who did not attend either meeting.

Krebs had her own worries, which included costly upgrades under way or planned for two other DOE neutron sources and an increasingly difficult struggle to fund a $1.3 billion Spallation Neutron Source at Oak Ridge. She and BESAC members say they grew convinced that closing the HFBR, although it would pose short-term problems for the neutron-scattering community, was for the long-term benefit of researchers given the pressing need for the Oak Ridge facility.

On 16 November, Richardson announced that the reactor would be shut down. Emphasizing that the HFBR posed no health threat, he declared that "we need to focus our limited resources on productive research."

"[Scientists] need a kick-ass logo, they need a hip-hop song."

—Jean Mannhaupt

Blame game

The decision—and its timing—infuriated lab officials as well as many activists. Both sides were gearing up for a public debate over the environmental impact statement, the draft version of which stated that there was no pressing reason to keep the reactor closed. "Washington took public participation out of our hands," says Mannhaupt angrily. "It's a hell of a way to run science policy, and a hell of a way to work with a community," adds local civic activist and former Brookhaven employee Don Garber.

Even STAR officials complained. Baldwin and Cullen say that Richardson deliberately defused public outrage over the leaks and waste dumps at the lab by abruptly ending the debate. In a meeting with reporters, Richardson insisted that budgetary reasons, not politics, were behind his decision: "I don't like to close scientific facilities, but it made no sense to restart it." He added that "my scientists unanimously said 6 months ago that we should shut it down." Both Dehmer and Krebs confirm that they recommended closing the facility prior to Richardson's decision. "It's never easy to make a decision like this, but sometimes you have to," says Dehmer.

Now DOE and Brookhaven must decide whether to mothball or decommission the reactor—the latter would cost hundreds of millions of dollars. Meanwhile, the lab's new contractor, Brookhaven Science Associates, gets good marks from all sides, and director John Marburger has been successful in establishing a basic level of trust between activists and the lab. Even Caldicott gives him grudging praise. "I respect him," she says, while insisting that all radiation-related activities at the lab should cease.

The emotional aftermath is harder to calculate. Lab scientist Tranquada remains deeply upset about the decision. "I'm still overcoming the loss," he says, his voice breaking in frustration. "There's a facility with 15 instruments and no place to put them." Longtime Brookhaven materials scientist James Hurst retired in December, complaining that DOE "should have drawn the line in the sand" to prevent antinuclear groups from thinking they could shut down other facilities as well. "Maybe I'm naïve, but I think this should have been about science," he says.

Beyond the blame game, however, some researchers and managers say they've learned a hard lesson about an axiom—perception is reality—that is taken for granted by politicians. "As a scientist, you believe in marshaling the facts and proceeding in a logical fashion," says Shapiro, "but politics adds so many variables." Adds SUNY's Crease, "People don't take in facts nakedly, and it is naïve to say that facts speak for themselves."

What happened at Brookhaven, say Crease and others, should be a stark warning to scientists about the growing public fears over everything from research involving fetal tissue to genetically modified crops. "It's very sobering," says Bates. "There are thousands of labs around the country doing work that may not be in vogue, and I hate to think they will become cannon fodder for local politicians." To win over such critics, says Mannhaupt, scientists need to fight fire with fire. "They need a kick-ass logo, they need a hip-hop song," she says.

But the battle over HFBR also demonstrates that researchers who ignore those who fund and regulate them can't expect help when the going gets tough. "Scientists have to look beyond their own self-interest to the neighborhood in which they work," says Richmond. "If we want to be part of a community," she warns, "we can't act like prima donnas."

—ANDREW LAWLER

ECOLOGY

The Unbearable Capriciousness of Bering

Scientists have labored hard to untangle the web of life in the Bering Sea; some strange new kinks have them wondering just what the web ought to look like

The short-tailed shearwater flies a long way for a good meal, migrating some 15,000 kilometers every summer from the seas south of Australia to prime feeding grounds in the Bering Sea, off the coast of Alaska. In July 1997, however, something went terribly wrong. Scientists estimate that about a half-million carcasses of this brownish-gray relative of the albatross were bobbing lifelessly in the water and washing up on shore. The scale of the die-off was "unlike any we had ever seen," says marine ecologist George Hunt of the University of California, Irvine, a 25-year veteran of Bering Sea research. The birds, it turned out, had starved to death.

The death toll was the latest sign of an ecosystem under siege. From unprecedented algal blooms to fewer salmon returning to spawn in Alaskan rivers and declines in fur seal and sea lion populations, the Bering Sea's ecological balance is shifting before researchers' eyes. The data now point to an assault on the food web from top and bottom: Fishing and hunting are taking out predators, while climate changes are reshaping the community of tiny marine plants and animals that sustain higher life-forms. It's an "ecosystem sandwich," says Robert Francis, a fisheries oceanographer at the University of Washington, Seattle, and chair of a 1996 National Research Council study of the Bering Sea.

Scientists want to understand this sandwich better, because the Bering Sea is such a remarkable crucible of life. Nearly half of its 2.3 million square kilometers is a shallow shelf, less than 180 meters deep. In winter, when waters of varying depths mix well, the shallows are fed by a rich load of nitrogen, phosphorus, and silica nutrients dredged by currents from the sea's deep basin. Each spring and summer, these enriched shelf waters nourish microscopic green plants—phytoplankton—that are consumed by zooplankton including tiny shrimp, themselves food for fish, birds, and some mammals. "This is one of the most productive of the world's ocean areas," says Elizabeth Sinclair, a marine mammalogist with the National Oceanic and Atmospheric Administration (NOAA) in Seattle. Indeed, the Bering Sea is home to the United States' largest single-species fishery, with an annual walleye pollock harvest exceeding 1 million metric tons.

Although weather plays an important role in shaping habitats everywhere, "the link between climate and the ecosystem is stronger [in the Bering Sea] than in many places," says Nicholas Bond, a research meteorologist at the University of Washington, Seattle. The strength and direction of the winds buffeting the sea determine how much of the surface is covered by ice in winter and how fast the ice edge retreats toward the Arctic Ocean in summer. The extent of open water is critical to phytoplankton populations and the creatures that depend on them: Ice, especially when covered by snow, acts as a sunblock, limiting photosynthesis by the phytoplankton.

Also critical to the ecosystem are air and water temperatures. When the surface freezes, the salt concentration increases in the underlying water. As ice melts in spring, the fresh water dilutes the saltiness of the surface water, lowering its density. Heat from the sun further reduces density to a depth of about 20 meters. Lower density is a problem, because the greater the density difference between surface and deeper waters, the harder it is for the layers to mix and bring nutrients to the surface. During calm, warm summers, the phytoplankton quickly exhaust the nutrient supply. It then takes strong storms to stir the pot and restock the shallows.

Even for an ecosystem extra vulnerable to climatic whims, "in the last 3 years, elements of the climate and the biology in the Bering Sea have been crazy," says Francis. Just before the shearwater die-offs, scientists realized something unusual was going on. In late June and early July 1997, a microscopic alga called ehux (*Emiliania huxleyi*), never before seen in the Bering Sea but common elsewhere, bloomed over an area larger than Nebraska. Ehux has minute reflective carbonate plates, which in multitudinous numbers are visible from space.

Unusual conditions may have favored the ehux bloom in 1997, says Phyllis Stabeno, a physical oceanographer with NOAA in Seattle. Very strong storms in May churned up an extra helping of nutrients from the Bering's deeper waters. Then, a summer of light winds and more sunshine than usual warmed the surface waters to about 2 degrees Celsius above normal. Similar conditions in 1998 triggered an ehux bloom that covered twice the area as that of 1997, extending through the Bering Strait and into the Arctic Ocean.

Although the connection remains unproved, the bloom may have sounded the death knell for the many shearwaters in 1997. Hunt speculates that ehux's appearance upset the food web. A tenth the diameter of diatoms—normally the dominant phytoplankton in the Bering Sea—ehux probably makes a good meal for smaller zooplankton such as copepods, which are the size of rice grains. Larger zooplankton like euphausiids (small shrimp) probably cannot eat enough ehux to grow beyond a small population. Diatoms and other large types of phytoplankton, the normal food for euphausiids, were crowded out by the smaller ehux. And euphausiids had been the mainstay of the shearwater diet.

Field data lend support to this scenario. Copepod numbers were at least 10 times higher in 1997 than in earlier years, while euphausiids had dwindled to numbers a tenth or fewer than usual. That's why Stephan Zeeman, a biological oceanographer at the University of New England in Biddeford, Maine, finds Hunt's ideas plausible. "The shift of the phytoplankton population to ehux and away from the more common and much larger diatoms is bound to cause changes in how the food web works," he says.

If vicissitude is the only constant in the Bering Sea, it is a fact of life that the region's denizens seem able to adapt to. For example, although euphausiid populations were low again in 1998, shearwaters survived, albeit a bit underweight for the return flight to their wintering grounds near Tasmania. Hunt and his co-workers found that the shearwaters augmented their diet with more fish than they had been observed to consume in the past. For reasons that are still not fully understood, the shearwaters were unable to find enough food of any type (fish or invertebrates) during the late summer of 1997. Meanwhile, to the relief of the fishing industry, the walleye pollock population thus far appears to have been unaffected by ehux.

Keeping scientists guessing, ehux bloomed again last year—even though water temperatures were colder than average. The erstwhile stranger now seems to be a member of the ever-changing Bering Sea family. "Ecosystems can occupy any number of distinct states if pushed hard enough by changed environmental conditions," says Suzanne Strom, a plankton ecologist at Western Washington University's Shannon Point Marine Center in Anacortes, Washington. "All of a sudden, there is a new community, in this case including ehux, and it may not want to go back to its original state." Scientists will be keeping close watch to see how long this new food web arrangement will last—and which species will next fall victim to the Bering Sea's capricious cold shoulder.

–ROBERT A. SAAR

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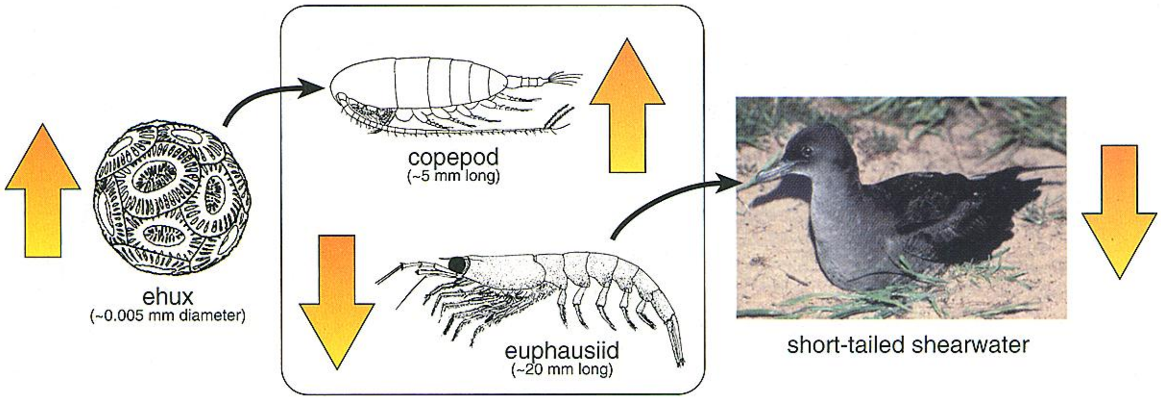

Chain reaction. Scientists think they have uncovered the cause of a massive die-off of short-tailed shearwaters in the Bering Sea in 1997. The most likely scenario is that a bloom of the phytoplankton ehux fueled an explosion of copepods and a corresponding crash in euphausiids, the shrimp preferred by the migratory shearwaters. The scarcity of euphausiids that year, it's thought, resulted in a half-million shearwaters starving to death.

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