been from the archaeological evidence, but nothing they've found meets the levels seen in the past eight years.

While seabird colonies can recover, they may face challenges the year following a die-off.

Credit: Lauren Divine

▲ **Conservation interns with the U.S. Fish and Wildlife Service perform necropsies on northern fulmars that were killed in a massive die-off in the Pacific.**

The year after the massive 2015-2016 die-off, researchers found that common murre colonies completely abandoned reproduction (Piatt et al. 2020). "It's like pushing the population over a cliff," Parrish said. "It was clear that birds

Credit: Andy Johnson/Cornell Lab of Ornithology

◀ **A red fox (*Vulpes vulpes*) kit eats a horned puffin. The number of dead seabirds that wash up in large die-offs overwhelms even scavengers.**

Credit: Andy Johnson/Cornell Lab of Ornithology

▲ **Coastlines throughout the North Pacific, like the Glory of Russia Cape on the northern end of St. Matthew Island, have seen high numbers of seabird die-offs in recent years.**

were very stressed." Other research showed that thick-billed murre colonies that suffered from die-offs in the Chukchi and Bering seas in 2017 experienced widespread reproductive failure in 2018 (Romano et al. 2020).

Population numbers may increase after a few years, however. Juvenile shearwaters or fulmars may pitch in by breeding earlier than normal. But Parrish cautioned that population numbers may never rebound to earlier levels. One reason for this is that climate conditions continue to shift ocean ecosystems in ways we are only just beginning to understand, with consequences ranging from a change in the type of prey available to where and when krill or forage fish can dependably be found. Since seabirds are often intensely loyal to a specific colony, what happens when conditions at or near a colony are no longer appropriate?

Changes in research and monitoring

Seabird loss also impacts human communities. In St. Paul, Aleut people have depended partly on sustainably harvesting seabirds and their eggs for generations. They used to harvest tufted puffins, and they still harvest murres. When numbers drop so low from die-offs, the practice stops.

"All of that is compounding into a really more vocal outcry or request for help to save the ecosystem," Divine said. "It's moving people to action."

In St. Paul, many of the puffin chicks had already molted in 2017 when the adult die-off occurred, so they could survive without their parents. But on a scientific level, the huge losses there and elsewhere in the past few years have resulted in COASST changing its response protocols. Volunteers normally walk their assigned beaches twice a month, but reports of large die-offs now trigger more frequent surveys, said Divine, who works with the organization in the Pribilof Islands. Each year seems to bring new concerns about a new species.

"Everything seems to be compounding," she said. ■

Joshua Rapp Learn is a science writer for The Wildlife Society.

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A RADical Approach to Conservation in Alaska

RAPID CLIMATE CHANGE REQUIRES A NEW PERSPECTIVE

By Jeremy S. Littell, Gregor W. Schuurman, Joel H. Reynolds, John M. Morton and Nicole Schmitt

Credit: Joel Garlich-Miller/U.S. Fish and Wildlife Service

▲ **To save walrus populations in Alaska, do we need to more aggressively resist or direct in response to loss of sea ice?**

In Alaska, conservation areas are managed to promote the persistence of wild species, habitats, cultural resources, visitor experiences and ecosystem services. Many conservation areas are managed by federal or state agencies, and they have specific boundaries, missions and legislative mandates. Others are also the domains of Indigenous and local people who derive livelihoods and cultural identity from these lands and waters. These areas vary considerably as to whether they are managed solely for conservation versus other additional resources and ecological functions.

Myriad threats challenge the sustainability of these values, and conservation areas often exist to mitigate such threats. But regardless of jurisdiction, legal contexts or historical impacts, all these places face challenges—unprecedented during human habitation—from one globally pervasive threat: anthropogenic climate change.

Yes, ecosystems, including the people who depend on them, have adapted to constant change in Alaska over most of the Holocene, if not before. This experience has conferred upon its constituents learned adaptive capacity, capabilities, and knowledges that are among the most flexible on the planet. But this time, the situation is different. The term "Anthropocene" has been used to describe an era in which humans influence planetary changes. Unlike the Holocene we have already experienced, the Anthropocene reflects a pace of change that has not been seen before.

Planetary temperatures warmed about 6 to 7 degrees Celsius from the last glacial maximum to the pre-industrial era (Osman et al. 2021). In the high latitudes, the amount of warming was roughly double the global average. But that was over a period of several millennia. Including warming that already occurred since the early 20th century (IPCC 2021, Markon et al. 2017), Alaska and northwestern Canada are expected to experience climate changes nearly as large, but in only a *century and a half*.

Climate change will continually and profoundly impact the whole Arctic system and the peoples who depend on it even more so than the changes of the Holocene, including the recent centuries. Possibly sooner than later, the resulting ecological transformations will entail adapting to and managing novel systems that bear little resemblance to those with which we have experience.

As we navigate the consequences of the Anthropocene, scientists, practitioners and decision makers will increasingly be forced to try to apply knowledge gained from systems that no longer exist. Conservation, therefore, cannot rely solely on the lessons of the past. We can no longer apply such lessons literally. As we try to adapt to the effects of climate change, we need new approaches. One such approach, called RAD (for Resist, Accept, Direct),

could have useful applications in Alaska, which is home to most of the land mass of national wildlife refuges and national parks in the United States.

Adapting our adaptations

Adaptation anticipates impacts and responds accordingly *before* opportunities are lost, costs of action increase or negative impacts become too severe. Sometimes, knowledge and experience indicate in advance what can be done differently to adapt. Other times, changes are surprising or novel or uncertain enough that adaptation must happen on the fly. Agencies that manage conservation areas have grappled with adaptation to climate change for two decades or more.

Most progress has focused on incorporating climate change information into already existing decision-making processes (through adding climate change vulnerability assessments and adaptation strategies) rather than developing new planning approaches. But increasingly, novel threats and fundamental changes to the very resources and ecological functions such places were established to protect are forcing more fundamental modifications in governance dimensions of agency-level planning and local conservation decision making.

Although many adaptation approaches devised in more developed landscapes might work in Alaska, others will not. Adaptation efforts in Alaska and northwestern Canada occur in a very different management context compared to their Lower 48 counterparts. Native peoples in rural villages comprise almost 22% of Alaska's population. They rely culturally and economically on subsistence lifestyles in landscapes with relatively recent histories of colonization.

The 1971 Alaska Native Claims Settlement Act and 1980 Alaska National Interest Lands Conservation Act added unique layers of complexity in natural resource management through establishing subsistence as a right and creating the current landscape of 100 million acres of federal conservation units and 44 million acres of Alaska Native village and regional corporation lands. These large wild areas present unique challenges and opportunities (e.g., Magness et al. 2018). While recent Arctic warming is four times the rate of the rest of the Earth (Jacobs et al. 2021), the impacts of many nonclimatic conservation stressors—such as industrial agriculture, pollution and urbanization—are much lower.

Over the last 15 years, the need to bridge the gap between what agencies do about climate change (interpret, plan, regulate) and what managers do in response to it (decide and, most importantly, act) has forced adaptation thinking to evolve toward a focus on *actions* that can address the challenges of climate impacts on conservation areas. The common themes that emerge result in frameworks that capture repeatable ways of engaging ideas and knowledge.

What is RAD?

One framework rapidly gaining traction in the conservation world is RAD (Schuurman et al. 2020, 2022; Thompson et al. 2021). At its simplest, when facing a sustained, directional change, decision makers can choose among three largely exclusive responses. They can resist, pushing back on the trajectory by trying to keep things as they have been. They can accept, letting the change occur, usually because there is little possibility of successfully resisting, but sometimes because the outcome is acceptable or minimizing human intervention is

Credit: D. Chorman

▼ We hesitate to *resist* the effects of declining sea ice by providing artificial haul-out platforms for walrus, but we enthusiastically extend the historical range of Anna's hummingbird (*Calypte anna*) northward by providing year-round feeders along the Cook Inlet.

prioritized. Or they can direct, actively intervening to steer the trajectory toward something more preferable or away from something unacceptable.

RAD streamlines the scope of future decisions. It requires considering—if not acting on—alternative futures and ways of managing. It forces clarity regarding intentions. It can encourage, but cannot guarantee, "outside the box" thinking. It also prompts clarifying questions regarding a potential action. Is the action trying to resist, accept or direct? Does it align with current or expected agency priorities, funding or policies? If not, why not? For example, adaptive management is a common planning approach used when knowledge is imperfect, outcomes are uncertain and course corrections may be required to achieve objectives. Adaptation actions might eventually have unanticipated outcomes that require revisiting strategies. In such cases, RAD can be a useful addition to adaptive management and decision making (Lynch et al. 2022).

Credit: U.S. Fish and Wildlife Service

▲ **We *accept* treeline rise in the alpine tundra and cottonwood colonization of Arctic tundra, but we hesitate when the first white spruce not deliberately planted on the North Slope is serendipitously translocated by a motor vehicle traveling up the Dalton Highway.**

With its emphasis on system trajectories and action, RAD is also compatible with multiple knowledge frameworks, including Indigenous knowledge. As community experience or scientific results emerge that clarify how ecosystems might respond to climate change and how management actions can alter responses, transitions from one approach to another (e.g., from accept to resist, or from resist to direct) might be warranted (Magness et al. 2022).

RAD thinking might sound daunting at first, but there are practical advantages. Direct experience with a system and its species' responses to disturbance or other effects is an advantage in using RAD, but it might not easily fit into other more abstract frameworks. Knowing how or when to intervene to achieve a desired outcome (or avoid an undesirable one) or even what plausible responses an action might trigger is critical to effective management.

RAD in Alaska

It is tempting to think that the relative connectivity, wildness and intactness of Alaskan ecosystems render them more ecologically resilient or resistant. As per conservation biology theory, this intactness supports a growing number of documented range expansions (not invasions, e.g., Urban et al. 2020) by climate-tracking species in response to novel conditions. White spruce (*Picea glauca*) is moving down the Yukon River (Juday et al. 2015). Hummingbirds *(Calypte anna)* and owls *(Strix varia)* are migrating farther north along the southeastern Alaska coast (Grieg et al. 2017, Livezey 2009, respectively). Fishers *(Pekania pennanti)* are expanding into southeastern Alaska from adjacent Canada (Kupferman et al. 2021). Moose *(Alces alces)* and beaver *(Castor canadensis)* (Tape et al. 2016, 2018) are spreading into the Arctic.

But it is unclear whether most plant and arthropod species can successfully expand over the mountain ranges that structure current biogeography. For species that depend on sea ice, terrestrial connectivity cannot compensate for their loss of habitat. Meanwhile, more than 560 exotic flora and fauna have been introduced to Alaska (Simpson et al. 2019), many more than range expansions among native species would suggest. So while existing conservation area networks in Alaska are necessary, they may not be sufficient to accommodate 21st-century species range expansions, adaptation and refugia. They do, however, provide a good foundation for alternative strategies to succeed. Examples of RAD point to some of these strategies.

Resist: A classic resist strategy is our conventional invasive species management—removing species colonizing under climate change in an effort to

preserve a previous ecological structure. Yet we have no clear framework for deciding, for example, when plant species native to Canada should be eradicated (as with *Elodea canadensis*) or planted (as with *Pinus contorta* subsp. *latifolia*) once they are introduced in Alaska. Common forms of resistance include curtailing the harvest of previously abundant species or herbiciding new but unwanted species (such as *Elodea*). More creative efforts might try to mimic disappearing habitat features, such as haul-out platforms for walruses *(Odobenus rosmarus)*.

Accept: Accepting is not necessarily just giving in or giving up. Accepting Pacific salmon colonizing rivers or reaches where they were historically absent (e.g., chum salmon, *Oncorhynchus keta*, Dunmall et al. 2022) embraces what many see as a positive aspect of warming rivers in northern Alaska. Intentionally accepting situations that result from climate changes and variability can be strategic. It can also be a better use of management resources than repeating historical approaches in new contexts where they no longer work. For example, access routes that were maintainable under historical climates might no longer be tenable given permafrost thaw or extreme precipitation events. A strength of the RAD framework is its explicit recognition of the choice to accept the ecological trajectory—something that often occurs by default after nonstrategic action.

Direct: One example of directing is facilitating colonization (perhaps by assisting dispersal, Karasov-Olson et al. 2021), sometimes to avoid extirpation elsewhere. Hastening inevitable climate-driven migration could increase the probability of species persistence. Alternatively, introductions could be used to direct landscape change. For example, introducing bison (*Bison bison*) has been explored in response to the recent development of novel grasslands without a native grazer on the southern Kenai Peninsula (Thompson et al. 2021, Magness et al. 2022), mainly to counter the system's trajectory toward lower landscape and community diversity. In protected areas in Alaska, such interventions can be contentious. Introducing species absent before European colonization could be interpreted as inconsistent with the concept of wilderness (Kaye 2015), a common value in protected areas. Similarly, deliberately accelerating permafrost thaw, such as in experiments near Denali National Park (Natali et al. 2014), may contribute to achieving desired future conditions on acceptable time frames or terms and prepare the way for directing a response, but it would hasten change away from historical conditions.

Credit: B. Olson

▲ **We hesitate to *direct* a fledgling *Calamagrostis canadensis*-dominated grassland on the southern Kenai Peninsula by introducing bison (*Bison bison*), which were here during the Pleistocene and occur elsewhere in Alaska today, but we welcome feral Chinese ring-necked pheasants (*Phasianus colchicus*) that now breed here.**

These examples highlight the important role that values play in managing a rapidly changing system (Clifford et al. 2022). When is a nonnative species welcome and when is it not? When is continued resistance warranted and when is acceptance more cost effective? Who decides and on what terms? How do conservation areas' founding mandates and management requirements determine what a desirable outcome is? When we ask questions like these, our decisions may be more likely to succeed in the future (e.g., Magness et al. 2022). However, we may need to update agency planning processes and guidance (e.g., National Park Service 2021) to account for these considerations.

Meeting the challenges

RAD demands that we evaluate our conservation goals based on historical conditions, current conditions and the future conditions we foresee or desire. To successfully apply the framework, we must acknowledge that in the foreseeable future, management under climate change—especially

in the high latitudes—will increasingly demand actions that respond to novel situations or take advantage of fleeting opportunities. At these junctures, decision makers may change course and experiment—and sometimes fail. Only by acting and learning from what happens will we discover how to operate effectively in this brave new world. This may require new flexibility at regional or local levels, as well as rethinking how and under what circumstances management choices can deviate from plans or norms founded on 20th century thinking and relative climatic stability.

RAD's emphasis on managing for desirable conditions raises another issue. In Alaska's patchwork of legal jurisdictions, desirable conditions can vary considerably along with underlying values across neighboring tribal, state, federal and private lands. Decisions to resist, accept or direct might have unintended or unanticipated consequences for neighboring managers. If historically independent decision making is used, contested spaces and decisions may result, presenting novel legal issues and conflicts. Anticipating these value conflicts (and looking for adaptive common ground) before they arise—even collaborating on or co-producing decision contingencies—could be beneficial.

We must acknowledge that in the foreseeable future, management under climate change will increasingly demand actions that respond to novel situations or take advantage of fleeting opportunities.

In practice, effective collaboration could focus less on agencies managing resources with input from stakeholders and more on communities and agencies partnering to determine desired futures, how adaptation strategies are constructed and what management actions support them. This approach reflects the reality that the fundamental driver—climate change—impacts all these lands, regardless of legal jurisdiction.

Finally, RAD decisions can be grounded in many knowledges, including Indigenous knowledges, local knowledge and science. Knowing how the near future will differ from the long experience in the Arctic is valuable, but so is understanding what people can do to promote desirable outcomes for themselves, species and landscapes. This is transformational knowledge, not focused just on how the coupled human-natural world works (systems knowledge) or how people might better use information to achieve goals (target knowledge, e.g., Pohl and Hirsch Hadorn 2008), but instead on navigating unprecedented change.

People, cultures and decision contexts are all part of the Arctic emerging in the Anthropocene—and have been for most of the Holocene. Successfully using RAD as an adaptation tool will require expanding the scope of—and better integrating—scientific inquiry across disciplines. Alaska has the capacity to develop use-inspired translational science (e.g., Enquist et al. 2017) and knowledge necessary to navigate this transition. Boundary organizations such as the Alaska Climate Adaptation Science Center, the Alaska Center for Climate Assessment and Policy and the Scenarios Network for Alaska and Arctic Planning work to collectively develop information needed and collaborate with diverse NGOs (such as the Alaska Conservation Foundation and Alaska Wildlife Alliance) to apply this information toward conservation adaptation.

Accommodating the unprecedentedly rapid changes and challenges will require adaptation in agency conservation decisions, the legal frameworks in which they are made and the ways knowledges inform them. RAD does not solve climate change problems, but it does provide a tool for focusing adaptation decisions. Paired with management and adaptive learning that draw on the lessons of the past while reckoning with an unfamiliar future, RAD provides a tool for conservation area managers to meet the challenges of climate change head on. ■

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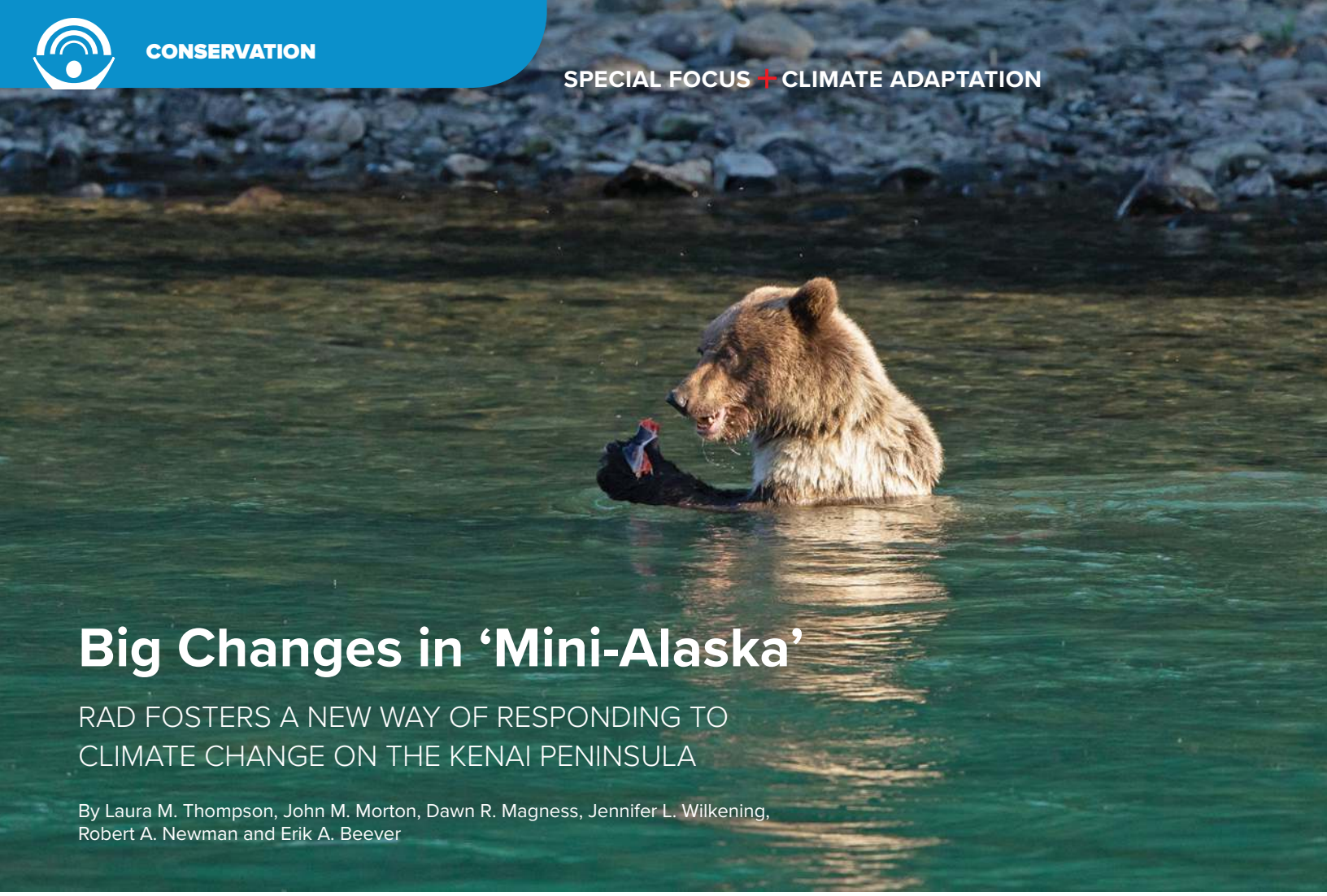

Big Changes in 'Mini-Alaska'

RAD FOSTERS A NEW WAY OF RESPONDING TO CLIMATE CHANGE ON THE KENAI PENINSULA

By Laura M. Thompson, John M. Morton, Dawn R. Magness, Jennifer L. Wilkening, Robert A. Newman and Erik A. Beever

Credit: Lisa Hupp/U.S. Fish and Wildlife Service

The Kenai Peninsula is a scenic jewel in Alaska. Home to boreal and coastal rainforests and ice fields, it reaches from sea level to peaks rising over 1,600 meters. The peninsula's 2.5 million hectares encompass the Kenai National Wildlife Refuge, Kenai Fjords National Park, Chugach National Forest and the Kenai River, which hosts a popular salmon fishery.

Climate change is obvious here. Conditions have been warming and drying since 1969. Many residents are planting nonnative species—trees like oak, maple, pine, ash and larch, and fruit trees like cherry, pear and crabapple—that can now survive in an area that once saw much harsher winters. Bird species such as Anna's hummingbirds (*Calypte anna*) that were previously distributed farther south are now being detected along the Cook Inlet (Peninsula Clarion 2019), and American martens (*Martes americana*) have colonized the Kenai Lowlands in recent decades (Baltensperger et al. 2017). Conversely, water temperatures in some nonglacial streams are exceeding physiological thresholds for salmon during July (Schoen et al. 2017).

In addition to species-level changes, there are entire ecological communities being affected by warming and drying conditions. Large expanses of spruce forests that occupy western portions of the peninsula are being decimated by spruce bark beetles capitalizing on warmer summers. In the Kenai Mountains, trees and shrubs are encroaching into alpine tundra, and glaciers are rapidly shrinking in surface area and mass.

Fire regimes are also changing. In the past, forest fires occurred in summer. Now, grassland fires commonly occur in spring, kicking off Alaska's official fire season a month earlier than the historical norm. The 2019 drought catalyzed the 170,000-acre Swan Lake Fire, whose extreme fire behavior was more typical of fires in Southern California chaparral. Recently, there have been drinking water shortages in Nanwalek, a remote Alutiiq village on the edge of the peninsula's eastern rainforest; the first lightning-caused grassland fires in contemporary times; and nonglacial streams exceeding in-stream temperatures not forecasted until 2069!

▲ **A brown bear (*Ursus arctos*) cub looks for fish in the Kenai River in the Kenai National Wildlife Refuge. Summer water temperatures are exceeding physiological thresholds of salmon in some nonglacial streams, making meals for the cub harder to come by in some regions.**

Credit: John Morton/U.S. Fish and Wildlife Service

▲ **The 170-acre Tustumena Lake Fire in 2019 was the first lightning-caused grassland fire on the Kenai Peninsula in contemporary times. The standing snags are white and Lutz spruce killed previously by the 15-year spruce bark beetle outbreak.**

Implementing RAD

Management on the Kenai Peninsula—often referred to as "mini-Alaska"—can be viewed through the lens of the Resist-Accept-Direct framework.

Some managers are resisting changes. Riparian parcels with groundwater seeps are being identified from thermal imagery and purchased by a local land trust to help maintain cold-water refugia for salmon. Native trees are being replanted in the aftermath of spruce bark beetle deforestation. Efforts to eradicate invasive plants such as *Elodea*, bird vetch and white sweetclover are well underway.

Elsewhere, many changes are being accepted as glaciers continue to melt, alpine tundra is afforested, peatlands dry out and hardwood trees increasingly replace spruce on the Kenai Lowlands in response to increased wildfire. Moreover, nonnative species such as Chinese ring-necked pheasants (*Phasianus colchicus*), lodgepole pine and earthworms are mostly embraced across the peninsula.

However, managers at the Kenai National Wildlife Refuge are actively considering directed change as well. A novel *Calamagrostis canadensis*-dominated grassland has been developing in the Caribou Hills after the one-two punch of deforestation from a 15-year bark-beetle outbreak and a human-caused 60,000-acre grassland wildfire in 2007. The potential for this transition from forest to grassland to be reinforced by grass-carried fire has prompted refuge managers to envision a future landscape that may include prescribed-fire treatments and the introduction of a nonnative large grazer such as bison (*Bison bison*) (Thompson et al. 2020).

In many cases, the choice of RAD strategy will come down to practicality (Lynch et al. 2021). A chosen strategy must be ecologically feasible in that it can be carried out given the biological constraints that govern the composition, structure or function of an ecosystem. For example, directing boreal forests to a more diverse grassland on the Kenai Peninsula is only feasible if grass-carried fires become frequent enough to mimic the fire regime needed to maintain a savannah. Managers are observing in real time whether the emerging climate conditions will support this novel disturbance regime.

Alternatively, societal factors, such as cultural norms, systems for valuing ecosystems and their services and regulatory or policy constraints, may affect strategy choices. For example, directing change on Alaska's Kenai Peninsula by introducing bison or another nonnative grazer could be challenging as species and lands fall under the Endangered Species Act and Wilderness Act, respectively. Finally, as mentioned above, options may be limited when operating at large scales, which are often required for stewarding transformations, because of financial constraints. Managers indicate that they are uncomfortable investing in adaptation strategies on their lands when the actions will only be a drop in the bucket within the larger region (Clifford et al. 2020). For example, understanding whether the grassland conditions are a local anomaly or a harbinger of change for the larger boreal region in Alaska changes the context of management decisions to resist or direct the grassland system on the Kenai. If the grasslands are a local anomaly, investing in translocating bison into a small and isolated grassland may not be practical or sustainable.

So what?

Unlike other decision frameworks, RAD puts approaches like assisted migration squarely on the table as it demands consideration of new pathways, such as direct options. Evaluating all three options simultaneously encourages bet hedging so that even as one path is chosen, there is full awareness that two other pathways are available.

On the Kenai National Wildlife Refuge, managers and biologists recognize that even as they accept these landscape changes being driven by a climate warming at two to three times the rate of the Lower 48, the logical follow-up question to their monitoring is "until when?" Similarly, as herbicides are applied to nonnative plants (i.e., resisting change), RAD thinking begets serious consideration of management efficacy and the new reality of accepting their invasion as perhaps part of the novel assemblages that will populate a future landscape in Alaska.

RAD presents a suite of viable options for responding to ecosystem transformation, and it may resonate with others elsewhere struggling with climate change and other stressors. Natural systems are no longer stationary. Management decisions may need to be perpetually revisited in order to keep pace with unprecedented rates of change.

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Climate Change Adaptation in Action

THE U.S. FISH AND WILDLIFE SERVICE CAN TAKE ACTION TO RESIST, ACCEPT AND DIRECT CHANGE

By Dawn Robin Magness, Jennifer L. Wilkening, Jennifer Smetzer, Kelly Guilbeau and Wendy Miles

Credit: U.S. Fish and Wildlife Service

▲ **A 2012 storm surge flooded parking lots and damaged the road to the beach at Chincoteague National Wildlife Refuge on the Virginia coast. The National Park Service's Tom's Cove Visitor Center is at risk after a series of severe storms made resisting island migration and dune overwash too costly. Accepting the transforming coastline changes is not a no-action solution. Infrastructure will need to be moved and redesigned.**

A New Climate Program

In October 2020, the U.S. Fish and Wildlife Service formed the Climate Change Action Program as a unified approach to climate adaptation and mitigation across the agency's programs and regions. The CCAP framework sets high-level objectives that fulfill congressional mandates and align with administration priorities through a number of teams tackling specific elements, such as interpreting and applying climate science for timely conservation implementation, integrating social and environmental justice into resilience efforts, developing a climate-literate workforce and infusing climate adaptation frameworks such as RAD throughout the agency's management community. Special thanks to CCAP members Jeff Burgett, Scott Covington, Mike Hudson, Amanda Sesser, John C. Tull and Emily Yurcich for their contributions to this article.

The latest headlines from the Intergovernmental Panel on Climate Change underscore what scientists at the U.S. Fish and Wildlife Service and elsewhere have spent years discussing and preparing for. "Human-induced climate change," it stated with high confidence, "including more frequent and intense extreme events, has caused widespread adverse impacts and related losses and damages to nature and people, beyond natural climate variability."

A long list of news reports over just the past two years seem to support that. Sea level rise and climbing water temperatures contributed to 21 named storms during the 2021 hurricane season, exhausting the naming list for only the third time in the last 68 years. In December of that year, a tornado leveled the town of Mayfield, Kentucky—a storm that occurred outside the normal tornado season and, as the belt of tornado activity shifts northeast, beyond the bounds of what historically was considered Tornado Alley. Three months later, a pair of unprecedented winter wildfires destroyed 1,000 homes in Boulder County, Colorado, forcing 19,000 people to evacuate. While the American West has suffered through a prolonged "megadrought," tidal flooding in coastal areas like Miami Beach is worsening. Climate patterns are even more extreme at the poles. In March 2022, Antarctica and the Arctic shattered records as a heat wave pushed temperatures at both poles to 30 to 40 degrees Celsius above normal.

Reflecting these dramatic events, the IPCC warned in its April 2022 report that projected global greenhouse gas emissions are "making it impossible to limit warming" to 1.5 degrees Celsius by 2030, and even limiting it to 2 degrees will be a challenge. Deep emission cuts and immediate policy action can still minimize the catastrophic consequences of climate change, the report warns, but time is running out.

The U.S. Fish and Wildlife Service is uniquely positioned to help steward natural resources in the

U.S. through this era of change. In 2010, the agency drafted "Rising to the Urgent Challenge," addressing how we would strategically approach climate change by applying a scalable set of principles based on priorities, partnerships, best science, landscape conservation, technical capacity and a global perspective. Since then, the Service has established a national inventory and monitoring program, developed a database to collect and share best available agency science and spearheaded landscape cooperatives. We have also partnered with others to assess important landscapes such as grasslands and sagebrush ecosystems, develop climate envelope models that predict climate change impacts on biodiversity and taxa redistribution and publish the National Fish, Wildlife and Plants Climate Adaptation Strategy.

The USFWS has made significant investments to produce actionable science. However, as unprecedented change accelerated and the science continued to advance, we recognized a need to develop new targets not originally discussed in the "Rising" plan. In 2020, the agency began to develop a new Climate Change Action Program.

A new normal

As part of the Climate Change Action Program, the USFWS is crafting a vision and strategy to reshape how we meet our fundamental mission of "working with others to conserve, protect and enhance fish, wildlife, plants and their habitats for the continuing benefit of the American people." Throughout our history, wildlife managers could largely conserve species in place or attempt to restore landscape conditions to the way wildlife had adapted to them. However, stable ecological communities and conditions are no longer a valid assumption. Today, species and habitats are shifting across landscapes while ecosystems and societies are transforming, creating unique and unprecedented wildlife management challenges. Continuing to simply resist ecological change may often be futile, causing the agency to waste limited management dollars and, more importantly, to miss valuable opportunities to guide and shape the inevitable ecological change.

The Resist-Accept-Direct framework (Thompson et al. 2020) provides an approach for framing, conceptualizing and defining management objectives in a world where change—not stability—is the new normal. RAD asks us to consider options beyond maintaining or restoring historical conditions and emphasizes an approach that is proactive rather than reactive. (See article on page 26.) Though challenging, this approach is an investment in preparedness that increases choices, flexibility and opportunities to respond when multiple future outcomes are possible, including novel conditions and surprises (Magness et al. 2022).

Credit: Tor Johnson

▲ **Crew members conduct a bird survey on Johnston Atoll, part of the Pacific Remote Islands Marine National Monument. The monument's low-lying islands are culturally important to Pacific Island peoples and provide critical nesting ground for seabirds. Sea level rise will force difficult decisions on when to resist, accept and direct the environmental changes underway.**

Implementing RAD will require a cultural shift in the agency and in the broader conservation community. Our perception of environmental change needs to evolve so that we see not only threats but opportunities. Natural and biocultural resource managers have the opportunity to facilitate forward-thinking management alternatives that incorporate biodiversity needs and community values. This new era of conservation requires systemic shifts in which we make decisions based on expanded integration of nontraditional approaches and transdisciplinary perspectives, including traditional knowledges held by Indigenous peoples.

Management regimes will continue to face challenges responding to ecological transformation if societal values, rules and knowledge do not keep up with the pace of a changing climate. To that end,

the social values underlying conservation decisions need to be made more explicit and actively shaped through deliberative engagement with stakeholders, partners and local communities (Yung et al. 2013).

An uncertain future

Climate change will force difficult choices in the years ahead. Rather than waiting until a decision point is at hand to build consensus, we need to proactively engage in difficult conversations and build collective trust so that future consensus is possible. The USFWS should strive to communicate about emerging environmental challenges clearly and consistently with other stakeholders and request their support in identifying our adaptation blind spots.

Reimagining the Southeast

The Southeast Conservation Adaptation Strategy brings together public and private organizations around a bold vision for connecting the lands and waters of the Southeast and Caribbean to support healthy ecosystems, thriving fish and wildlife populations and vibrant communities.

With a data-driven spatial plan and an ambitious regional goal, SECAS helps accelerate conservation in places where it will make the biggest impact and can help identify places across the 15-state region where resist, accept and direct can be implemented.

For example, Pocosin Lakes National Wildlife Refuge in eastern North Carolina serves as a critical hub for regional connectivity, contributing to multiple intact habitat cores as large as 35,000 acres in size. The refuge is also remarkably resilient to climate change. Even at 6 feet of sea level rise, most of the Refuge is not projected to experience inundation at high tide.

Thirty-seven percent of Pocosin Lakes NWR scores above average as a resilient terrestrial site, with another 54% scoring average, suggesting that much of the refuge will likely be able to sustain biodiversity and ecosystem function in the face of climate change. Eighty-two percent of the floodplain scores in good condition on network complexity, suggesting it is connected to a network of different stream size classes, allowing species to access climate refugia and move between habitats.

Although some coastal protected areas will be lost to sea level rise, resist actions are important to protect the areas that can serve as a safe harbor for coastal wetland species, such as the black rail (*Laterallus jamaicensis*), buying time to put adaptation plans in place in other areas.

Effectively responding to climate change also requires a culture of adaptive learning and nimbleness in which people make informed decisions that incorporate the risks of status-quo management versus forward-looking alternatives. RAD can help management agencies such as the USFWS implement and normalize this cultural shift by providing a framework that enables more transparent communication about the values and assumptions that underpin conservation decisions in the Anthropocene.

To prepare for a future that may be very different from the past, we need to build knowledge about what futures are possible. A wealth of existing data, models and tools can help us develop scenarios that account for rapid ecological and societal change. We are not waiting until more data become available because we lack the time to wait. Climate change is not something happening 100, 50 or even 10 years in the future. Changes have already happened. They are happening now, and we must act now.

Scenario planning has been embraced by the USFWS (Rowland et al. 2014), and the agency has made substantial progress in using scenarios to describe uncertainty about drivers that are outside of management control and to identify management options that work across the range of plausible futures. For example, protecting and enhancing landscape connectivity is a low-risk adaptation strategy because it ensures that animals can move in response to changing conditions.

Making choices

RADical management is focused on identifying when and where it is strategic to either resist change, allow for change to occur autonomously or direct change toward the most desirable possibility. To implement RAD, we need to be able to recognize how climate change is unfolding in order to be intentional about investing in actions that align with emerging reality. If not, we might create conditions that require constant management interventions and miss out on opportunities to promote resilient, self-organizing, self-sustaining systems.

The time has come to use the scenario planning efforts, climate envelope models, vulnerability assessment, climate impact research and other tools developed throughout the last decade to elucidate decision points for contingency planning and

highlight data gaps that are hindering our ability to intentionally direct and manage change. Timing and probability estimates are less important than being able to recognize and respond to changes coming over the horizon. For example, projections for the first ice-free Arctic summer range from 2023 to 2100. This uncertainty does not preclude us from deciding how to identify significant ice-free events and the management responses that could be triggered if and when they occur.

Our capacity to intentionally resist, accept or direct ecological change will be increased by planning actions well upstream of decision points. If we develop scenarios that communicate the conditions and events that have the potential to tip change toward alternative futures, we can rigorously explore and test how we can intervene to shape the outcome.

Moving away from familiar current conditions can be uncomfortable. The RAD framework creates space to explore all options, including facilitating a future that is very different from the past, even if we decide that some interventions and outcomes are unacceptable. To choose which futures are desirable or unacceptable, we will need to navigate both conservation and social justice issues. Social, economic, technical, political and legal constraints may bind choices about if, when, how and where to intervene effectively. Talking early and often—before a window of opportunity to shape future conditions closes—can help us understand and possibly remove barriers to action.

Getting proactive

There is also a critical need to address how local-scale adaptation actions fit into regional conservation strategies. Managing for species and habitats into the future requires a diverse portfolio of climate change adaptation strategies that can be implemented across spatial and temporal scales. To begin to address this need, the USFWS is working with partners to build a robust portfolio of actions that managers can use to bridge the gap between broad-scale data and local management actions.

These portfolios serve to unify the diversity of local RAD actions into a coordinated strategy and help RAD choices to be strategically informed by larger-scale perspectives. Although adopting the RAD framework within the agency represents a potential shift in how we approach and frame

Credit: Jennifer Wilkening/U.S. Fish and Wildlife Service

▲ **Isolated desert springs provide critical water resources for wildlife, such as this desert bighorn sheep (*Ovis canadensis nelsoni*) at Point of Rocks Spring in Ash Meadows National Wildlife Refuge. These aquatic areas frequently contain rare or endemic species and are threatened by hydrological change and potential increases in groundwater pumping resulting from climate change. USFWS managers are collaborating with other organizations throughout the Mojave Desert to monitor desert springs and identify adaptation actions. Information from this eco-regional assessment is used to build a portfolio of RAD actions, applied at different spatial scales and designed to ensure preservation of the entire Mojave Desert.**

Credit: Kelly Guilbeau based on Thompson et al. 2020 and Lynch et al. 2021

◀ **The RAD framework encourages managers to creatively consider how to shape ecological conditions. The Resist-Accept-Direct categories depend on if intervention will be used to explicitly shape future ecological conditions and the time frame used as a reference point to define management objectives.**

management problems, we already have some excellent examples of how the USFWS is working to proactively direct change.

In the modern context of rapidly shifting climate conditions, it is no longer effective to simply react to ecological change as it occurs. Instead, this reality necessitates a shift to a proactive management approach in which we intentionally direct change towards a desirable and plausible future condition (Magness et al. 2022). Such an approach is not only imaginable and achievable. It is essential to ensure the persistence of ecosystems and the continuation of the USFWS' conservation mission.

The RAD framework encourages the kind of shift in management thinking that will be instrumental in moving agencies toward more effective management. This is a call to action—not just for the USFWS but for the larger conservation community. We need to build a portfolio of RAD management activities, develop a formal mechanism for implementing the RAD framework and prioritize actionable research activities that will inform efforts to intentionally resist, accept and direct change into the future. ■

The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the U.S. Fish and Wildlife Service. Any use of trade, firm or product names is for descriptive purposes only and does not imply endorsement by the U.S. government.

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The Ice Don't Lie

SEA ICE IS RAPIDLY DIMINISHING, CREATING CHANGES IN POLAR BEAR ECOLOGY AND CHALLENGES FOR MANAGERS

By Todd C. Atwood

The first time I saw a polar bear was March 28, 2012. I had just started a new job studying the iconic bear at the U.S. Geological Survey's Alaska Science Center, and I was immediately sent north to join my colleagues for the annual field effort.

Our flight crew of four—three biologists and a pilot—departed the small community of Kaktovik by helicopter and headed north. The flat and featureless landfast ice quickly gave way to the pack ice mosaic of tented pressure ridges, ever-moving floes and narrow slivers of inky black water known as leads. We had been flying low and slow over a network of leads when we encountered tracks leading away from a melted-in depression—a spot where a polar bear (*Ursus maritimus*) had been waiting over a seal breathing hole for a quick meal.

We followed the tracks for about seven miles before someone shouted, "There's the bear!" I scanned the landscape through the helicopter windscreen until I caught a flash of pale yellow moving against the flat light of the snow-covered ice. As we closed on the bear, it broke into a slow trot, then turned and rose on its hind legs to face us. It was magnificent, and I was humbled to be in its presence.

After seeing hundreds of bears over the ensuing years, the awe, excitement and humility has never diminished. But over time, another emotion has taken center stage—concern that time is running short if we hope to mitigate fundamental changes to the Arctic marine ecosystem, the species that inhabit it and the people who depend on it for subsistence.

The loss of sea ice is the primary threat to the long-term persistence of polar bears. They rely on sea ice to meet several life history needs, including feeding, mating and denning. Progressively warmer air and rising ocean temperatures have reduced the extent and thickness of sea ice, and they have altered annual patterns of sea-ice phenology and drift (Fox-Kemper et al. 2021). As is frequently noted in the scientific literature and popular media, a phenomenon called "Arctic amplification" is causing the region to warm twice as fast as the rest of the world. As sea ice declines, greater amounts of ocean are exposed. The dark surface absorbs more energy from the sun and creates additional warming. Recent research suggests the rate of Arctic warming may be closer to four times the global average (Jacobs et al. 2021).

Credit: Suzanne Miller/U.S. Fish and Wildlife Service

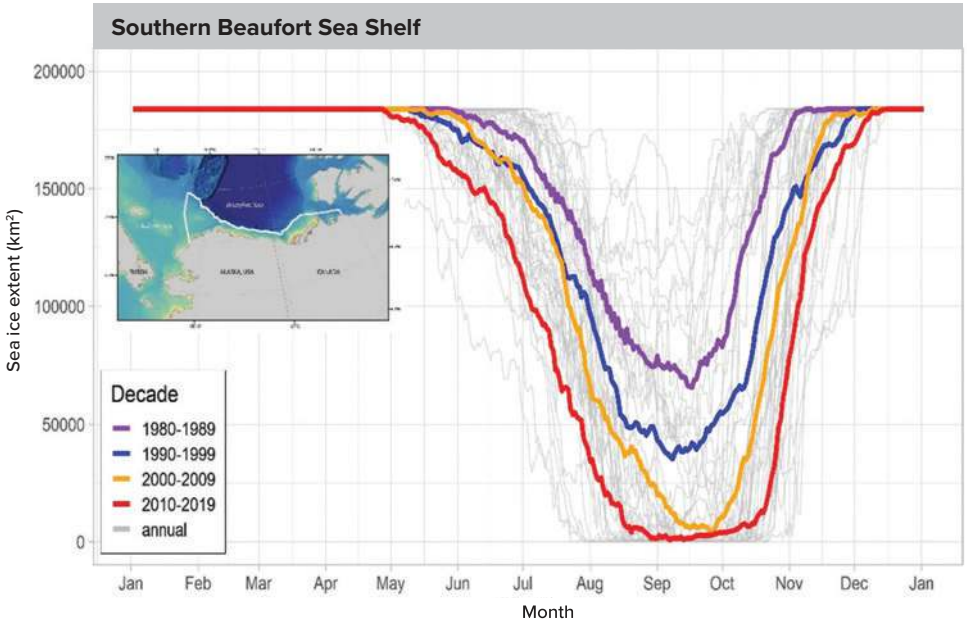
▲ **The loss of sea ice is the primary threat to the long-term persistence of polar bears.**

Declines in sea ice extent and thickness have been particularly pronounced in the marginal seas of the Arctic Ocean. For Alaska's southern Beaufort Sea, the most notable outcome of those changes has been the loss of sea ice over the continental shelf in summer and fall. The southern Beaufort Sea is characterized by a narrow continental shelf, which is where most of the sea's biological productivity is concentrated. This shelf has transitioned from having ice present year-round as recently as the late 1990s to now being functionally ice free for two to three months each year. Changes in sea ice phenology and characteristics have been associated with modifications to polar bear behaviors, which,

in turn, have affected population health and vital rates. The result is a number of climate-induced changes in the ecology of the Southern Beaufort Sea population of polar bears, which the United States and Canada share, creating several management challenges.

Changing behaviors

One of the ways bears have compensated for changes to their sea ice environment is by modifying their spatial behavior. Satellite collar data collected from adult females over three decades revealed the progressive decline and displacement to the northeast of optimal sea ice habitat in summer (Durner et al. 2019). In response, polar bears expanded their range—the average home-range size increased by 64% (Pagano et al. 2021)—and occupied greater areas of suboptimal habitat, including land.



Credit: D.C. Douglas/U.S. Geological Survey

▲ **Decadal (1980-2019) mean sea ice extent for the continental shelf region of the Southern Beaufort Sea subpopulation of polar bears. The continental shelf region is delineated in white on the inset map.**

For some bears, the shift in distribution was accompanied by a notable increase in energy expenditure associated with moving from the pack ice to land, which can involve a long-distance swim of 50 kilometers or more (Pagano et al. 2020). Similarly, Iñupiaq residents in Alaskan coastal communities have reported increased observations of bears being exhausted and lethargic when arriving on shore in the summer and fall after extensive swims from the pack ice (Rode et al. 2021).

Most bears stay with the sea ice in the summer and fall, while others make the decision to head to land. The proportion of the population coming ashore increased from an average of 4% in the early 2000s to nearly 30% by 2015, and the time spent on land increased with the amount of time ice was absent from the shelf (Atwood et al. 2016a).

The growing reliance on land has not been limited to summer. As sea ice has thinned, it has become a less stable surface for denning. As a result, most dens now occur on land instead of sea ice (Olson et al. 2017). Yet, despite these changes in seasonal distribution and an occasional long-distance walkabout to Russia or Greenland, the bears show strong fidelity to the greater Beaufort Sea region.

Health effects

Since ringed seals (*Pusa hispida*) are the main prey of polar bears, declines in seal productivity can affect polar bear hunting success. From 1985 to 1999 and 2000 to 2016, the probability of polar bears fasting in spring increased 44%, concurrent with a decline in seal body condition (Rode et al. 2018a), which could affect the production and survival of seal pups.

Other long-term data indicate that the ability of adult female polar bears to devote energy reserves to reproduction has declined over time. The mean annual litter mass of cubs-of-the-year declined 23% between 1983 and 2015. Mean annual body mass of single adult females—the individuals that enter dens in the fall—declined by about 13% (Atwood et al. 2021).

The southern Beaufort Sea bears are one of three polar bear subpopulations exhibiting a long-term decline in abundance (Bromaghin et al. 2021). None of the 19 polar bear subpopulations have increased over the long term (Polar Bear Specialist Group–Established 1968 (iucn-pbsg.org); accessed 31 March 2022). Our studies suggest that declining sea ice and prey condition have been associated with nutritional limitations that have affected body condition and reproduction in southern Beaufort Sea polar bears.

Meanwhile, the growing use of land in summer has exposed bears to a number of potential stressors. While on shore in summer, the bears congregate near settlements to scavenge on the remains of

Credit: U.S. Geological Survey

▲ **Todd Atwood, left, and Anthony Pagano use a tripod and chain hoist to weigh an adult male polar bear captured on sea ice.**

subsistence-harvested bowhead whales (*Balaena mysticetus*). They obviously benefit from the subsidy, but there's a downside—exposure to land-based pathogens. As land use has increased, we've detected evidence of exposure to pathogens that are new to polar bears—pathogens like *Francisella tularensis,* which causes tularemia; *Neopsora caninum*, which has been known to cause abortions in cattle; as well as an increasing trend of exposure to *Toxoplasma gondii*, the parasite that causes toxoplasmosis; and *Brucella spp*., which causes brucellosis (Atwood et al. 2017). Exposure to pathogens is likely to increase under ongoing climate change as hungry bears become less discriminating in what they eat, further stressing some subpopulations.

As bears spend more time on land, they're increasingly sharing space with humans, which raises the risk of human-bear interactions. The U.S. Arctic Coastal Plain has a relatively (by Arctic standards) large industrial footprint associated with oil and gas development in the Prudhoe Bay and Kuparuk oil fields on the central coast and in the National Petroleum Reserve-Alaska to the west. In 2017, legislation was passed allowing for exploration and development in the 1002 Area of the Arctic National Wildlife Refuge.

The concurrent increase in industrial activity and decline in availability of sea ice has been associated with the occurrence of polar bears near infrastructure. From 2010 to 2016, the industry reported 2,373 polar bear observations to the U.S. Fish and Wildlife Service (U.S. Fish and Wildlife Service 2017). In the Arctic, large-scale industrial activities like seismic surveys occur in winter. At the same time, female polar bears are in maternal dens giving birth and nursing cubs, and they are vulnerable to disturbances like those caused by large vehicles driving over or near dens and to seismic waves from nearby vibration source trucks during periodic seismic surveys (Wilson and Durner 2020). Premature emergence from dens may lead to decreased cub survival (Rode et al. 2018b).

Management challenges

Polar bears are fundamentally dependent on the sea ice ecosystem. Mitigating greenhouse gas emissions will be critical to their long-term persistence (Atwood et al. 2016b). If emissions continue to rise unabated, climate models estimate that mean surface air temperature will increase four to five degrees Celsius above preindustrial levels by the end of the century (Fox-Kemper et al. 2021). As a result, the Arctic Ocean will be ice free in summer for as long as five months. The most consequential outcome will be reduced access to marine mammal prey. Although polar bears may be able to exploit alternative sources of food on land, that will likely be insufficient to offset the nutritional benefits of feeding on fat-rich seals (Rode et al. 2015).

A short-term consequence of the lengthening ice-free season will be the escalating risk of human-polar bear interactions resulting from nutritionally stressed bears sharing space with people for extended periods of time. Local communities must increasingly manage larger numbers of bears in their midst (Rode et al. 2021).

Although emergent population stressors like those associated with increasing human activities are more tractable to manage than sea ice loss, they are unlikely to meaningfully improve the long-term outcome for polar bears absent greenhouse gas mitigation (Atwood et al. 2016b). Polar bear managers are still wrestling with the path forward for short-term stressor management, whether that be a focus on harvest, mitigating potential adverse effects of industrial activity or both.

But it is clear that these bears are important—to the general public as a symbol of our commitment to environmental stewardship, to the food security of northern communities and to those of us in the scientific community seeking to understand—and hopefully avoid—the dire consequences of a warming climate. It is critical that we implement short-term stressor management until greenhouse gas emissions are mitigated and sea ice habitat stabilizes over the longer term. ■

Todd Atwood, PhD, is a research wildlife biologist at the U.S. Geological Survey Alaska Science Center, where he leads the Polar Bear Research Program. He is a member of TWS' Climate Change and Wildlife Working Group.

A Policy for a Changing Climate

THE OREGON DEPARTMENT OF FISH AND WILDLIFE IS INTEGRATING CLIMATE AND OCEAN CHANGE IN ALL ITS ACTIVITIES

By Davia Palmeri, Caren Braby, Andrea Hanson and Shaun Clements

Here in Oregon, the impacts of the changing climate and ocean have been evident for years. Unusually acidified waters were identified as the source of a larval die-off at an Oregon oyster hatchery in 2007 (Barton et al. 2015). Low stream flow and high temperatures have triggered multiple mortality events for aquatic species over the last 10 years. And the Oregon Department of Fish and Wildlife's wildlife research program has documented impacts of earlier spring conditions on the forage quality and body condition of mule deer (*Odocoileus hemionus*).

Also here in Oregon, there has been strong political interest in reducing the state's greenhouse gas emissions. In March 2020, Gov. Kate Brown announced the Climate Protection Program, directing state agencies to take all steps within their authority to reduce the state's emissions. In 2021, the legislature adopted the 100% Clean Energy bill, which set the most aggressive timeline in the country for moving to 100% clean electricity by 2040.

▼ **The ODFW's wildlife research program has documented impacts of earlier spring conditions on the forage quality and body condition of mule deer. The key principles of the Climate and Ocean Change Policy will be applied to the forthcoming update of the Oregon Mule Deer Management Plan.**

Credit: Oregon Department of Fish and Wildlife

But, as the stewards of Oregon's fish and wildlife, we know that reaching zero emissions in Oregon through alternative energy development will come at a cost to fish and wildlife—and it will not halt the progress of the climate-driven impacts we are already observing. The ODFW is concerned that we will see dramatic losses of fish and wildlife if we can't direct all of the state's natural resource management capacity to prepare for and respond to climate change.

Our 2018-2024 strategic plan included climate change and ocean acidification among the state's top issues in need of creative, transformative, department-wide efforts. We convened a Climate Change Focal Team comprised of policy, communications and administrative staff; fish and wildlife biologists and researchers; and conservation issue coordinators, which identified opportunities related to increasing our capacity to respond to the impacts of climate change. Above all, the team identified a need for direction from department leadership on what it means to prepare for and respond to the impacts of the changing climate and ocean.

In late 2018, with representation from all divisions, the ODFW Climate Change Focal Team set out to develop a Climate and Ocean Change Policy.

Defining our approach

Our team looked across the country for other states' climate action plans, adaptation strategies and frameworks to provide us with inspiration and lessons learned. We found that many organizations had crafted climate adaptation plans parallel to—and distinct from—the organizations' primary efforts. These plans tended to assess the likely impacts of climate change on the organizations' mission and provided long lists of prioritized actions to address them.

But we knew the impacts of the changing climate and ocean affect *everything* within the ODFW's

mission. A comprehensive accounting of actions the department would need to prepare would be overwhelming to read and unwieldy to implement. We also recognized that a standalone climate action plan would come with a perception that we needed an entirely new program with new funding streams. Our own experience in Oregon supported this view, as two prior statewide efforts to develop climate adaptation plans have gone largely unimplemented for lack of resources and failure to make a direct link to individual staff work plans.

We wanted to create a policy that ensured that every ODFW employee, program and financial resource could help us respond to and prepare for the impacts of climate change. A comprehensive planning effort that mirrored what we found elsewhere didn't seem like it would accomplish that. Our team decided to pursue a policy we could implement through existing procedures, policies and partnerships.

We conceived of our Climate and Ocean Change Policy as a framework for integrating climate and ocean change information into everything we already do. Since the policy would be adopted by the Fish and Wildlife Commission as administrative rules, we wanted a high-level approach that would be relevant and applicable to fish and wildlife management across ecosystems—from coastal waters to the Cascades, from sagebrush meadows to old-growth forests—and could be maintained for the long term. We have already seen it applied in diverse situations across the state. As we update our Mule Deer Management Plan, the climate policy provides guidance on using the plan to address climate impacts on mule deer populations. Principles of the climate policy were also integral in guiding the science and management strategies while developing a multispecies conservation and management plan for fish in Southwest Oregon.

The policy needed to respect the department's legal authorities, though. Most of the impacts of the changing climate and ocean affect fish and wildlife through the ability of land and water to provide functional and accessible habitat. Yet, ODFW's statutory authority relates mostly to managing fish and wildlife populations, not land and water. The department relies on partner engagement, voluntary opportunities and consultation with other organizations for most of the habitat mitigation, restoration and protection we do. We wanted this policy to respect that limited authority and voluntary engagement while motivating and empowering the department to wield our influence more effectively for better land and water management outcomes for fish and wildlife.

Credit: Oregon Department of Fish and Wildlife

Credit: Oregon Department of Fish and Wildlife

▲ **The ODFW's Climate and Ocean Change Policy is intended to be relevant across all of the state's ecosystems, from the nearshore marine to upland terrestrial habitat types. Top: ODFW's Marine Reserve program completes a biodiversity assessment at Cascade Head Marine Reserve. Bottom: Spring wildflowers bloom in Hells Canyon.**

Putting it to work

The policy we developed is based on key principles that staff must consider, whether they are implementing science and research, developing or revising plans and policies, performing habitat restoration or protection actions, consulting with partners and the public or any number of daily activities. By taking this approach, we hoped that the climate policy would engender strong support for future budget requests for new climate-smart programs, guide staff on climate-informed shifts they can make in existing programs and encourage staff to incorporate information on climate change in their ongoing work.

Credit: Oregon Department of Fish and Wildlife

▲ **The Oregon Department of Fish and Wildlife's 2018-2024 strategic plan identified climate change and ocean acidification among the state's top issues in need of creative, transformative, department-wide efforts.**

For example, the policy's key principles on species and habitat management say:

"The Department should generally use the following approach when implementing management actions that relate to fish and wildlife habitat, unless directed otherwise through a Commission adopted plan:

(a) Give priority to protecting habitat for native fish and wildlife that is currently high functioning and projected to remain or become high functioning despite the impacts of changing climate and ocean conditions;

(b) Give priority to restoration and enhancement actions where such actions would result in creation of high functioning habitat despite the impacts of changing climate and ocean conditions; and

(c) Assign lower priority to actions where projected habitat changes caused by climate and/or ocean change are likely to exceed native species' ability to persist.

(d) Support actions that maximize carbon sequestration as long as such actions do not result in loss of habitat to fish and wildlife."

This "protecting the best" principle offers staff a framework for focusing habitat-related work in locations where they have the greatest chance of sustaining fish or wildlife populations despite the impacts of climate change. We hope this will help us apply limited conservation dollars more efficiently and result in the maintenance and enhancement of more functional fish and wildlife habitat in the long term. For example, this principle supports overlaying known locations of likely coldwater refuges with our existing list of fish passage barriers that are top priorities for removal. The result is a fish passage barrier list informed by climate impacts.

While dedicated staff members work to stem the loss of habitat from other conservation issues, climate change is causing further habitat loss for some species. Each of the key principles in the policy can be applied across many tasks and contexts of our staff's work. By framing this policy around key principles, staff can integrate climate adaptation efforts with planning for habitat management, consulting on land use proposals and prioritizing their workloads.

Working together

In addition to the key principles, the climate policy emphasizes coordination, urging the ODFW to "exhibit leadership in facilitating a coordinated statewide response to minimizing the impacts of the changing climate and ocean conditions on Oregon's natural resources and the people who depend on those resources."

Thanks to the governor's call to action and the urgency of climate-driven events in Oregon each year, state agencies are all working to adapt. The Department of Energy is seeking new areas for renewable energy development to reduce emissions.

The Housing and Community Services Department is seeking affordable housing options for an influx of residents from states that may be less climatically hospitable in the future. The Department of Health is planning for confronting extreme smoke conditions due to the increased frequency and intensity of wildfires.

All of this work will benefit from a coordinated approach across state agencies. Proactive engagement by the ODFW with other agencies can help minimize conflict and ensure that fish and wildlife aren't inadvertently harmed through other agencies' adaptation efforts. The climate policy directs the department to approach other agencies and engage with their efforts now—collaboratively and proactively—to find ways to protect the best places for fish and wildlife and direct new land use to areas that are least likely to be suitable for fish and wildlife.

Sharing with the public

After early drafts of the policy were reviewed and revised by members of the Climate Change Focal Team and leadership from across the organization, the department hosted a series of public meetings for stakeholders. The public review was overwhelmingly positive and supportive.

Perhaps the most controversial element was the "conservation efficiency" key principle, which acknowledges that the changing climate will drive some populations of native species to extirpation, despite every possible conservation intervention. This key principle also allows for future commission action that may accept losses for some species in exchange for greater conservation emphasis on populations in places where scientific evidence indicates their persistence is possible.

This principle of accepting or directing change rather than fully resisting it has been discussed in the

Credit: Oregon Department of Fish and Wildlife

▲ **ODFW staff meet with Oregon Parks and Recreation Department staff on the coast. The Climate and Ocean Change Policy focuses on the need for deep collaboration across state agencies.**

Goals of the ODFW's Climate and Ocean Change Policy

- Ensure the department understands the risks and opportunities associated with changing climate and ocean conditions and incorporates that understanding into all of the department's actions to maximize the conservation, use and enjoyment of fish, wildlife and their habitats for present and future generations.
- Provide leadership toward a coordinated statewide and regional response that minimizes the impacts of changing climate and ocean conditions on Oregon's natural resources and the communities, culture and economies reliant on them and allows for sustainable use of natural resources in the future.
- Increase public awareness about the current and future impacts of climate and ocean change on fish, wildlife and their habitats and the value of resilient habitats for fish and wildlife, clean air and water, flood attenuation, recreational opportunities and the natural resource-based economy.
- Provide leadership towards achieving the reductions in global greenhouse gases emissions that will be needed to prevent worsening of the impacts by reducing the department's carbon footprint to the extent practicable, with the goal of reaching carbon neutrality.

To read the complete policy, visit dfw.state.or.us/climate_ocean_change

Species and Habitat Management Principle #5

"The Department should prioritize conservation actions for native species and their habitats to be most efficient and effective in achieving conservation outcomes. In some instances, naturally-produced, native species will be unable to persist in an area because the impacts of changing climate and ocean conditions are practicably irreversible. In these instances, the department, only through the commission, may consider modification of the conservation approach as long as healthy populations of the species exist elsewhere in the range and the modification is in compliance with other state and federal laws."

literature (see previous articles in this issue), and it has been implemented in some systems, like national wildlife refuges. But among fish and wildlife advocates, it can trigger strong fears of loss. Discussing this principle with our partners as part of developing the policy was a good first step in addressing the reality of this possible outcome. After public review, we added the requirement that "accept loss" decisions must be made by the commission, offering assurance that such decisions will be made openly and will not be made lightly.

Credit: Matt Hill/Douglas Timber Operators

▲ **ODFW staff and partners returned to Rock Creek Hatchery as soon as possible after wildfires in 2020 to salvage fish and infrastructure. Rock Creek Hatchery on the North Umpqua River in southwest Oregon sustained the most severe damage of any hatchery during Oregon's unprecedented wildfires in the fall of 2020. The ODFW has commenced a comprehensive vulnerability assessment of the state's hatchery system to identify opportunities to mitigate for the impacts of climate change on these facilities.**

Adopting the policy

In January 2020, we presented an informational exhibit on the draft policy to the Fish and Wildlife Commission with an opportunity for public comment. In April, ODFW hosted a half-day workshop for commission members, during which department staff reviewed the science behind climate and ocean change, discussed observed and anticipated impacts on fish and wildlife, shared information on current ODFW climate-related activity and emphasized that the impacts of climate and ocean change affect fish and wildlife through changing habitat suitability. In July, the commission formally adopted the policy.

Its structure makes it challenging to do a comprehensive assessment of progress on implementation of the policy, because its implementation is dispersed across the department by design. However, a number of measurable steps have been taken, including an assessment and realignment of many of the departments' monitoring resources to better track the occurrence and impacts of climate change, development of fishery frameworks that are responsive to downturns but still allow harvest during years of sufficient returns and an assessment of the climate resilience of aquatic habitat across the state. Additionally, the department has completed an assessment of its own carbon footprint and is in the process of completing a climate vulnerability assessment of its fish hatcheries.

Staff members also host a monthly update for the commission highlighting case studies of the policy's implementation. At the January 2022 commission meeting, staff discussed a partnership that allows the Oregon Department of Transportation to repair high-priority failing culverts to a lower standard than is normally allowed but that still improves fish passage. To compensate for this lower obligation, ODOT pays into a compensation fund that provides full discretion for ODFW to address its highest-priority fish passage barriers. Through this program, the department has opened over 800 miles of habitat in the last few years, allowing fish access to cooler and more resilient headwater areas.

We also saw success in applying the key principles in developing the 2021-2023 budget, which created a new ODFW Habitat Division. The division elevates the land and water issues affecting fish and wildlife and better equips the department to coordinate with other agencies to improve fish and wildlife habitat. Bringing

our terrestrial and aquatic habitat staff together within a single division and filling in key resource gaps leads to several critical benefits. As it relates to implementing the climate policy, the new division will improve the department's ability to respond consistently to climate change impacts, monitor impacts on the ground and improve ODFW's integration with land and water management around the state. The entire state government is gearing up for rapid conversion to renewable energy, including solar and wind energy, which have well-documented impacts on fish and wildlife habitat. The Habitat Division will help the department work with the agencies permitting such activities and will allow ODFW to foster deeper collaboration as called for in the climate policy.

The biggest challenge with implementing the climate policy is ensuring that all our staff members are versed in the policy and buy in to it. The Climate and Ocean Change Policy is not a plan. It is a framework for thinking about climate change. Its less direct, less tangible nature requires that staff adapt their own approach to their work for the policy to be most successful in advancing fish and wildlife conservation in the face of climate change. Our next step is to develop tools that empower staff members to embrace this way of thinking, have the information they need and incorporate it.

The Oregon Department of Fish and Wildlife knows these threats are unfolding locally, regionally and globally. We hope this policy will help lead us to a more secure future for Oregon's fish and wildlife and inspires others to think about the long-term relevance of today's conservation actions in light of the impacts of the changing climate and ocean. ■

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A Call to Action on Climate Change

THE CLIMATE CHANGE AND SUSTAINABILITY ADVISORY COMMITTEE IS CHALLENGING TWS MEMBERS TO ENGAGE

By Don White Jr., Grant Hilderbrand, Gregg Servheen, Robert Newman, Valorie Titus, Carolyn Decker and Jonathan Trudeau

In the 85 years since The Wildlife Society was founded, wildlife professionals have strived to meet the broad challenges in wildlife conservation and management. TWS members and wildlife professionals have consistently focused on understanding the ecology and biology of wildlife, including their habitat requirements; on establishing sustainable harvest levels; and on providing objective recommendations for managing human impacts on wildlife populations and their habitats.

Climate change, defined as a significant long-term shift of weather patterns, now must factor among the top priorities facing wildlife professionals. Climate change threatens not only wildlife populations. It also affects their ecological communities, ecosystems and ecosystem services. It would be difficult to conceive of a threat and threat multiplier to wildlife more insidious, more far reaching and more defining.

Credit: Kyle Joly/National Park Service

▼ **Caribou migrate through Gates of the Arctic National Park and Preserve. Warming temperatures are expected to bring an earlier green-up, increase winter icing events and reduce snow cover.**

We now have irrefutable evidence, documented in the rapidly growing scientific literature, that climate change is driven primarily by humans, specifically by the burning of fossil fuels (IPCC 2022). Collectively, direct and indirect human activities are raising the levels of CO_2, methane and other greenhouse gases in the atmosphere, which are increasing average global temperatures and altering patterns of precipitation. Its effects take different forms in different parts of the globe—more acidic oceans; drought; rain replacing snow; rising sea levels; warming lakes, rivers and streams—leaving few places on Earth unaffected. The biochemical processes that pump oxygen into the atmosphere, plant succession, soil decomposition, the hydrologic cycle, vector-borne diseases and many other physical, chemical and biological processes are all being impacted with unknown consequences.

The current climate crisis is also a crisis of environmental justice. The impacts of climate change are not shared equally by humanity across space and time, nor do we expect them to be in the foreseeable future. Industrialized nations are responsible for most of the changes occurring in Earth's climates through the burning of fossil fuels and, as a consequence of these nations prioritizing economic growth, the environmental costs were inadequately considered. While less industrialized nations bear a smaller responsibility for the increasing input of greenhouse gases into the atmosphere, these nations and under-resourced human communities worldwide are likely to suffer disproportionately from climate change (IPCC 2022).

The most-developed nations with the greatest wealth have greater capacity and ability to adapt and mitigate the impacts of climate change on their food supply chains, housing, health and national and personal security than the less wealthy. Moreover, climate change threatens natural ecosystems—impacts likely to be most harmful to human

communities that rely on harvesting natural resources for food. These insecurities and threats have led to and will continue to maintain environmental injustices with no equity in either the impacts or ability to adapt to or mitigate changing climates.

An uncontrolled experiment

Climate change, as witnessed firsthand by wildlife professionals, is having and will continue to have far-reaching consequences for wildlife, including changes in temporal and spatial relationships and population and community dynamics. Temporal changes include, for example, changes in migration patterns in birds and mammals, timing of breeding and reproductive success, timing and duration of hibernation and trophic mismatching, such as disrupting the synchrony between the phenology of consumers and their resources. Although our current understanding of the microevolutionary responses and consequences of wildlife populations to climate change remains rudimentary and far from complete, wildlife responses to climate change will be determined by species' ability to adapt.

Changes in the spatial relationships of wildlife populations and communities include latitudinal and elevational range shifts and shifts in vegetation communities. Contemporary climate changes have already influenced the distribution of species by shifting their ranges to higher elevations and higher latitudes. These shifts have been documented chiefly in the Northern Hemisphere between 30 degrees and 60 degrees in latitude. Unfortunately, much less is known about range-shift patterns within the tropics. That is cause for concern given the species richness, high level of endemism and the large numbers of threatened taxa in this climate zone.

Changes in population and community dynamics include predator-prey dynamics, host-parasite dynamics and inter- and intraspecific competition. Unfortunately, little is known about how climate change may influence interacting wildlife species, populations and communities. We know, however, that climate change can result in phenological mismatches and range expansions within, for example, host-parasitoid communities. Such changes result in changes to the strength and integrity of competitive interactions, which impact not only agroecosystems but natural ecosystem functioning as well.

Climate change subjects environmental processes and the biodiversity of planet Earth to a human-caused, worldwide, uncontrolled experiment with little understanding of the outcomes. The only rational response to this unprecedented and ominous experiment is to take actions that will reduce both the rate and scope of climate change.

Credit: Kim Arthur/National Park Service

▲ **Moose calves forage in Denali National Park and Preserve. Changes in vegetation community structure and fire regime will impact many ungulate species.**

Confronting climate change

The Wildlife Society's members and the broader wildlife profession value wildlife and recognize that functionally intact ecosystems are essential for human survival. TWS and its members can further sustain and steward all wildlife by accepting the challenges involved and adapting to and mitigating

The Wildlife Society's Climate Change and Sustainability Advisory Committee has three broad objectives:

1. Engage members on the need for a cultural shift within TWS to actively address climate change and sustainability. Engagement will emphasize how climate change is affecting the prospects for wildlife populations and their ecosystems in the future and the need for integrative solutions within TWS and across organizations with shared interests.
2. Amplify TWS' voice relative to climate change and sustainability as it relates to wildlife and natural resource management, science and policy, both internal and external to TWS.
3. Incorporate sustainability into the operations and culture of TWS and facilitate sustainability in the wildlife profession and broader society.

Credit: Kara Lewandowski/NPS

▲ A brown bear walks along at Silver Salmon Creek in Lake Clark National Park and Preserve. Salmon, an important food resource for many bears, are being adversely impacted by warming waters in both the ocean and freshwater streams.

climate change. In so doing, we cannot only treat the symptoms. We must also address the causes.

TWS and its membership cannot afford to assume a position of neutrality and function as detached observers. We must continue as champions of the scientific method, science-based management and science-management partnerships. Doing so must be in the context of communicating science-based management action to slow climate change and mitigate its effects. We must prioritize those actions that will most effectively and efficiently preserve, steward and sustain all wildlife and all biodiversity as climates change. We must acknowledge, reduce and mitigate our professional climate footprint. We must also encourage TWS members and those we serve and collaborate with to advocate for operational and policy actions that reduce climate impacts and provide wildlife with the time and space to adapt to climate changes.

To this end, TWS and wildlife professionals must confront the driving forces of our society causing global climate changes, and we must design and implement wildlife adaptation and mitigation strategies to reduce the effects of changing climates.

To maintain credibility as well as leadership relevance, TWS and its members must broadly and widely communicate science-based information, not only about the impacts of changing climates on wildlife and their habitats, but adaption and mitigation strategies as well. We must all advocate for actions that reduce climate impacts. We must develop collaborative system-level solutions. And we must identify and call out actions, organizations and policies that fail to reduce climate change and impair sustainable wildlife populations. This includes the role and value of wildlife in society and the need for effective methods for valuing wildlife and all other natural capital beyond the utilitarian perspective.

Catalyzing action

TWS' president formed the Climate Change and Sustainability Committee as an advisory committee to Council in 2021. The committee's mission is to catalyze action by facilitating, integrating, accumulating and communicating ideas from all TWS organizational units, working groups, standing and ad hoc committees and members. Where appropriate, the CCSC will identify and recommend actions and policies to Council to help guide TWS and the wildlife profession to meet the challenges of climate change and sustainability. In fulfilling this mission, the CCSC views climate change and sustainability as inseparable from TWS' diversity, equity and inclusion vision.

The joint pursuit of climate response and DEI efforts—rather than being redundant—underscores their inherent connection and amplifies both areas. We can benefit our publics, employers and other constituents by acting as science, policy, operations, culture and communication laboratories and entrepreneurs to advance climate impact reduction and adaptation consistent with DEI efforts and principles. Only with the full engagement of and communication with the network of wildlife professionals comprising TWS can we hope to enable action and overcome hesitancy to take on these challenges. The CCSC will emphasize the insights, expertise and greater investment that students and early career professionals can bring to climate action, but they need to be enabled and mentored by mid- and later-career professionals.

Get engaged

We are looking for TWS members who are leading local and regional efforts on diversity and environmental justice. At the 29th Annual Conference in Spokane, Washington, in November 2022, we want to hear from TWS members and discuss climate efforts and the evolving nature of work, conservation and sustainability across the wildlife profession.

We encourage all those with ideas; those leading or seeking to lead local, chapter and regional efforts; and those who want to help move TWS and the profession forward to contact members of the CCSC and attend the roundtable at the Annual Conference in Spokane.

There is no right way for climate and DEI progress to proceed. None of us has ever been here before, but we know the need is great and that we must act sooner rather than later for biodiversity, for our profession, for our Society and for the wildlife that is everyone's public trust. ■

Don White, Jr., PhD, is the James M. White Professor of Wildlife Ecology in the College of Forestry, Agriculture and Natural Resources at the University of Arkansas, Monticello, and chair of TWS' Climate Change and Wildlife Working Group.

Grant Hilderbrand, PhD, CWB®, is the Northwest Representative to The Wildlife Society Council.

Gregg L. Servheen, MS, is a retired wildlife program coordinator with the Idaho Department of Fish and Game. He is a board member of several wildlife conservation organizations and a past president of the Idaho Chapter of TWS.

Robert Newman, PhD, is a professor at the University of North Dakota. He is co-chair of TWS' Climate Change and Sustainability Advisory Committee, past chair of TWS' Climate Change and Wildlife Working Group, board member of TWS' Native Peoples' Wildlife Management Working Group and president-elect of the North Dakota Chapter of TWS.

Valorie Titus, PhD, TWS Fellow, is the wildlife resource management program manager at Hocking College and co-adviser for the student chapter of TWS. She is president-elect for the North Central Section and on the board of the Hunting and Trapping Conservation Working Group, a former Northeast representative to TWS Council and a graduate of TWS' Leadership Institute.

Carolyn Decker, MS, is an ecologist and science communicator and a member of TWS' Climate Change and Sustainability Advisory Committee.

Jonathan Trudeau is a PhD candidate at the Boone & Crockett Quantitative Wildlife Center at Michigan State University and a past chair of TWS' Early Career Professionals Working Group.

The Wildlife Society's Climate Change and Sustainability Advisory Committee Action Items

Listed below, in no order of priority, are action items the CCSC has identified and is striving to implement. We request all TWS members to review this list and send additions and modifications to the CCSC.

Enhance climate change education

- Survey TWS members to better understand member perspectives, concerns, ideas, barriers and knowledge gaps about climate change and adaptation.
- Engage with TWS' Leadership Institute on topics related to climate change, sustainability and TWS culture as potential themes.
- Establish a CCSC webpage on TWS' website to share up-to-date climate change information, ongoing CCSC initiatives and TWS actions.
- Discuss with TWS' Publications Committee about adding a "Climate and Sustainability Implications" section to TWS' journals. Other avenues could also be explored (e.g., journal subsections) for highlighting the implications of climate change.
- Identify outlets for TWS members to share adaptive management successes and case studies that do not fall within the realm of hypothesis-driven science.

Enhance climate change communication

- Convene roundtable discussions on wildlife, sustainability and climate change at TWS annual conferences with organization units, working groups, committees and members to identify issues and potential solutions. Discussion themes will change annually. Produce an annual report summarizing the main topics of discussion and actions/solutions proposed.
- Convene an annual forum/consortium with other societies (e.g., Association of Fish & Wildlife Agencies, American Fisheries Society, Society of American Foresters, Ecological Society of America) to share ideas, approaches and combine efforts on the shared challenges of climate change and sustainability.

Encourage an institutional culture of action on climate change within TWS

- Meet annually with TWS' CEO, committees and staff to identify specific legislation and other priorities related to climate change and sustainability.
- Initiate discussions with TWS' CEO and staff about the importance of carbon neutrality and how and where this might apply to TWS activities. Develop for Council's consideration recommendations for policies and guidelines to move TWS toward carbon neutrality in its operations.
- Cooperate with the Position Statement Committee on revising the Climate Change Position Statement.
- Develop a climate change policy document similar to TWS' DEI Vision document for distribution among TWS organizational units to encourage action.
- Promote the role of early-career professionals in TWS generally and in the work of the CCSC, in particular.
- Propose recognition awards for individuals, organizational units and/or other conservation groups to highlight and demonstrate support for innovative actions in the climate change and sustainability arena (e.g., carbon neutrality, adaptive management, education).

Working in a World of Wounds

HOW DO WE COPE WITH "ECOGRIEF" IN A CHANGING CLIMATE?

By Michelle Doerr

Credit: Michelle Doerr/Anavah Consulting LLC

▲ **Sometimes ecogrief occurs simply when a beloved species, like the author's favorite bird, the black-capped chickadee (*Poecile atricapillus*), makes fewer appearances.**

Over the past year, I have started asking a question during my workshops on self-care, team care and ecowellness: "On a scale of 1 to 10, how hopeful do you feel about your work in conservation most days?" Of nearly 100 participants, ranging from students to retired conservation professionals, 12% gave a rating of four or below. Half gave a middle rating. That leaves 38% in the upper levels of hope.

I realize this is not a scientific poll, and I did not ask what was behind each person's rating. But their responses, in addition to a general check-in before each workshop, provides anecdotal evidence that leads me to believe that many are suffering.

They're not alone. A 2020 study by the American Psychological Association reported that more than two-thirds of adults say they have at least a little "eco-anxiety"—anxiety or worry about climate change and its effects.

As biologists and ecologists aware of healthy ecological processes, we cannot "unsee" the damage caused by humans. It's easy to understand why a wildlife biologist who has spent 25 years trying to protect Florida manatees (*Trichechus manatus*) may feel hopeless or unmotivated after watching pollution eliminate the seagrass upon which the manatees rely. "One of the penalties of an ecological education," Aldo Leopold wrote in his classic *A Sand County Almanac*, "is that one lives alone in a world of wounds. Much of the damage inflicted on land is quite invisible to laymen. An ecologist must either harden his shell and make believe that the consequences of science are none of his business or he must be the doctor who sees the marks of death in a community that believes itself well and does not want to be told otherwise."

Conservationists face the same situation today, but hardening our shells is not the best approach—for ourselves or the species and habitats we work with. It is important for us to acknowledge the psychological effects of conservation and our work on the environment.

Acknowledging 'ecogrief'

"Ecogrief" is one term used to describe that feeling of hopelessness many of us experience. Others include "eco-anxiety," "climate grief" and "solastalgia." The label we use isn't as important as how we respond to these feelings. Faced with overwhelming challenges in our work—natural disasters, endangered species, habitat loss, ocean acidification—feelings of hopelessness, dread, anxiety and grief are normal. If you find yourself feeling a sense of overwhelm when you think about your work challenges, you may be experiencing this grief.

Healthcare and mental health professionals have documented encountering "compassion fatigue" in their work (Cocker and Joss 2016). The professionals on the front line of wildlife conservation, climate change and environmental protection experience a similar fatigue. Evidence from my own work and the research I've read suggests some wildlife professionals are on the edge of dropping into more serious mental and emotional struggles unless we

open the conversations and normalize the acceptance that these mental and emotional struggles exist in our profession. I believe we need the gifts that everyone provides to conservation. We cannot afford to lose even one person in this work. That means we all play a part in providing safe spaces in our workplaces to have these difficult but emotionally important conversations.

Acknowledging and normalizing all feelings around the grief and loss in our work is the most important action. Grief and anxiety are normal reactions to the climate crisis and other ecological concerns that conservationists face each day. No one needs to be "fixed" if they are experiencing overwhelming feelings of grief and dread. In fact, acknowledging the pain and grief, naming it, sitting with it and allowing it to move through the body in a compassionate manner is vitally important to resilience.

In the workplace, we must have the bravery to hold spaces where people can express emotions without judgment. What will help most is being able to share stories and grieve together as a group. If I have one takeaway from all my work in self-care for conservationists this past year, it is that people want to know they are not alone in their suffering and wellness concerns. Supervisors need to understand that this grief is not something to control or manage. It should be met with genuine compassion.

Overcoming overwhelm

There are two quick and simple ways to overcome the sense of overwhelm. First, breathe deeply into your belly through the nose and release the breath slowly out the mouth while relaxing your body. This helps stop the brain from spinning and lets the body know it is safe. Practice this anytime you catch yourself in useless thinking patterns or worry. Simply pause and switch focus to your breathing body.

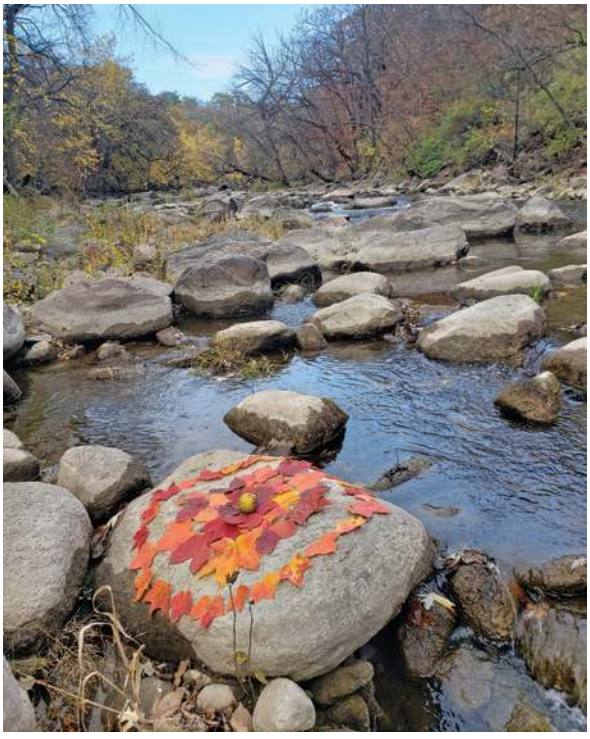
A second uncomplicated way to shift out of anxiety is gratitude. I have mentioned gratitude in previous articles, and it is worth repeating. When we appreciate what we have, our brains shift from scarcity thinking to having and being enough. A grateful brain gives off drops of dopamine and serotonin that tell the body all is presently OK.

Then, we can acknowledge the pain. Joanna Macy, a long-time activist and expert on this issue, suggests this step as a necessary part of the process of maintaining action. We must be able to share our feelings of overwhelm and dread without judgment and in group settings. Having spaces to share stories and feelings is how we normalize and process our emotions. If we skip this processing time, more harm might occur if individuals are left feeling isolated in their negative feelings.

Credit: Michelle Doerr/Anavah Consulting LLC

▲ **Cycling to the local prairie oak savanna restoration helps author Michelle Doerr when she is feeling overwhelmed by her work in conservation.**

I have been doing a lot of work around trauma, including my own processing and study of collective trauma. What I have learned is that silence and lack of places to talk about traumatic events without judgment is what keeps the effects of trauma in the body. When left in silence, trauma may show up in



Credit: Michelle Doerr/Anavah Consulting LLC

◀ **Creating art using items from nature that will decompose is one way to practice being mindful in nature.**

myriad physical health effects, such as chronic pain, sleep issues and more (van der Kolk 2014).

We must provide spaces for difficult conversations where people are free to express their pain and worry. Please also note that people of different genders, races, ethnicities and generations may experience this pain differently and more dramatically. No one's experiences should ever be judged, interpreted or fixed. We all must learn to acknowledge this pain as a part of the experience of deep loss, however that shows up for every individual.

Navigating the challenges

I have started to reconsider the term "self-care" because our society has relegated self-care as optional. Instead, I have started to think about it as each person's energy level for life. If you think you can just "push through" whatever stress you are facing, I ask, what does "through" mean? What conditions would be in place for you to rest, refuel and re-energize? If you cannot answer definitively, I bet your body will shut you down before you reach whatever "through" is. Once I approached a bout of pneumonia with this "push through" mentality. It took me six months to fully recover.

Your mind and body need nutritional fuel, rest and exercise to be in peak performance. Mentally, you also need time in social activities and the love of friends and family to live a fulfilling life. If you are not prioritizing what you need to keep your mind and body energized, you may be causing more harm to yourself and others. Your energy is finite. As time goes on, climate change and the natural resource issues it affects will only require more of us, not less. Insert more rest, exercise, healthy food, social time and love into your life so when you do the work, you are ready and able.

We need each other as we navigate the challenges of climate change. Think about what part of the climate crisis causes you the most pain or is your highest passion. Once you determine that point, find a community of people in that specific area of work who can support you. I have joined the Global Regeneration CoLab, where I have met many people doing incredible regeneration work of all kinds—regenerative agriculture, regenerative eco-communities, regenerative leadership and more. They give me hope. There are many groups out there, so find one that matches your passion.

Another option is to join an existing group whose focus is ecogrief. I suggest two here: The Work That Reconnects and Good Grief Network. Both have trained facilitators and multiple groups with the goal to help process feelings and help you move toward hope and action. Or, consider creating a community of your own. This does require any facilitator to be able to hold space themselves without becoming overwhelmed. It also requires the ability to be non-judgmental of stories and feelings as well as keeping

Here are some helpful resources for dealing with ecogrief.

Therapy for Black Girls: Repairing our Relationship to Nature: This podcast by psychologist Joy Harden Bradford features an interview with public health leader Phoenix Smith, founder of the Alliance for Ecotherapy and Social Justice.

The Earth, The City and the Hidden Narrative of Race: On his website, author Carl Anthony shares his work on the intersections of race and place in the United States.

The All We Can Save Project: This diverse climate change effort focuses on the people, communities and networks that make transformation possible.

Welcome to Gwichyaa Zhee: This short film explores the commonalities among Indigenous groups protecting their cultural heritage and environment.

Robin Wall Kimmerer: A SUNY distinguished teaching professor of environmental biology, Kimmerer is a scientist interested in restoration ecology and has written several books and essays from an Indigenous perspective.

The Work that Reconnects Network: This project seeks to help people discover and experience their innate connections with each other and the self-healing powers of the web of life, transforming despair and overwhelm into inspired, collaborative action.

The Good Grief Network: This nonprofit organization brings people together to metabolize collective grief, eco-anxiety and other emotions that arise in response to planetary crises.

The Archipelago of Hope: Wisdom and Resilience from the Edge of Climate Change: In this book, author Gleb Raygorodetsky explores the links between Indigenous cultures and their traditional territories as the foundation for climate change resilience.

Saving Us: A Climate Scientist's Case for Hope and Healing in a Divided World: Climate scientist Katharine Hayhoe writes about the need to find shared values to collective action to address climate change.

A Wild Love for the World: Joanna Macy and the Work of Our Time: Writers and activists explore author Joanna Macy's contributions.

Climate Cure: Heal Yourself to Heal the Planet: Author Jack Adam Weber devotes this book to offering strategies and exercises for readers to transform distress into forces for hope and regeneration.

group judgments in check. I highly recommend *Coming Back to Life,* by Joanna Macy and Molly Brown, which offers specific guidelines for facilitators. Training is also available, but it's not required. As we open these conversations more, I imagine communities will be created organically. Just start talking.

The data I have collected on time spent in nature through my human-nature workshops over the past two years are alarming and sad. Many in the conservation community are not taking their own time outside. When they do, they often find themselves thinking about work, analyzing the place or ruminating on what isn't working. They don't notice the beauty that's around them.

The first step is committing to spend 15 to 30 minutes a day of mindful time with nature. This does not mean you have to go trek deep into the wild. If all you have available is a plant or a pet, spending time cultivating the plant or fully focused on your pet has been found to have similar nervous system calming effects (Lohr 2010). If you can go for a walk outside, try to leave your devices behind. Consider setting an intention of focused attention on nature before your walk and making a statement of gratitude at the end. The more mindful your presence to nature, the more you become aware of the beauty and life force it provides.

If these practices are not already encouraged in your workplace, I suggest you start by setting the example yourself. Encourage others to join you. The more this is observed and practiced in the workplace, especially by supervisors, the more energy will be brought back to the creative work needed right now.

Sharing our gifts

If you feel like you have gotten yourself too far into a pathway of self-defeat, please ask for help. I have a list of ecologically informed counselors I can provide. As we open these conversations, I will also start collecting names of individuals who may be willing to help you process your feelings and let you know you are not alone. We need you and the gifts you bring to ecological and climate-related solutions.

Humans are social animals and were never meant to be in isolation. I like to rephrase asking for help as sharing gifts. My weakness is another person's strength. When I ask them to share their strength with me, they get the feeling of significance. When I share my strengths and gifts with someone else, I feel significant. Let us share gifts.

Credit: Michelle Doerr/Anavah Consulting LLC

▲ **Rural areas, like the fields near the author's home in Minnesota, provide a sense of tranquility that belies environmental degradation taking place unseen.**

Part of my gift is opening and facilitating these conversations. U.S. Fish and Wildlife Service refuge manager Jimmy Fox, consultant Tom Kalous and I have created a half-day workshop called Acknowledging Ecogrief and Developing Resilience to start addressing this issue head on. In our initial pilot, we have already learned that opening this conversation is a heavy responsibility and is imperfect. We are doing our best to practice gratitude, leave space for people to share their pain and guide them to resilience practices. We end the sessions asking participants to commit to action in whatever small way they can.

For supervisors, this is not something to "manage" to help your staff move past the issue. If you suspect staff are suffering and you do not feel you have the skills to hold a safe space for discussion, find someone who can. I passionately believe the people facilitating these discussions must be feeling ecogrief and overwhelm themselves, so they can align with others. This is about being with and holding each other with compassion and grace.

Feelings of ecogrief are a normal reaction to the climate and other natural resource crises. There is nothing wrong with you for experiencing negative feelings as we watch the planet suffer. Acknowledge your feelings through journaling or in groups if you can. Express gratitude frequently for what you have. Find a community of support in your area of passion. Share your gifts with others, and ask them to share theirs. Take time to rest and refuel in the way that works best for you. Simplify your life. Imagine what our natural and human world could be like if we all practiced these steps together. ■

TWS MEMBER **Michelle Doerr** is the president of Anavah Consulting LLC in Glencoe, Minnesota.

Credit: Melissa McGaw/NC Wildlife Resources Commission

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High Expectations

QUANTITY AND QUALITY OF EDUCATIONAL CONTENT WILL MAKE FOR STRONG ANNUAL CONFERENCE

By Nick Wesdock

Session proposals and abstract submission numbers have historically been early predictors of attendance at The Wildlife Society's annual conferences. A high number of submissions generally indicates that the conference will be well attended, whereas lower than normal submissions have produced smaller conferences.

This year, we have had some of the highest submission numbers in recent history. Submissions for oral presentations and posters totaled 911. In addition, out of more than 60 special session proposals, the program steering committee accepted 27 symposia, 15 panel discussions and 14 workshops. These numbers rival those of the 2019 conference, which set the record for in-person attendance.

Credit: The Wildlife Society

▲ **After a two-year hiatus, The Wildlife Society's Annual Conference will be in person again, with a long list of symposia, panel discussions, workshops and presentations for attendees.**

With so many changes in the world during our two-year hiatus from in-person conferences, it remains to be seen if this year's registration will follow historical predictors. But high attendance or not, we do know that interest and excitement is mounting for The Wildlife Society's 29th Annual Conference.

Take a peek at some of the top-ranked educational sessions you can expect at this year's conference in Spokane, Washington, and register now to take advantage of the early-bird discount!

Symposia

Drone applications in wildlife and spatial ecology

Wildlife biologists rely on an ever-increasing suite of tools to answer questions and solve problems related to wildlife ecology, management and conservation. Unoccupied aerial vehicles—also known as UAVs or drones—are increasingly being used in ecological studies, especially in wildlife biology. This symposium highlights how drones are applied to wildlife and spatial ecology and provides a forum for experts and potential drone users to discuss how the devices can be used in future research collaborations between wildlife biologists in academic, government and private sectors.

New technologies to address old questions: harnessing data ranging from landscapes to individuals to advance conservation and wildlife ecology

Modern technologies—remote sensing, Global Positioning Systems (GPS) telemetry, biologging and metrics of animal condition—have revolutionized the ways researchers and managers collect and combine data from animals and their environments to address theoretical and management questions rooted in classical ecology. This symposium will highlight applications of wildlife studies that harness remotely sensed data, GPS data and physiological monitoring to address classical ecological questions regarding conservation and management

that the field has not been able to quantify prior to the development of these technologies.

Conservation of native pollinators in managed forested ecosystems

Insect pollinators are under-studied in forested landscapes, despite being hyper-diverse and providing critical ecosystem services. Throughout North America, millions of hectares of managed forest can provide resources to sustain pollinator populations and communities, especially native bees. This symposium will highlight current research on native bees in forests that have a primary goal of timber production or multiple uses. Speakers will explore how stand age and structure correlate with bee diversity and abundance. They'll also discuss techniques and patterns that can be applied to floral resources. The goal of the symposium is to provide a summary of current research and suggest conservation opportunities for pollinators, specific to forested landscapes.

Gold and new methods for determining wildlife diets

Recent advances in methods for determining diet composition promise to improve our quantitative understanding of what wildlife eat. But with so many new methods, it can be overwhelming to determine which is most appropriate for a given study. Speakers will provide a comprehensive overview of wildlife diet composition methods (DNA metabarcoding, video, fatty acids, stable isotopes, etc.), including their strengths and limitations, validation efforts and case studies that demonstrate the relevance and applicability of various methods to management and conservation. Attendees will gain insights into which methods may be most appropriate for their studies.

Women in wildlife sciences: building equity, diversity and inclusion

This symposium features speakers promoting diversity, equity and inclusion in the fields of wildlife conservation and management. Speakers will review history, analyze the status and celebrate achievements of women in wildlife. LGBTQ+ individuals, people of color, Indigenous people and members of marginalized communities will share stories and experiences that may help attendees explore how to support women, from classrooms to workplaces. Speakers will also provide practical advice on how to be an ally for underrepresented groups and describe methods to increase the inclusion of women in the wildlife profession. This symposium highlights findings in a newly published book, *Women in Wildlife Science: Building Equity, Diversity, and Inclusion*.

Workshops

Fundamentals of structured decision making

Wildlife and fisheries management are, at their core, decision-making exercises. Decision analysis offers a vast set of tools for framing, structuring, solving, implementing and revisiting decisions, as well as for understanding the frailties of humans and institutions as decision makers. This workshop will outline the fundamentals of decision analysis, with an emphasis on participatory discussion and hands-on exercises. Topics include the structure of decisions, articulating objectives, developing creative alternatives, using the best available ecological and social science to evaluate alternatives, methods for analyzing different classes of decisions, decisions in the face of uncertainty and the value of information.

REZ-E [reciprocity, an enduring zoogenic ethic]

In wildlife biology and management, there is a dire need to understand ways to connect more meaningfully with Native American communities. There is also a need to build capacity for Native American students who seek to work in these spaces. This workshop, with foundations in Indigenous-led programming by Native American graduate students, will focus on developing co-created wildlife research projects, improving management conditions and expectations and understanding basic principles for scientific engagement with tribal communities. Proceeds from this workshop will benefit TWS' Native Peoples' Wildlife Management Working Group.

Do the genomics: an introductory course in analyzing genomic data in R

Genomics has revolutionized the fields of conservation genetics and molecular ecology. Genomic datasets from nonmodel organisms are now easier and more cost efficient to generate and can allow researchers to explore new questions where traditional genetic markers were limited. However, a significant hurdle to analyzing genomic datasets is the bioinformatic knowledge. The goal of this workshop is to provide a basic overview of how to analyze genomic data sets in R—specifically covering importing data sets, variant filtering and basic population genetic analyses. Participants are encouraged, but not required, to have a basic understanding of R and to bring their own laptops.

Panel Discussions

Community building through mentorship

The Wildlife Society promotes continuous learning and growth of our members by expanding and adapting our professional development and mentorship opportunities. Mentorship can help support the next generation, empower our peers, and contribute to our own growth, development and passion for our profession. During this panel, participants will learn more about and connect with existing TWS mentorship programs and resources. This will be an opportunity to support a community of lifelong learning and professional development. Especially for students and early-career professionals engaging in the conference, participants will discuss ways to initiate and sustain healthy mentorship experiences.

Maintaining momentum & cultivating leadership pathways

This panel discussion will build on the diversity, equity and inclusion topics that have been elevated in our social consciousness in recent years. We hope to continue to support efforts that enact change and identify ways to maintain momentum that supports leadership capacity and widens pathways for diverse leaders. It is key to cultivate a collective vision of the wildlife profession and achieve conservation successes by addressing inequities and roles of leadership.

Ranching with predators: ecological, economic and cultural considerations

Rural working lands are critical to sustaining both people and wildlife. Predator-livestock conflicts challenge the livelihoods of producers. Successfully mitigating these conflicts is a complex endeavor that requires analyzing the efficacy of practices as well as collaborative information sharing across stakeholders. Often, managers and producers are unaware of the most promising mitigation practices because their impacts are the least researched and communicated. We hope this symposium and landowner panel discussion increase information exchange around effective implementation of conflict mitigation practices and provide greater awareness and knowledge around the challenges involved with managing and conserving wildlife while sustaining western working landscapes. ■

Nick Wesdock is the business relations and conferences program manager for The Wildlife Society.

Supporting Members' Policy Engagement

TWS LAUNCHES A REVISED EDITION OF ITS POLICY TOOLKIT

By Kelly O'Connor

Nearly a decade ago, The Wildlife Society was looking for a solution to close a communications gap. Our chapters, sections and members were regularly engaging on policy issues that affected wildlife and wildlife professionals, but they lacked resources that could help them collaborate across units and regions.

Discussions between TWS staff and members led The Wildlife Society to create the Conservation Affairs Network in 2014. The initiative was meant to strengthen wildlife professionals' voices across all levels of policy engagement. With it came a new tool to guide members and organization units in their work—TWS' CAN Policy Toolkit. The Toolkit combined the expertise of TWS staff, the experience of members who were engaging on wildlife conservation policy and broader guidance on policy advocacy to create an extensive resource for members looking to become more involved in the policy arena.

Our hope has been that the Toolkit is useful to members and that it reflects their experience and the unique role they can play as wildlife professionals. In the eight years since the CAN launched, communication and collaboration on policy engagement has greatly increased between TWS headquarters and units.

Now, we're releasing a second edition of the Toolkit, building on the collective experiences of the CAN, unit-led Conservation Affairs Committees (CAC), individual members and TWS' government affairs program.

New content

The CAN's successes since the Toolkit's publication are due in no small part to Conservation Affairs Committees' advocacy. In the second edition, we've expanded CAC-focused content to include more resources for units looking to start a CAC or policy-focused group. This includes guidance on how to identify policy priorities and suggestions on how to engage broader unit membership in CAC activities based on the experiences of TWS members and CAC leaders.

This edition also includes new content developed collaboratively with Canadian Section leadership. Developing policy engagement resources for TWS units and members in Canada is a current priority for TWS government affairs program staff. These new content areas include suggestions for how members can engage at different stages in the Canadian federal legislative and budgeting processes.

Since policy engagement takes many forms, the Toolkit has expanded to include more ways that units and members can advance wildlife conservation policies. Section 3 includes scripts to use when making phone calls to decision makers and guidance for submitting comments on agency rulemaking. We've also updated our suggestions for meeting with decision makers to account for virtual meeting opportunities, which have become much more common since the Toolkit was first released.

A resource for all members

Although some members of TWS and the CAN engage with wildlife policy as part of their job, as the Toolkit reiterates, you don't need to be a policy expert to be a powerful advocate. The new edition of the Toolkit offers resources for members with all levels of experience and interest in wildlife policy engagement.

If you are new to advocacy and wildlife conservation policy, and are looking for some resources to get started, the Toolkit offers an overview of TWS' policy resources, information on how to engage locally with the CAN, and suggestions for easy ways to leverage your expertise as a wildlife professional in decision making. For educators teaching wildlife conservation policy or working with students who are interested in gaining experience in policy engagement, the Toolkit includes in-depth information on the processes underlying policy development. You can also supplement the Toolkit with TWS' other policy resources available for all members at wildlife.org/policy. For current CACs and units interested in becoming more formally engaged with the CAN, the Toolkit continues to offer guidance on CAC operations and how best to utilize members' expertise in your CAC's policy engagement.

Whether this is the first you've heard of the Toolkit or you've used it regularly, your thoughts on new Toolkit content or improvements to existing chapters and sections are always welcome. It is intended to be a living document that changes to meet the needs of TWS members and the Conservation Affairs Network. Please reach out to TWS staff at policy@wildlife.org with any feedback you'd like to share on the Toolkit or TWS' other policy resources. ■

Kelly O'Connor, MS, is the Conservation Affairs Network Fellow for The Wildlife Society.

Bird maps can help inform localized conservation

When managers look for maps to predict local bird species declines, they face a bit of a dilemma. Maps that are fine scale don't include a large enough area to be useful. Maps that cover broad areas are less precise.

So researchers set out to create a new set of maps to help conserve local bird species, organized by guilds—groups based on characteristics like behavior, habitat, diet and conservation status.

"We feel like there aren't products out there that cover broad enough areas, with fine enough resolution to be relevant," said Anna Pidgeon, a professor in the forest and wildlife ecology department at the University of Wisconsin-Madison.

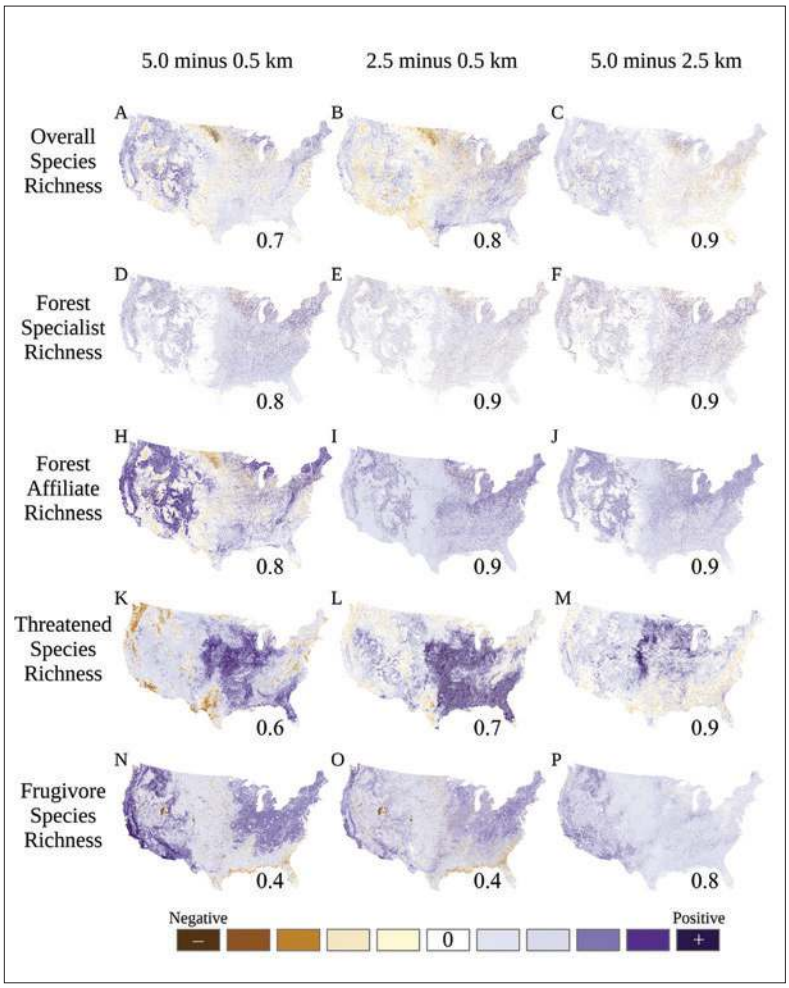
Research in 2019 showed that nearly 3 billion birds have been lost in North American in the last 50 years or so (Rosenberg et al. 2019). While the findings focus on birds, some scientists believe they may be indicative of wildlife declines more broadly. Pidgeon and her team hope these maps can help conservation efforts get started to begin reversing these declines.

In a study published in *Ecological Applications*, she and her team created maps of bird richness across the U.S., designed to be both accurate and fine scale. They synthesized 18 years of data from the North American Breeding Bird Survey showing exactly where bird species occur and categorized birds into 19 guilds based on their similarities. For example, they grouped species that require forest or species that migrate to the neotropics. Then, using earth observation satellite data, the team generated 42 maps of bird richness based on climate, vegetation, geomorphology and human land use.

After comparing three different resolutions, the team found that maps with a resolution of 2.5 kilometers had an optimal balance of accuracy and detail, particularly for managers working across jurisdictions in joint ventures or at an ecoregion level.

"These are the first spatially consistent nationwide maps of breeding bird richness that are thorough enough and detailed enough to inform local management decisions," Pidgeon said.

—Contributed by Dana Kobilinsky



Credit: Anna Pidgeon

Maps at 2.5-kilometer resolutions had the optimal balance of detail and area coverage.

Credit: Anna Pidgeon

Western kingbird (*Tyrannus verticalis*) populations are declining in their range. Researchers created new maps to help inform bird conservation efforts.

Courtesy photo

Robert H. Giles Jr.

Robert "Bob" Hayes Giles Jr., of Blacksburg, Virginia, died May 5, 2022. He was 88.

Giles was born May 25, 1933, in Lynchburg, Virginia, where he developed an early interest in wildlife biology, winning a Bausch & Lomb science award in high school for studying pheasants.

He first joined TWS in 1955 and was the editor for the third edition of The Wildlife Society's *Wildlife Techniques Manual* in 1969 and the author of the textbook *Wildlife Management*, published in 1978.

Giles received a bachelor's degree in biology in 1955 from Virginia Polytechnic Institute (now Virginia Tech), and continued on to receive a master's degree in wildlife management from Virginia Tech. After working as a biologist for the Virginia Commission of Game and Inland Fisheries from 1958 to 1961, he received his PhD in zoology from The Ohio State University and went on to teach at the University of Idaho from 1964 to 1967. In 1967, he joined the faculty of the Department of Fisheries and Wildlife Sciences at Virginia Tech, where he taught for 30 years.

During his time as a professor at Virginia Tech, Giles served as adviser to 12 PhD students and nearly 60 master's students. He was a pioneer in the use of computers for wildlife management, including the use of GIS technology to address land management questions. Giles created a number of wildlife management software applications used by federal and state agencies, including an early wildlife information system, BOVA, or Biota of Virginia, which is still used today.

He is survived by his daughters, grandchildren and great-grandchildren.

—Contributed by Scott Klopfer

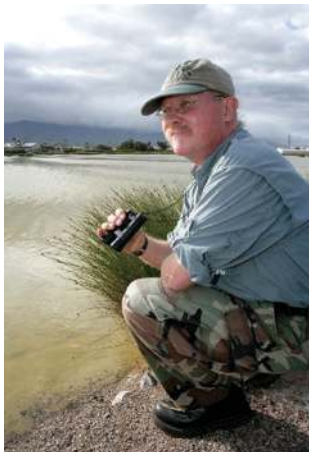
Courtesy photo

Henry Lloyd Alexander Jr.

TWS member H. Lloyd "Butch" Alexander Jr. died April 21, 2022. He was 76.

Alexander was born Sept. 27, 1945, in Niagara Falls, New York, and received his bachelor's and master's degrees in applied ecology and entomology from the University of Delaware. Starting as a state biologist, he went on to become the Delaware state director of fish and wildlife. After retirement, he continued to work at The Ohio State University Veterinary School.

Survivors include his wife, Ann, and two children.



Courtesy photo

Fern P. Duvall II

TWS member Fern Duvall, a longtime conservationist in Hawaii recognized for his work with native birds, died Feb. 23, 2022, from heart complications. He was 68.

Duvall retired last year from the Hawaii Department of Land and Natural Resources after a 38-year career in which he was credited with helping prevent the extinction of the ʻalalā, or Hawaiian crow, and other endangered Hawaiian birds. An advocate for native species and ecosystems across the state, Duvall co-discovered two plant species. The rare *Cyanea duvalliorum* was named in his honor.

"Fern's deep knowledge of the natural world in Hawaiʻi was unparalleled, and his curiosity never ceased," wrote Pacific Birds Habitat Joint Venture, with which Duvall served for nearly a decade, on its website.

Originally from Michigan, Duvall earned master's and doctoral degrees in avian biology at Freie Universität in Berlin before moving to Hawaii to work with the DLNR. He arrived as a contractor in 1984 to help develop captive breeding techniques for endangered birds, including the incubation process for ʻalalā. He went on to serve as the state aviculturist and a wildlife biologist. He retired as the Maui program manager for Native Ecosystems Protection and Management.

Duvall advised more than a dozen conservation organizations and helped found several conservation partnerships. The Hawaii Division of Forestry and Wildlife named him a conservation leader earlier this year, and the Hawaii Invasive Species Council honored him as the Maui 2021 MVP.

Survivors include his wife, Mary Santa Maria, and daughter, Anna Duvall.

Courtesy photo

Harold Duebbert

Longtime TWS member Harold Duebbert died Jan. 18, 2022, at the age of 92.

Duebbert was a wildlife research biologist with the U.S. Fish and Wildlife Service Northern Prairie Wildlife Research Center for over 20 years, where he was known for his research on nesting prairie ducks in the Dakotas. He was instrumental in developing what became known as dense nesting cover, a mix of tall wheatgrasses and legumes seeded to provide attractive nesting cover for upland ducks. He was also a leader in describing nesting ducks' use of islands. He studied the extensive use of islands by nesting gadwalls in North Dakota and was part of the Miller Lake Island duck nesting study team in Divide County, North Dakota.

Duebbert was an active member of the North Dakota Chapter of The Wildlife Society. In 1978, he received the chapter's North Dakota Award. He was devoted to prairie, prairie pothole wetlands and the ducks that occupy those habitats, and he devoted his career to their protection. He was also an accomplished waterfowl decoy maker.

—Contributed by Rick Warhurst

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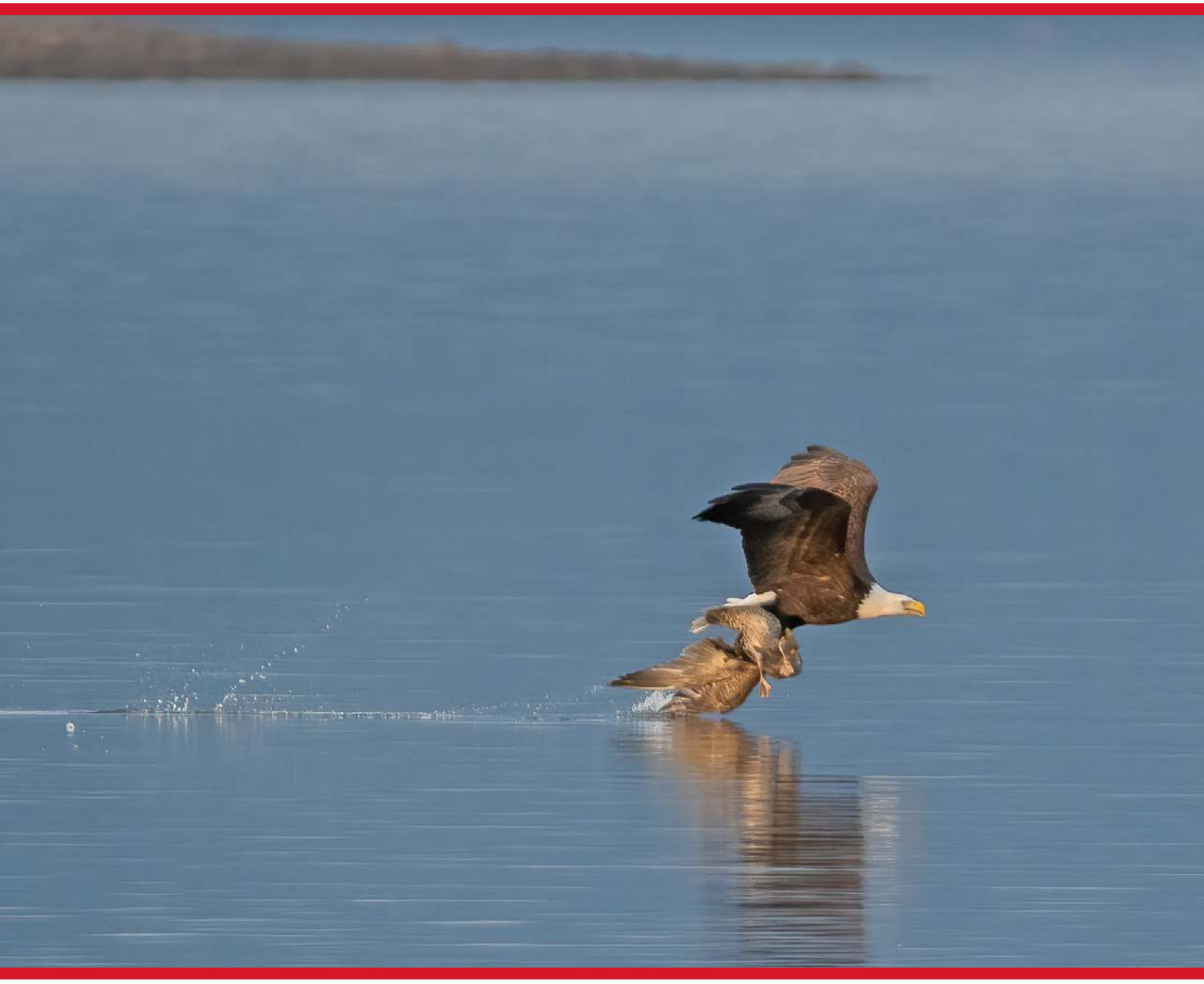

Photo by Christopher Wyzykowski

Gotcha!

Within the last decade or so, bald eagles (*Haliaeetus leucocephalus*) returned to the area around the Great Sacandaga Lake in upstate New York in the Adirondack Mountains. Christopher Wyzykowski captured this image of an eagle carrying off a gull to a nearby island. Wyzykowski notes that the local community has really enjoyed the presence of the eagles around the lake, which now hosts multiple nesting pairs.

Want to share your photo here? Send it to editor@wildlife.org.

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