remediation efforts do succeed in reducing nitrogen levels, a shifting nutrient balance could shake up the gulf's phytoplankton community in unpredictable ways that abet hypoxia or even lead to blooms of toxic dinoflagellates, such as those found in red tide, warns Quay Dortch of the Louisiana Universities Marine Consortium. "We could see some unintended consequences in getting to where we want to be," she says.

As scientists hash out the best strategy for battling the dead zone, gulf fishers like Darda and midwestern farmers like Sievers are beginning to appreciate how tightly bound their livelihoods are to the mighty Mississippi and the dissolved nitrogen it sweeps into the sea. "Never before," says Downing, "has the interconnectedness of life in distant rural communities been so apparent." **–DAVID MALAKOFF**

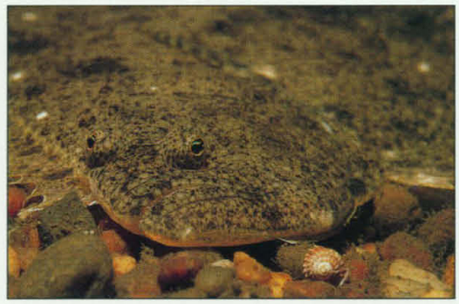
David Malakoff is a writer in Bar Harbor, Maine.

Ecology's Catch of the Day

NEWS

A massive federal undertaking to learn where fish live in the ocean could lead to major changes in the way the United States manages its fisheries

Dave Packer probably knows more about the mid-Atlantic summer flounder than any other person on the planet. The marine ecologist has spent a year scouring journals, digging up graduate theses, and tracking down survey data to assemble a picture of exactly where off the U.S. eastern seaboard the fish spend their lives. Packer's daunting task—as he describes it, to find out "everything you've always wanted to know" about the flounder's habitat, from Maine to Georgia—involved sorting through more than 250 papers and sometimes conflicting accounts on, among other things, the fish's preferred water temperatures, bottom types, and food. The grueling exercise has yielded an "incredible overview of the species," says Packer, who works for the National Marine Fisheries Service (NMFS) in Highlands, New Jersey.



HERB SEGARS / ANIMALS ANIMALS

Flounder's flat. A painstaking effort is under way to define and protect the summer flounder's habitat.

Packer's labors are part of a sea change in the way the U.S. government hopes to manage increasingly fragile ocean fisheries. His flounder opus is one of hundreds of similar studies spawned by a federal effort to force fishery managers to take into account the health of a fish's habitat—and not simply its population size—in setting restrictions on fishing. This move to give ecologists a greater voice in the management of commercial fish stocks comes courtesy of the 1996 Magnuson-Stevens Fishery Conservation and Management Act. "For the first time, people who manage fisheries must consider habitat, and that is an overdue and giant leap forward," says Elliott Norse, president of the Marine Conservation Biology Institute in Redmond, Washington. The law mandates that by 11 October, eight fishery management councils around the country must have finished mapping out "essential fish habitat" for more than 600 species, from groupers off Florida to salmon off Alaska.

Industries that operate along the coast are anxiously awaiting the results: Areas designated as essential habitat should gain protection under the act, and harmful commercial activities—including some fishing practices—could be curtailed. But specific repercussions are still unknown. For instance, East Coast councils haven't tipped their hands yet on whether Packer's findings might help trigger restrictions on activities such as dredging in estuaries or waste discharges. That the law might wrap a protective cocoon around coastal nurseries delights the fishing industry. "We hope [implementing the law] will unlock fish stocks that we currently cannot use because they are contaminated by pollution or harmful algae blooms," says Richard Gutting of the National Fisheries Institute, an industry lobby group.

In a rare show of solidarity, scientists, conservationists, and fishing industry officials agree that safeguarding habitat is a key to restoring beleaguered fish stocks. But the effort faces a big obstacle: Scientists know so little about the habitat needs of many fish species that they are starting virtually from scratch. Indeed, some observers argue that, in the face of this yawning knowledge gap, the federal effort to define essential habitats is badly underfunded. Others worry that the program could be politically vulnerable if it leads to tighter regulations. Still, scientists are thrilled about the prospect that ecology could soon help underpin fishing regulations. The act and its "far-reaching implications," predicts Jim Murray, a fisheries biologist at North Carolina State University in Raleigh, "will be a cornerstone of fishery management for years to come."

Essentially black boxes. The effort to define essential habitats is aimed at remedying a key shortcoming of the Magnuson Fishery Conservation and Management Act of 1976, landmark legislation that laid the groundwork for regulating where, when, and how many fish can be caught in a season. "Right now, the fishery management models assume that habitat is stable, but that's not the case," says Jim Burgess, director of the National Oceanic and Atmospheric Administration's (NOAA's) habitat restoration center, who until May directed NMFS's habitat conservation office. Habitat for commercial species is being degraded by a host of factors, Burgess says. They include pollution from oil spills, urban and agricultural runoff (see story on p. 190), dredging, damming coastal rivers needed for spawning, and filling or draining salt marshes. Fishing methods that disturb the seabed, such as trawling, also alter fish habitat, although the damage they inflict is still hotly debated.

But, although experts say it's clear that human activities are degrading fish habitat, it's still uncertain how much the intrusions contribute to declines in fish stocks. That's why environmentalists and commercial fishers joined forces and lobbied Senator Ted Stevens (R–AK) 2 years ago to include a provision in a new version of the law—the Magnuson-Stevens Act—requiring that each of the eight regional fishery management councils identify essential habitats, and threats to those habitats, for each species in its jurisdiction. The act defines essential habitat as "waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." NMFS has instructed the councils to use survey data on a species at a given location to map habitats used by fish, from birth to death. For overfished species that now occupy reduced ranges, the councils can consider historical data.

For most species, there are major knowledge gaps. "We tend to know where the adults are but not the juveniles," explains Burgess, who says the missing data present "a major obstacle" to implementing the law. In many cases, fishery managers infer likely habitat based on notions about a species' needs at various stages in its life cycle. But that requires knowledge—such as where kelp forests and rocky bottoms are located—that too is often lacking, Burgess says.

Even when there's good information about a species' geographic range, it's not easy to determine which areas are truly essential. That will require data on a species' reproductive and growth rates in different geographic areas—information that is scarce for any fish, says Paul Brouha, executive director of the American Fisheries Society (AFS). "We don't know enough by orders of magnitude" for

even one of the best studied species, the summer flounder, says Brouha. "We know where they spawn, where the adults and juveniles go, but we don't know how much habitat needs to be maintained in order to maintain productivity."

This limitation leaves some experts doubting that firm links can be drawn anytime soon between a fish population's health and its essential habitat. "I'm not sure we'll ever get to the connection between habitat and productivity," says Roger Pugliese, habitat coordinator for the South Atlantic Fishery Management Council in Charleston, South Carolina. Instead of focusing on individual species, Pugliese's council is mapping the location of habitats—such as coral reefs, sargassum algae, oyster beds, salt marshes, and mangroves—and using data on fish distribution to verify locations of important habitat types.

Faced with an incomplete picture, NMFS has sent mixed messages to the councils. In January, the agency told the councils to err on the side of caution and broadly designate essential habitat. For the summer flounder, says Packer, a swath of estuaries along the East Coast—including Long Island Sound, Chesapeake Bay, the Hudson-Raritan estuary, Delaware Bay, and Pamlico Sound—will likely be proposed as essential habitat because they serve as nursery areas. According to Burgess, the first designations may be too large, but they will be pared down as more data are collected. But in a letter last May, NMFS director Rollie Schmitten urged the councils to define essential habitats as narrowly as possible. "When we got the letter, we wondered if he was changing the rules," says one council analyst. According to NMFS spokesperson Scott Smullen, the rules are the same; Schmitten, he says, was only asking the councils to refrain from going overboard in defining habitats to ensure political support and steady funding for the program.

Regulatory sea change? Pinpointing essential habitat is hard enough, but it's just the first step. And the next steps—determining the threats to critical areas and how to deal with them—could lead regulators into choppy waters. Take the potential threat posed by some fishing practices. NMFS and AFS asked two scientists—Peter Auster, science director of the National Undersea Research Center at the University of Connecticut, Avery Point, and Richard Langton of the Maine Department of Marine Resources—to review 95 studies on how fishing affects marine habitats. The pair concluded that trawling and other methods that disrupt the sea floor can harm ecosystems, with long-lived species such as sponges and corals suffering the steepest population declines. "There's a strong inference that fishing is a widespread factor in changes to sea-floor communities," says Auster. Still, he says, no one has yet quantified how specific fishing gears and the frequency and intensity of their use relate to the severity of disturbance: "How many passes of a trawl is equal to a single sea scallop dredge? That kind of exercise has not been done." What's sorely needed, he and others argue, are controlled experiments to see how various fishing methods alter different marine habitats. "This is basic stuff—what foresters and terrestrial scientists have known for decades," says Norse of the Marine Conservation Biology Institute. "When we get those answers, then we can say trawl here, dredge there, and not here."

In the meantime, Burgess predicts, the councils are unlikely to clamp down on commercial fishing practices. With that in mind, Auster says he's encouraging the councils to establish more no-take zones—where all fishing is banned—while researchers study how these areas recover. But that could antagonize industry. "If this law is used to attack fishermen, then the political support to implement the law will not be there," warns Gutting of the National Fisheries Institute. He contends that enough marine sanctuaries already exist for study.

The councils are holding hearings through the summer to help them hash out whether to propose new marine reserves and new fishing regulations in their management plans. Some environmental groups are downbeat about the prospect of reform. "We've seen few signs that councils will actually enact habitat protection measures—the real teeth behind the essential fish habitat provision—by the October deadline," says Tanya Dobrzynski of the American Oceans Campaign.

Efforts to curb other threats to essential habitats could prove equally contentious. Starting this fall, the Secretary of Commerce (the department in which NMFS operates) must be notified of any federally regulated projects—for example, logging in national forests, mining on the continental shelf, or development of coastal wetlands—that pose a threat to essential fish habitat. In each case, NMFS will make recommendations for minimizing habitat damage. Although NMFS cannot shut down projects, the Magnuson-Stevens Act gives it the authority to consult with agencies that have regulatory power, such as the Environmental Protection Agency. NMFS's new consultant role may well lead to court battles over the act's interpretation, predicts AFS marine affairs specialist Lee Benaka.

Already, several forest industry groups have asserted that NMFS is misinterpreting the law. They worry about added red tape, as NMFS could have a say in how forestry is practiced as far inland as Idaho—part of the spawning habitat of Pacific salmon, which migrate from coastal rivers to the sea. "NMFS is trying to extend its jurisdiction into land management," charges Greg Schildwachter of the Intermountain Forest Industry Association in Missoula, Montana. He contends that NMFS should have no jurisdiction inland because the Endangered Species Act, U.S. Forest Service policies, and other laws already give salmon ample protection. NMFS has not ignored its critics: In his letter to the councils last May, Schmitten asked them to include in their deliberations industries besides fishing that may be crimped by the essential habitat designations.

Other observers are more concerned that NMFS lacks the staff and funding to fulfill its consulting duties. The agency now employs 50 people to handle more than 10,000 requests for consultation—"totally inadequate" resources, says AFS's Brouha. NMFS has requested $2.85 million in 1999 to deal with essential habitat issues, a hefty boost over this year's $2 million budget, but AFS is lobbying Congress to add much more. Contends Brouha, "Essential fish habitat needs to become a $50 million program in the next 3 or 4 years if it's to respond to the Magnuson-Stevens Act in a meaningful way."

Political and budgetary obstacles suggest that translating the act's good intentions into meaningful practice is a long way off. But many conservationists believe the new emphasis on habitat is at least a step in the right direction. "We've known that habitat questions are crucial to conservation on land," says Norse. "Now we can no longer ignore them in the sea." **–KAREN SCHMIDT**

USGS

Deep impact. Sea-floor snapshots from Georges Bank, off New England: undisturbed *(top)*, after scallop dredging *(middle)*, and recovery after a disturbance.

Karen Schmidt is a writer in Washington, D.C.