



ARCHAEOLOGY

Archaeologists Race Against Sea Change in Orkney

Coastal erosion, accelerated by climate change, is threatening the Orkney Islands' wealth of archaeology, but researchers are adapting to the changes

KIRKWALL, UNITED KINGDOM—Holding her jacket shut against the powerful wind, archaeologist Julie Gibson picks her way along the foot of a rock-studded cliff face on the western shore of the main island in north Scotland's Orkney archipelago. "I never know what I'm going to find when I come down here," she says, brushing her fingers through the dirt at eye level to look for fragments of bone or pottery. "It's so different every time, all these new faces exposed on the cliff." At her touch, bits of the soil crumble and fall away, loosened by storms that lash rain and waves up against the sandstone cliff and rapidly erode it.

As Orkney's county archaeologist, Gibson is one of the leaders in a charge to understand how erosion affects the islands' abundance of coastal archaeological sites. The cliff she's examining is only about 50 meters away from the incredibly well-preserved 5000-year-old Neolithic village of Skara Brae, a World Heritage site that draws 70,000 tourists per year and is a major source of income for the islands. The tight cluster of little round stone houses, complete with intact stone dressers, beds, and garbage heaps, has been an unparalleled resource for archaeologists like Gibson to learn how northern Britain's earliest agrarians lived.

Skara Brae looks safe at the moment, perched near the cliff edge overlooking the Bay of Skaill and protected by a 3-meter-high seawall. Yet powerful waves from just one violent storm could overwhelm the site's defenses and suck the village out to sea. "Even without anthropogenic global warming, Skara Brae's in trouble," says archaeologist Caroline Wickham-Jones of the

University of Aberdeen in the United Kingdom. "At some point, we're going to have to say, so be it."

Hundreds of coastal sites from Orkney's 10,000-year human history are similarly endangered by climate change. Archaeologists can't fight the ocean so, like the people whose climate adaptation they study,



Racing time. Ingrid Mainland hopes to record Rou-say's archaeology before erosion takes its toll.

modern researchers continue to adapt themselves. They take advantage of the fact that destructive storms can reveal and even excavate sites, though they're not the most delicate of diggers. And, by adopting new techniques such as 3D laser scanning, they can record, if not save, sites before they are taken by the sea. For Orkney, whose dense archaeology is covered with shell sand that preserves both stone and bone unusually well, the danger from storms and sea

Beachfront. Storms are predicted to increase in northern climes like Orkney.

level rise are especially acute because of its northern latitude.

The history of Skara Brae is marked out by storms. In about 2200 B.C.E., a catastrophic storm drove the villagers away and blew masses of shell sand, called machair, over their houses, preserving them intact. Another massive storm, during a warm period in 1850, blew the sand off again and revealed the village to a local landowner, who excavated it himself. The village was originally well inland but during the centuries it lay buried, the sea rose more than 40 meters and turned a freshwater lake into the Bay of Skaill.

Now storms threaten it again. As waves ricochet about in the bay, Gibson explains, "you've got the full weight of the Atlantic piling into soft stuff, with hardly any resistance to sea taking back the sand." That story is repeated all along northern coasts. Archaeologist Thomas Dawson of the University of St. Andrews in the United Kingdom estimates 50 meters of the coast on a beach in western Scotland was lost in a single night in 2005. "We were walking along the beach finding bits of human skulls and Iron Age pottery for weeks afterward," he says. The Intergovernmental Panel on Climate Change predicts that in the future the North Atlantic will become stormier and storm surges may raise sea levels by 2 meters.

Local archaeologists say smaller storms are already accelerating erosion. "There's been more change [to the area near Skara Brae] in the last 10 to 15 years than in 100 years," says archaeologist Jane Downes of Orkney College, part of the University of the Highlands and Islands here, as shown by historical maps and photos of the site. In the mid-1990s, a team from Orkney College excavated a butchery and garbage heap, or midden, close to the village, finding bones, beads, and other detritus that created a picture of the people's lifestyle. Today, that site is entirely gone, swept away by crashing waves that have scoured about 5 meters of coastline. "It's ferocious," Downes says.

Letting nature take its course, or "managed retreat," is now the approved method of dealing with coastal erosion, Dawson says. "Also called the do-nothing approach," he adds. Seawalls tend to exacerbate erosion by redirecting the energy from the waves in unnatural ways.

There's only so long that researchers can mourn the loss of sites. "The fact is that they are [disappearing]," Downes says, "so rather

than just bleating about it, it's much better to turn it into a positive." Coastal erosion helps by exposing sites, taking what Gibson calls "sea bites" out of cliffs and providing peepholes into a layer cake of archaeology, the remnants of waves of settlers and invaders who built upon the same attractive spots. This can save a lot of digging but leaves very little time to decipher what's there.

On the small Orcadian island of Rousay, waves have been unearthing buried treasures along all of its beaches. Between rain showers, Rousay is haloed with multiple rainbows so vivid that it feels like you could drive beneath one. Archaeologist Ingrid Mainland of Orkney College squelches past several dozen sheep down a steep, grassy hill to the beach where she will inspect the remains of a 1000-year-old Iron Age building called a broch. Brochs, which were originally round stone towers several stories high, abound in northern Scotland, especially on Orkney. Built by late Iron Age people, it's still unknown whether they were defensive castles or summer homes for the wealthy.

"There's my broch." Mainland points out a large grassy mound in what was her backyard while she was growing up on Rousay. Although the mounds make brochs clearly visible, researchers hesitate to excavate new ones both for lack of funds and fear of exposing them to the elements.

But in this case, coastal erosion did the work for them. Mainland points out a site on a beach called Swandro where, in July, researchers from the University of Bradford spotted the remains of what appeared to be a broch half-claimed by the sea. Waves had unearthed it at an angle, revealing that the lowest accessible part dated from 400 to 200 B.C.E. while the top part was remodeled as a Viking longhouse in the 1200s, says lead investigator Steven Dockrill. Because so much of the building had gone, the members of the team, which had only 3 weeks to work on the site, realized they may be able to get down to its base without much digging when they return next summer, Dockrill says. This will allow them, using modern technology for the first time, to sample the soil from the floor of a broch for bones and plant remains, perhaps settling the question of what brochs were used for.

A nearby graveyard contains both Viking boat burials and graves of Picts, a Scottish Iron Age people, suggesting possible con-

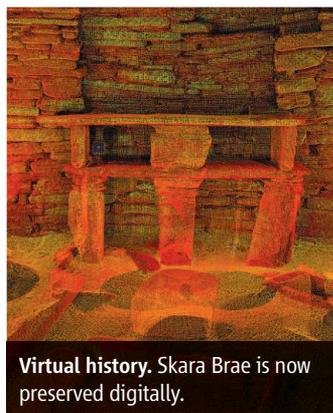
flict or mixing. If Vikings spent time in the Pictish broch, Dockrill hopes they left clues for his team to discover next year. That is, if the site is still there. Covered with a tarp weighted by stones, it lies only a few meters from the sea at high tide.

But even if the broch disappears before the team can finish its excavation, it has already given the researchers an opportunity to test out a new tool: a high-resolution 3D laser scanner that took a digital record of the site. The device needs only 30 minutes to scan across 270° out to a distance of up to 300 meters, allowing the archaeologists to slip onto a threatened site at low tide, quickly scan it, and slip out again.

"It's a godsend," Gibson says. The speed



Sea bites. Erosion of cliff faces reveals artifacts and skeletons.



Virtual history. Skara Brae is now preserved digitally.

of the scanner saves the team from the need to mark out a grid over the site with bits of string and meticulously record everything that is there, often while battling high winds and rain. Gibson hopes to use it extensively to monitor erosion season by season. Back in the lab, technicians overlay the 3D reconstruction onto high-resolution color photos also taken by the scanner. The detail is sufficient for researchers to see bits of the archaeology that have been eaten away "like a mad quarrier has been at it," Gibson says, and watch for new pieces to pop out. The group plans to put this and future data online so that colleagues can read and analyze it.

"These sites are very emotive," says architect Chris McGregor, who heads a team called the Scottish Ten—funded by the government agency Historic Scotland—that is systematically laser-scanning world heritage sites, preserving them as educational tools both online and for museums. One of their targets is the Heart of Neolithic Orkney site, which includes Skara Brae, a ring of standing stones called the Ring of Brodgar, and a Neolithic cairn called Maeshowe in which 12th century Vikings sheltered and left runic graffiti. Laser scanning,

McGregor says, is useful for monitoring erosion as well as recreations for the public. "We could take you into Skara Brae's houses virtually," he says.

Given the threat to sites around Scotland's coast, Historic Scotland has been running a "coastal zone assessment survey" since 1996, sending out surveyors to tramp more than 16,000 kilometers of coastline, record what's there, and send the data back for archaeologists to prioritize and make tough decisions about what to excavate, what to preserve, and what to abandon.

Dawson directs a group called Scottish Coastal Archaeology and the Problem of Erosion (SCAPE), which has been carrying out the survey for Historic Scotland since 2000. So far, the survey has inspected only 30% of Scotland's coastline and identified 11,500 archaeological sites. Its archaeologists recommended some kind of action on 3750 of these sites, be it excavation, laser recording, or other preservation—if the money is available. "This [huge number] is one reason you're not going to get people jumping up and down saying let's build coastal defenses," Dawson says. To help prioritize, SCAPE has begun crowdsourcing: asking local communities

to measure and photograph the state of erosion in an area. In return, communities have a say in which of their favorite beach sites get excavated.

When people get worried about climate change, Wickham-Jones says she wants to remind them that Orcadians have dealt with it for ages. Situated at the edge of an ice sheet that covered mainland Scotland, Orkney was particularly susceptible to sea level rise when the sheet melted at the end of the Ice Age. How ancient peoples dealt with a changing climate is one of the primary questions that archaeologists hope to answer by studying farming and migration patterns. "What do you do when you know your land is getting smaller around you?" Wickham-Jones asks.

The people of Orkney are grappling with similar problems today, although the current rate of sea level rise, about 2 millimeters per year, is a far cry from what people have often experienced in the past. But by studying ancient climate change and Orcadians' history of adaptation, "archaeology will start to pay dividends," Gibson says. "Now we're trying to foretell what happens to ourselves."

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