

Audubon

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On a remote Alaskan sandbar in the Beaufort Sea, climate change is forcing a colony of seabirds into a real-time race: Evolve or go extinct.

ARCTIC RECKONING BY HANNAH WATERS



CLIMATE

NO SHELTER FROM THIS STORM

On an island in the high Arctic, seabirds and scientists sleep in bunkers to stay safe from polar bears. But no fortress can protect the colony as climate change forces it through an evolutionary bottleneck unlike any seen since the last ice age.

BY HANNAH WATERS
PHOTOGRAPHY BY PETER MATHER



 **ALCID INCOMING**
A Mandt's Black Guillemot approaches
a nest for landing. In 2011, after
predators decimated the colony, birds
began nesting in plastic cases.

AN INVOLUNTARY DIET

Black Guillemot chicks huddle next to a sculpin they've rejected. Sculpin are harder to digest than Arctic cod, their preferred food.

ON COOPER ISLAND, THERE AREN'T many rules. But one rule that is wordlessly respected is *you never look directly at South Beach*, because South Beach is the designated bathroom, sited on a gravel sandbar so flat you can take a head count of all inhabitants from a mile away, no lenses required.

Another rule is you shouldn't go out alone, but if you do, you should take a walkie-talkie and a shotgun, because you never know when a polar bear might show up, and if one does, you don't want the polar bear between you and the cabin, the only structure on the island that might sustain a clawed assault.

Not that I know how to fire a shotgun, much less how to disable a starving bear keen on making me its meal. But rules are rules, so I carry one anyway.

When camping on an island a short boat ride from the northernmost point of Alaska, it's difficult not to fixate on the bears, one of the few remaining animals that make humans prey. When bears do visit, though, they're still not the most charismatic megafauna on Cooper Island. That distinction goes to George Divoky, a septuagenarian who's spent nearly 11 cumulative years here. By the time I reach Cooper Island on August 7, Divoky has been here for two months. Between his mop of gray hair and unkempt beard—there are no mirrors in the South Beach bathroom—shine bright, darting eyes that don't miss much. He wears what you might expect of an Arctic field ornithologist: rain pants and a parka flecked with splatters of bird poop

and undergirded with wool-sweater strata.

But few remember Divoky for his appearance; it's the words that pour from his mouth like water from a burst dam that define him. Any object in his periphery can inspire a story, told in fractal spurts and with oppressive detail, and if he's interrupted—by a question, a task, another thought—he'll return to his story minutes later, as if the world paused in wait of his next word.

For 43 years, Divoky has spent every summer here, usually in a tent, and usually by himself. But the colony of Black Guillemots holds an even greater claim to the place.

His lingual floodwaters can be disorienting and, to some, off-putting. A life-long outsider in self-imposed exile, Divoky commands a conversation and is prone to unwittingly drowning out its more subdued participants with his contrarian convictions. But it's hard to blame him, for you, the conversant, are the odd one here on Cooper Island, a mere visitor in his world. For the past 43 years, he's spent every summer here, usually in a tent, and usually by himself.

Even so, the island's other seasonal inhabitants—the colony of Black Guillemots that nest here every summer—hold a greater claim to Cooper than Divoky. They are the reason he's here, and their progenitors were here first. It was July 6, 1972, when a Coast Guard icebreaker dropped

him off for a seabird survey, that he discovered 10 pairs of the handsome seabirds nesting under scattered debris—ammo boxes, floorboards, and innumerable wood planks—abandoned by the U.S. Navy after the Korean War. His find was a northern range expansion for the species in Alaska. Like a kid flipping rocks to find salamanders, a 26-year-old Divoky flipped boards and boxes to search for eggs and

create new nesting crevices. By the end of the summer, his nest count for the island was up to 18. When he returned to Washington, D.C., for a fellowship at the Smithsonian, he couldn't stop thinking about Cooper Island. He was struck by the scientific potential of its accessible nest sites and seduced by the opportunity to indulge himself in solitary nature. He soon relocated to Fairbanks, Alaska, and by 1975 got his hands on enough funding to return to Cooper Island for an entire summer. He hasn't missed one since, serially sacrificing employers and girlfriends who demanded he choose between them and the guillemots.

"You have to be careful what you fall in love with in your twenties," he says, unprompted, one evening. "I fell in love with this island."

Divoky returned each summer to watch the colony mature, collecting meticulous data—growth, breeding, feeding, kinship—on every nesting pair and chick, and banding every adult and fledgling. The colony thrived, and grew to 200 breeding pairs by 1989. Since then, it's taken a turn for the worse, slowly at first and then into free fall, and Divoky now cares for an island and its birds in decline. "I used to see chicks hatch, and I'd see them grow, and they had an 85 to 90 percent chance of flying away," he says. This year 85 pairs bred on the island, fledging just 45 chicks out of 120 hatched—not enough to maintain the colony's population.

Nearly all the causes for this decline—changes in food, competitors, and predators—track the warmer air, warmer ocean water, and retreat of sea ice near Cooper

DAY AND NIGHT

Top: Guillemots chatter and preen around Big Guillemot Pond. Bottom: Divoky gestures by the light of Alaska's midnight sun.



Island, all symptoms of global climate change caused by carbon dioxide. These molecules build up in the atmosphere and trap heat, like the layers of blankets required to sleep through the night on a sandbar on the Beaufort Sea. Somewhat ironically, if it weren't for climate change, guillemots may never have nested on Cooper in the first place: Until the late 1960s, snow blanketed the ground for too much of the summer.

"During my research lifetime, Cooper Island will no longer be able to support this species," Divoky says. "It went from too cold to too warm. It should have taken centuries, not decades."

And yet he keeps coming back to watch his beloved island decline, collecting as much data as he can along the way. Through his ruthless devotion, Divoky has created one of the few ecological studies with enough long-term, rigorously collected data to illuminate how climate change will force populations through an evolutionary bottleneck unlike any seen since the last ice age. And the only reason we have even this glimpse is because of Divoky, a rare bird indeed.

EVERY DAY GOES ABOUT THE SAME on Cooper Island. We get up, share breakfast in the cabin, and begin the rounds: visiting every nest to check up on the chicks' growth.

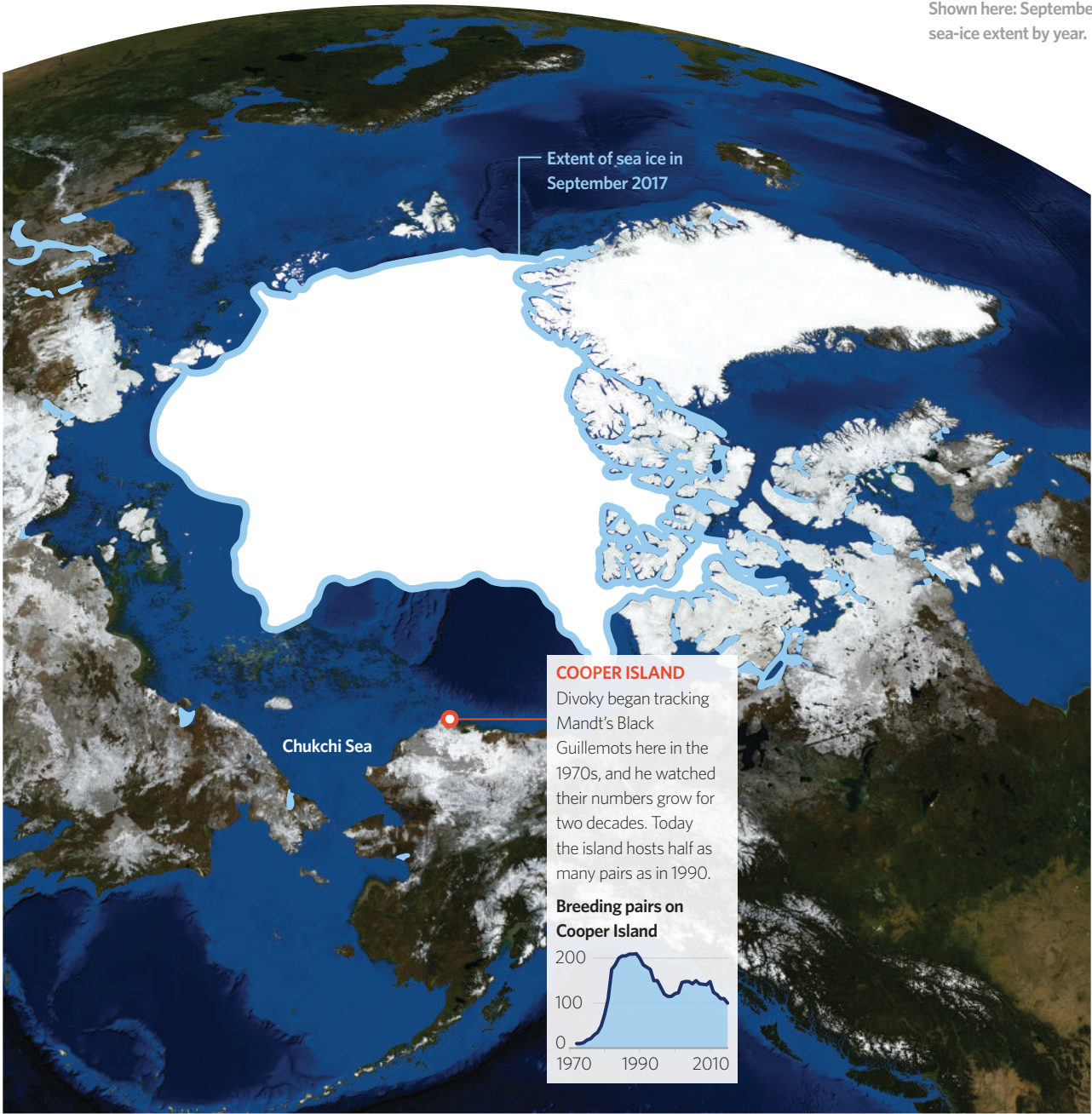
Divoky gingerly lays his shotgun on the ground, then sits cross-legged in front of a nest and slowly lifts its lid until rasping peeps resound from the interior—that's the chicks. Working quickly, he scoops up a black fluffball, places it in a bag to weigh it, scribbles its weight in his notebook, presses its wing to a six-inch ruler, scribbles its length in his notebook, and then releases the chick back to its nest. He repeats the process with the second chick, if there is one.

When a guillemot chick hatches, it weighs 35 grams (a little over an ounce). To survive its first winter at sea, it needs to bulk up by an order of magnitude, reaching 350 grams within five weeks, and grow wings long enough to navigate rough waters—rapid development requiring a lot of fish to fuel it. Mandt's Black Guillemots, a subspecies that lives wedged between Alaska and Russia along the sea ice edge, specialize in one fish: Arctic cod. They're fatty and common and easy to find because they feast on plankton blooming at the ice edge, a visible landmark. Parents spend their days winging

How a Breeding Colony Loses Ground

DATA VISUALIZATION BY KATIE PEEK

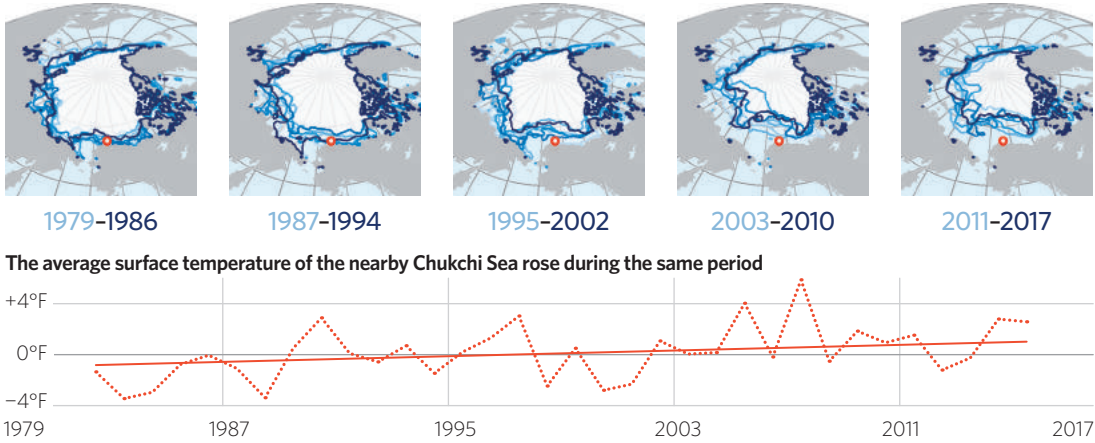
Every summer, Mandt's Black Guillemots gather at Cooper Island to breed. A single pair—they mate for life—may produce about two dozen chicks during their 20-year lifetimes. But since 1990, the guillemots' numbers have been dropping; fewer of those chicks are surviving to adulthood. Because George Divoky has collected 43 years of data at Cooper Island, it's possible to see why.



1 Because the Arctic is warming, sea ice is farther away during the summer breeding season.

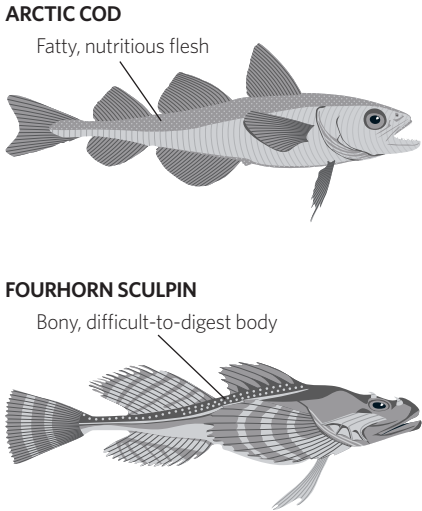
Cooper Island was once ideally situated for Mandt's Black Guillemots, which hunt along the sea-ice edge. But since 2003, offshore waters have grown warmer and more ice-free by September—and less favorable to prey.

Shown here: September sea-ice extent by year.



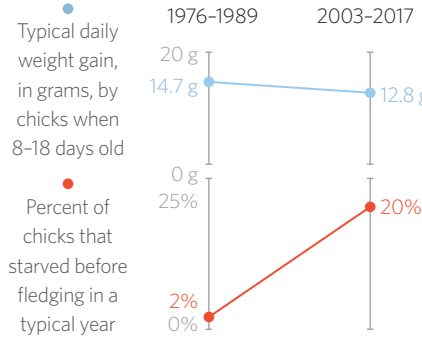
2 Arctic cod are following the ice north, so Mandt's Black Guillemots must rely on fourhorn sculpin.

Arctic cod tend to track the ice edge, where they feed on plankton common along the edges. When sea ice is near Cooper Island, guillemots feed the cod to their young almost exclusively. But in the widening open sea, guillemots catch fourhorn sculpin instead. Sculpin are the same size as cod, but their bonier bodies are more difficult to digest.



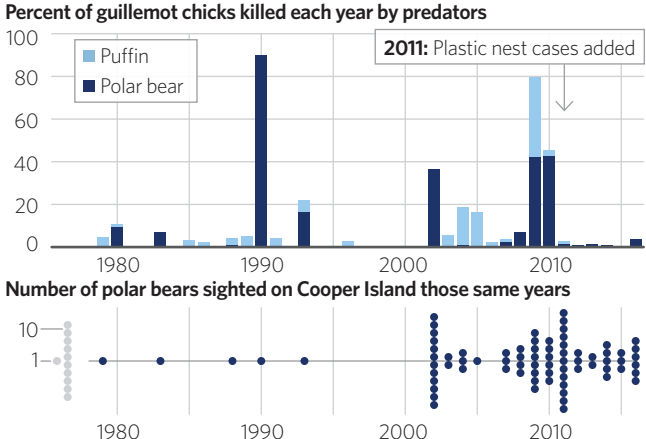
3 That means more chicks die.

From 1975 through 2002, cod dominated chicks' diets for the entire season. But since 2003, the dominant prey has shifted mid-summer to sculpin each year except for 2006. When sculpin take the place of cod, chicks grow more slowly—and more of them starve.



4 And guillemots have more predators, too.

As Arctic waters have warmed, polar bears that used to hunt from atop sea ice have made their way to Cooper Island instead, and the number of Horned Puffins has also increased—with deadly consequences for guillemot chicks. In 2009, puffins and polar bears together took 80 percent of the chicks.



5 Too few chicks survive, so the numbers drop.

With worse food sources and more predators, fewer chicks than ever are fledging from Cooper Island. Today, each breeding pair fledges 0.5 guillemots annually on average—far behind the 1.1 needed to hold the population steady.

OUT OF PLACE

The white fur of a polar bear makes for less-than-ideal camouflage against the backdrop of Cooper Island's brown gravel and sand.

INSIDE THE FORTRESS

Divoky sits on his bed in the one-room cabin where the island's human inhabitants gather to cook, eat, warm up, and socialize.

to the ice to catch cod and ferrying it back to insatiable chicks. To keep track of the parents' comings and goings, Divoky added a few data-collection gadgets in recent years: geolocators to follow their locations year-round and, during the breeding season, time-depth recorders to let him calculate how far, how deep, and how often guillemot parents dive to chase fish.

For many summers, he did all this work himself, but now he gets outside help during the busiest weeks. Often crouched beside him in early August is Penelope Chilton, a field technician who's worked with Divoky for a decade, or Erin Brown, a McGill University undergrad and Cooper first-timer. As he goes through the rounds, he relates stories about a nest's prior inhabitants: "Over 22 years, WOGy [named for its white-

detailed dataset. "The strength of George's work has been in his utter tenacity to go back and go back and go back and get those data every year," says Julia Parrish, a University of Washington ecologist who studies seabirds as monitors of ocean health. She compares him to the carbon-dioxide sensor near the peak of the 13,680-foot-high Hawaiian volcano Mauna Loa that documents the rise of atmospheric carbon dioxide as the infamous Keeling Curve. "That is a long-term dataset collected year in and year out in the same way and in the same place," she says. "Applying that same technique to biodiversity means that researchers have to be there. The number of people in the world who are willing to do that is vanishingly rare, and George is one of them."

His study also has particular power be-

normal, functioning Mandt's Black Guillemot colony. "At one point, he had the whole story told in his mind," says Stan Senner, vice president of bird conservation for Audubon's Pacific Flyway and Divoky's longtime friend. "The birds are there, the ice is near shore, the cod are associated with the ice, the birds don't have to go very far, they get the cod. Life is good."

Then everything changed. For the first 28 years of Divoky's study, chicks ate cod almost exclusively. But in 2003 parents began serving fourhorn sculpin, an ugly fish with a lumpy head and spiny fins. Divoky would find chicks choked dead with enormous sculpin lodged in their throats. Parents eventually learned to catch smaller sculpin, but chicks still suffered. "It takes a long time to break down all that cartilaginous mass" in sculpin fins, Divoky says. Just one fish is enough to fill a chick's stomach. "It's like, 'I can't get anything else down, I've still got the last sculpin head in my stomach.'"

The ensuing hunger makes siblings turn aggressive: In many nests the larger chick bullies the smaller one, sometimes to starvation. As we examine one nest, Divoky points to matted, thin feathers on the back of one beta's neck—physical evidence of aggression. Under the sculpin regime, chicks grow more slowly and fledge at less than 300 grams. Nearly one quarter starve in their nests.

It's an ugly scene, but the parents are doing their best as they face a novel Arctic landscape. The sea ice that previously drifted and persisted near the island through the summer is now melted and effectively gone—sometimes hundreds of miles away—by August or even July. Arctic cod can't survive in warm water south of the ice, and guillemot parents can't fly fast enough to make additional trips to the edge every day. So they've decided that more sculpin, for all its faults, is a better bet than fewer cod.

"This is a pivotal time," Divoky says. "You can see the size of the chicks now. They need all the energy they can get. And the primary prey is gone."

Seabird parents at other colonies face the same conundrum as Cooper's guillemots. Four hundred miles southeast is Herschel Island, where Cameron Eckert, a conservation biologist at the Yukon Department of Environment, monitors the descendants of Mandt's Black Guillemots found nesting beneath floorboards in the 1970s. There, the birds switched from



Make no mistake: These seabirds, and other species across the Arctic, are entering a period of rapid natural selection that will lead to either their extinction or evolution.

orange-gray leg bands] was the only vertebrate I saw annually, because sometimes I didn't see my family members, and I had different girlfriends. WOGy was the constant." Or he narrates the chicks' relative progress: "The chicks aren't gaining weight like they did yesterday. But then all the world's carbon would be caught up in guillemot chicks."

The monotonous routine, performed the same way for decades, makes for a uniquely

cause of dumb luck: It happens to cover a period of rapid atmospheric warming. Most scientists studying the biological impacts of climate change can't define "normal" for a given species or ecosystem, and now it's too late; the effects are manifest. But Divoky spent his first 28 years following individual birds, individual chicks, their partners, their offspring, through their entire lives—surely enough data to describe a



Arctic cod to eelblennies, "and when they get desperate, they switch to sculpin," Eckert says. Another 1,600 miles southeast is Coats Island, in north Hudson Bay, where Kyle Elliott, a McGill University ecologist (and Erin Brown's thesis advisor), studies Thick-billed Murres who switched from cod to capelin, a lower-calorie fish.

"What we're seeing is not necessarily about where we're studying. It's happening across the Arctic," Elliott says. "They're able to switch to other prey, but the population is declining. These really are Arctic-cod species. And as the ice disappears and [the birds'] range moves farther north, eventually they'll be squeezed out at the top."

If seabirds are barometers of ocean health, then Arctic birds are screaming that there's a major shift in the system, a shift so extreme the barometers themselves are now changing. Make no mistake: These seabirds, and other species across the Arctic, are entering a period of rapid natural selection that will lead to either their extinction or evolution.

Mandt's Black Guillemots, the ice-adapted subspecies of Black Guillemot, likely evolved some 25,000 years ago, according to evidence from mitochondrial DNA. Their speciation may have been triggered by a very different evolutionary

bottleneck. During the last ice age, glaciers blanketed the north. Divoky speculates that most ancestral Black Guillemots who found themselves iced in couldn't survive the new conditions, but a small number may have had an advantage: They could find Arctic cod in small cracks in the ice. In short, they adapted and evolved, and today descendants of those survivors nest on Cooper Island.

Now the population is marching through another bottleneck, except this time it's caused by warming, and this time the survivors will be birds who can hunt for anything besides cod. "There are guillemots here who have just gotten by," Divoky says. "But when crunch time comes, it's going to be the ones that are really fit [that survive]. And this is crunch time."

AT 9 ONE EVENING, AFTER A MEAL of beans, rice, and rehydrated mushrooms cooked on the cabin's two-burner stove, I stand outside and squint at a clump of snow about three-quarters of a mile from camp. There isn't any snow on the island, though, and the clump is moving, which means one thing: polar bear. Its bum is muddy, its white coat tinted brown. It glances up, distracted, at Arctic Terns dive-bombing overhead as it climbs atop a green

mound of beach ryegrass. Its hips relax; its shoulders press into the ground; and finally its head rests on its front paws.

"You think a polar bear is scary. But then you see them all tucked out," Divoky says. "It's like, 'I'm not going to die, and all I can do now is sleep because I'm just exhausted.'"

Most polar bears used to hunt seals on the ice all summer long. But over the past 16 years, the average Beaufort Sea summer gained 36 days of open water, and more bears have been coming ashore, spending an extra 31 days on land to match. To travel between land and ice, they sometimes undertake monumental swims; one GPS-tracked mother swam 420 miles in nine days, non-stop. When they reach land, they're ready for a nap. And when they wake, they're hungry.

A guillemot chick is chump change compared to an ice seal, but these are desperate times. In 2002 12 polar bears visited Cooper Island—more than double the total number Divoky observed in his first 26 years. He installed his 8-by-12-foot fortress the very next year, a worthwhile endeavor because the bears haven't relented. Except for 2006, a particularly cold year, when even Arctic cod were plentiful, bears have been constant features of Cooper's landscape—and constant terrors for the guillemots.

A BRIEF INTERRUPTION

Divoky releases an adult bird after attaching a geolocator to its ankle. His location data show that the birds closely track the sea ice edge when they're not on Cooper Island.



MOMENT OF SILENCE

An infinite sky looms over the frail body of a chick, which lies dead on the gravel after being removed from its nest. Out of 120 chicks that hatched this summer, only 45 fledged.



Every summer, bears raid nests to snack on chicks and any adults they can catch.

As a result, guillemots, themselves coping with climate-change-induced food scarcity, must also cope with the fallout as other species adapt, and not just polar bears. In the mid-1980s, Horned Puffins migrated north from subarctic waters and began nesting on Cooper Island. Like Black Guillemots, Horned Puffins nest in crevices, which are scarce in the open water north of Alaska, and any tunnel excavated in permafrost will warm and collapse on itself. So puffins compete with the guillemots for territory, and do so aggressively, even killing chicks. “It’s gruesome, to have an older chick that’s almost ready to fledge and it looked like someone took vice grips and just crushed the skull,” Divoky says. In 2009 the pressure from the pair of interlopers overwhelmed the colony: From 184 hatched chicks, polar bears killed 90, and Horned Puffins killed 81. A single chick fledged.

Enough was enough: If Divoky got a bunker, the birds should get bunkers, too. In 2011, he destroyed the wooden nest sites and replaced them with plastic cases with guillemot-sized holes cut into the sides. The cases aren’t entirely resistant to polar-bear intrusions—occasionally a bear manages to shake a chick free—but bears don’t have the thumbs required to unclip the lid. “I wouldn’t [put out the cases] if I thought it would make any difference in polar bear survival,” Divoky says. “But if they’re opening [a chick’s] body cavity and only eating the livers, what good can it be doing?”

Additionally, he reasons, his study’s value in documenting climate-change adaptation is too great to sacrifice to a few hungry bears. “I’m not trying to conserve [guillemots]; I’m trying to study them,” he says. “I had to do the cases to study them.”

Divoky and the birds have bunkers, but the rest of the island’s human inhabitants are stuck in tents. Our encampment is surrounded by what Divoky calls a “polar-bear-proof” electric fence, but the fence is barely a meter high; it’s not hard to imagine a bear plowing right through it. So I sleep with a shotgun by my side and hope that if the worst comes to pass, someone else fires first.

At 5 o’clock one morning, Divoky’s voice crackles through the walkie-talkie: “Polar bear outside camp.” I extract myself from my sleeping bag, hurriedly lace up my boots, stumble outside, and freeze: There,

not 20 feet away, The Bear rolls through the mist. What can only be a primal fear response sublimates my thoughts. My entire being focuses on the predator; space and time still. I don’t remember that I left my gun inside the tent.

The bear doesn’t even pause to investigate. It marches across Cooper Island, sniffing at the occasional plastic case, before it disappears back into the sea.

After my primal terror subsides, I feel only sympathy. The bear, like countless Arctic animals facing novel, warmer en-

THIS SUMMER, HALF OF COOPER’S nests failed, and nearly all of the remaining nests fledged a single underweight alpha. Each day, our nest checks turn up dead chicks. When we discover my first, Divoky kneels in the gravel, cradles the limp bird, its black fluff matted, in his hands, and then delicately tears its breast open like the skin on rotten fruit. Its stomach is empty.

Somehow, from all this death emerges something like hope: six parents, paired into three couples, who have the makings of survivors. “There were six individuals

Divoky kneels in the gravel, cradles the limp bird, its black fluff matted, in his hands, and then delicately tears its breast open like the skin on rotten fruit. Its stomach is empty.

vironments, is merely trying to survive. “I don’t know what it is one can do” to help these animals, Audubon’s Senner says. “In the end you circle back to the idea: ‘Well, we have to do what we can to reduce carbon emissions.’ You want to try and maintain areas like the coastal plain of the Arctic National Wildlife Refuge, where the wildlife at least have a chance to adapt to changing conditions free from the stress of industrial development. And you want to have big areas that are protected to give birds as much opportunity as possible for their own Plan B and Plan C.”

All they need, then, is space and time.

who were reproducing like it was 1979,” Divoky tells me after his return to civilization in September. “And they weren’t just getting two chicks out the door: One of them had a 400-gram chick!”

Those birds, and others like them, may be the future of the species. If those chicks thrived because of advantageous genes—maybe the chicks can process sculpin, or the parents are generalists who can hunt in open water—they’ll pass those genes on to their progeny. Maybe those genes will lead some birds through the bottleneck and into the next iteration

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of Mandt's Black Guillemots. "It would be both very interesting and very depressing to see the colony get down to less than 10 pairs, but 10 pairs who can figure things out," Divoky says.

Whoever those survivors might be, Divoky will know them intimately, including detailed growth and survival data for every chick they've raised, and likely the histories of their parents, too. "He probably knows most or all individuals on the island," says Christophe Barbraud, a population ecologist at the National Center for Scientific Research in Paris. In June Barbraud was awarded funding to analyze long-term datasets on eight Arctic and Antarctic species as they adapt to climate change—including Divoky's guillemots. Next year a postdoctoral researcher will be dedicated to Divoky's dataset full-time. "His dataset is huge," Barbraud says. "I'm not sure one postdoc will be enough, but at least we'll start."

This is potentially groundbreaking work, the first step in understanding how populations and species adapt to rapid climate change—and whether people can do anything to help them. "That is not a system that we're going to maintain by flying in frozen fish for all the chicks," Parrish, the seabird ecologist, says. "You can provide great nesting habitat, but you actually can't make the ice closer. You might be able to ward off a bear here and there, but the large-scale changes that are also making those predators hungrier—that's going to overwhelm."

"There's a point at which the world is going to overwhelm George and overwhelm that colony," she continues. "He's going to end up on a barrier island with no birds and/or a barrier island that's underwater. We know that's going to happen. He knows it, too. And it doesn't stop him."

Indeed, Divoky is already fundraising for his nonprofit Friends of Cooper Island to gather as much data as possible during these crucial years of adaptation. He's hoping to continue his work on Cooper Island until at least 2025, the 50th anniversary of his study as well as the year when some models predict an ice-free Arctic summer.

Really, though, the renewed urgency is only an excuse; Divoky would return regardless. He didn't dedicate his life to Cooper Island to document the effects of climate change; it's something that happened to him—and the birds—along the way. He returns because guillemots comprise a significant part of his social circle, and because he needs to know what happens next. "To maintain a long-term relationship, you have to keep things interesting," Divoky says, "and Cooper Island has stayed interesting." **A**