The tiniest catch

BY WENDEE HOLTCAMP

Marine scientists are prowling the Bering Sea to learn how climate affects minute sea creatures and the lucrative fishery that depends on them.

Themisto libellula.

PHOTOS: T. SHAW

At 2 a.m. in the far north, marine scientist Alexei Pinchuk started his work as the summer sun dipped below the horizon. Using a winch, he lowered a 10-metre-long net — split like a giant pair of trousers — over the starboard side of the RV *Thomas G. Thompson*, which was cruising in the Bering Sea, west of Alaska. He dropped the net to the sea floor and then hauled it back up to examine his catch.

Pinchuk, a Russian working at the University of Alaska's Seward Marine Center, had harvested a whole zoo of minute animals, including larval fish, squid, crabs and octopuses, plus amphipods, copepods and krill.

"They're much more interesting than mammals," he says, wryly. These miniature zooplankton form critically important middle links in the food web, helping to sustain the rich life of the Bering Sea. The region provides half of the commercial seafood caught in the United States annually, including cod, sole, flounder, salmon and crabs. The tiny animals have also given Pinchuk and his colleagues a breakthrough in understanding how climate fluctuations affect Alaska walleye pollock (*Theragra chalcogramma*) in the largest single-species fishery in North America. The Bering Sea yields one million tonnes of pollock each year, amounting to one billion dollars. But the pollock population has begun to fall and scientists are concerned that climate change could put further stress on the fishery.

For the past three years, Pinchuk has been studying this region as part of the six-year, US$52-million Bering Sea Project, a collaborative effort between the US National Science Foundation (NSF) and the North Pacific Research Board. The project has funded more than 100 principal investigators, including oceanographers, biologists, geochemists, social scientists, economists and ecosystem modellers, as well as their technicians and students.

At its heart, the Bering Sea Project is an attempt to understand how climate change may affect the region's fisheries, by studying the ecosystem from top to bottom. Researchers hope this strategy will help fishery managers to protect the pollock and other species as the Bering Sea warms.

"The Bering effort is one of the few times a truly multidisciplinary effort has come together to create an integrated model of such depth, largely from scratch," says Beth Fulton, an ecosystem modeller with the Australian Commonwealth Scientific and Industrial Research Organisation's Marine and Atmospheric Research division in Hobart, which helps to manage Australia's fisheries.

HOME AWAY FROM HOME

As he surveyed his haul of plankton, Pinchuk swirled the container, causing tiny crustaceans called copepods to emit a fluorescent blue glow. Although many of the researchers on board thrilled at the occasional sightings of whales and short-tailed albatrosses, Pinchuk remained single-minded in his plankton obsession. "I hate birds. Walruses are ugly," he jokes.

This summer Pinchuk spent several weeks on board the *Thompson*, which left port just after the last of the winter sea ice melted in mid-June. Carrying 30 scientists, the ship cruised a zigzag trajectory across the eastern Bering Sea shelf, stopping every few hours to collect water, mud and samples of marine organisms (see 'Fishing for answers').

It will take some time for Pinchuk to sort his specimens. But he has already observed a distinct difference between the dominant zooplankton species during the past three years — the coldest on record — and the three previous decades, which culminated in five of the warmest years on record, from 2001 to 2005. An Arctic amphipod, *Themisto libellula*, that hasn't been seen here since the 1970s, is invading the Bering Sea now that temperatures have dropped. Pollock diets have preferentially shifted to these large, fatty invertebrates and to the big copepods and krill that thrive in cold years.

For researchers, one of the big questions about the Bering Sea

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food web is how year-to-year changes in ocean temperature influence plankton abundance, in turn affecting pollock and other commercial fish. A decade ago, oceanographer George Hunt of the University of Washington in Seattle developed an overarching model called the oscillating-control hypothesis. In simple terms, this suggests that the survival and growth of the youngest pollock fluctuate with shifts in the timing of the sea-ice melt in spring. Warm years help the cold-blooded zooplankton grow faster, and they provide ample food for the pollock born that year. In contrast, the hypothesis predicts that zooplankton and young pollock would not do so well in cold years.

"That was the first attempt to develop a broad conceptual framework for how climate might be impacting the Bering Sea," says Hunt. He approached the NSF for funds to test his hypothesis, but the agency instead asked Hunt to develop a broad programme for the Bering Sea, allowing others to examine his hypothesis in a much more comprehensive way. Hunt became chairman of a steering committee that planned the Bering Sea Project.

HOT AND COLD

As it turns out, zooplankton collected by Pinchuk and his colleagues during the project and in the warm years before it have both supported the oscillating-control hypothesis and turned it on its ear.

"The original hypothesis considered zooplankton as one group, and assumed they would all do better in warm years," says Pinchuk. New data, however, paint a more nuanced picture.

Small zooplankton species thrived in warmer conditions, as predicted, but larger, fattier species did not. The youngest pollock eat small copepods, but as the fish get bigger, they prefer energy-dense large copepods, amphipods and krill, says Pinchuk. As a result, the pollock initially fare well in warm years, but then start to falter for lack of nutritious food, and are unable to lay down enough fat to survive winter.

Warmer conditions can also hurt by revving up the metabolism of the pollock, increasing the amount of food they need, says Franz Mueter, a fisheries biologist from the University of Alaska in Juneau who is collaborating with Pinchuk and others to revise the hypothesis.

As part of the Bering Sea Project, Mueter looked at pollock data going back to 1964 and found that survival of the younger fish does not improve in a linear way with temperature, as the oscillating-control hypothesis predicts. Instead, the relationship is a bell curve: they don't survive winter well in extreme warmth or in extreme cold. (Unusually chilly water during the past few cold years has forced the young pollock into relatively warmer regions, where they can more easily fall prey to older pollock.)

The results gleaned from work in the Bering Sea do not bode well for pollock, says Hunt. Although the sea has been colder than normal recently, temperatures have risen significantly since the 1980s and forecasts suggest that trend will continue. Juvenile pollock suffered in the hot years of 2001–05 and if they do not fare any better as the water warms in the future, "prospects for the pollock population are grim", says Hunt.

Researchers are trying to give the fish a fighting chance by providing the foundation for a new way to manage the Bering Sea fishery. Like others in the United States, it is managed by a council made up of state fisheries agencies, the general public and federal agencies. Each year, the North Pacific Fishery Management Council reviews data on the pollock population in the Bering Sea and recommends limits on how much the industry can catch.

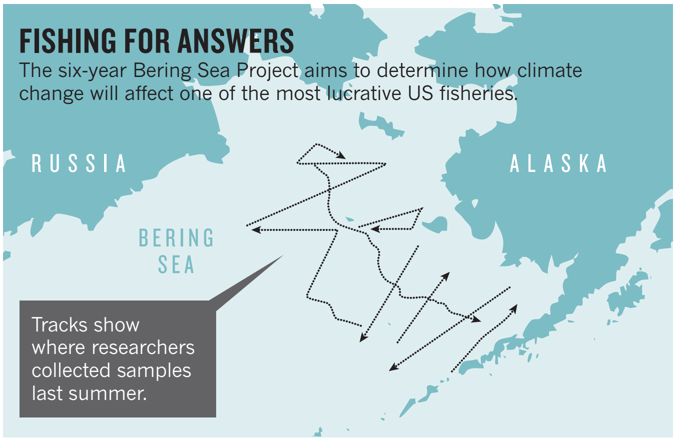
The Bering Sea Project is providing information that could help to establish a much more sophisticated strategy — one that takes into account not just the size of the pollock population but also zooplankton numbers, predator data and many other factors to decide how much pollock should be caught each year.

The big question is whether this comprehensive strategy will be ready fast enough. The Bering Sea pollock fishery is regarded as one of the best-managed fisheries in the world, and the Marine Stewardship Council certified it as sustainable in 2005. But shortly after that, pollock stocks dropped dramatically, perhaps because of the cold snap. Last year, researchers who conducted surveys in the area were shocked to find relatively few three-year-old fish.

That caused Greenpeace to move pollock to its 'red list' of seafood to avoid. Some researchers worried that the population was heading for a crash.

"It's quite possible to take too many fish for the ecosystem to function as it once did," says Jon Warrenchuk, ocean scientist with the conservation organization Oceana. He thinks that the Bering Sea Project could help in creating a better management system.

A larval squid caught by researchers with the Bering Sea Project.



"Prospects for the pollock population are grim."

Not everyone agrees that the system is broken. Jim Ianelli is a scientist with the National Oceanic and Atmospheric Administration who runs the pollock-stock assessment models used to set current catch limits. "I think we're harvesting sustainably and responding appropriately by scaling catches according to trends in abundance," says Ianelli, who is also a principal investigator on the Bering Sea Project. He says that information gleaned from the project and other studies has already helped managers make more informed decisions.

On board the *Thompson* last summer, researchers hurried to collect as much data as possible in the short time available. After Pinchuk finished gathering his harvest, the ship headed off through steely grey waves towards a horizon shrouded in fog.

Pinchuk has been studying the northern seas for more than two decades, long enough to witness the changing climate firsthand. He has watched Alaska's glaciers melt and zooplankton populations shift in response to rising temperatures.

Arctic amphipods have shown up in his hauls, lured south by the cold snap of the past three years. But if temperatures resume their climb, as expected, Pinchuk suspects the amphipods will disappear once more. And with them, some of the pollock may also head north into Russian territory, in search of cooler waters. ■

Wendee Holtcamp *is a freelance writer in Houston, Texas.*