CONTENTS

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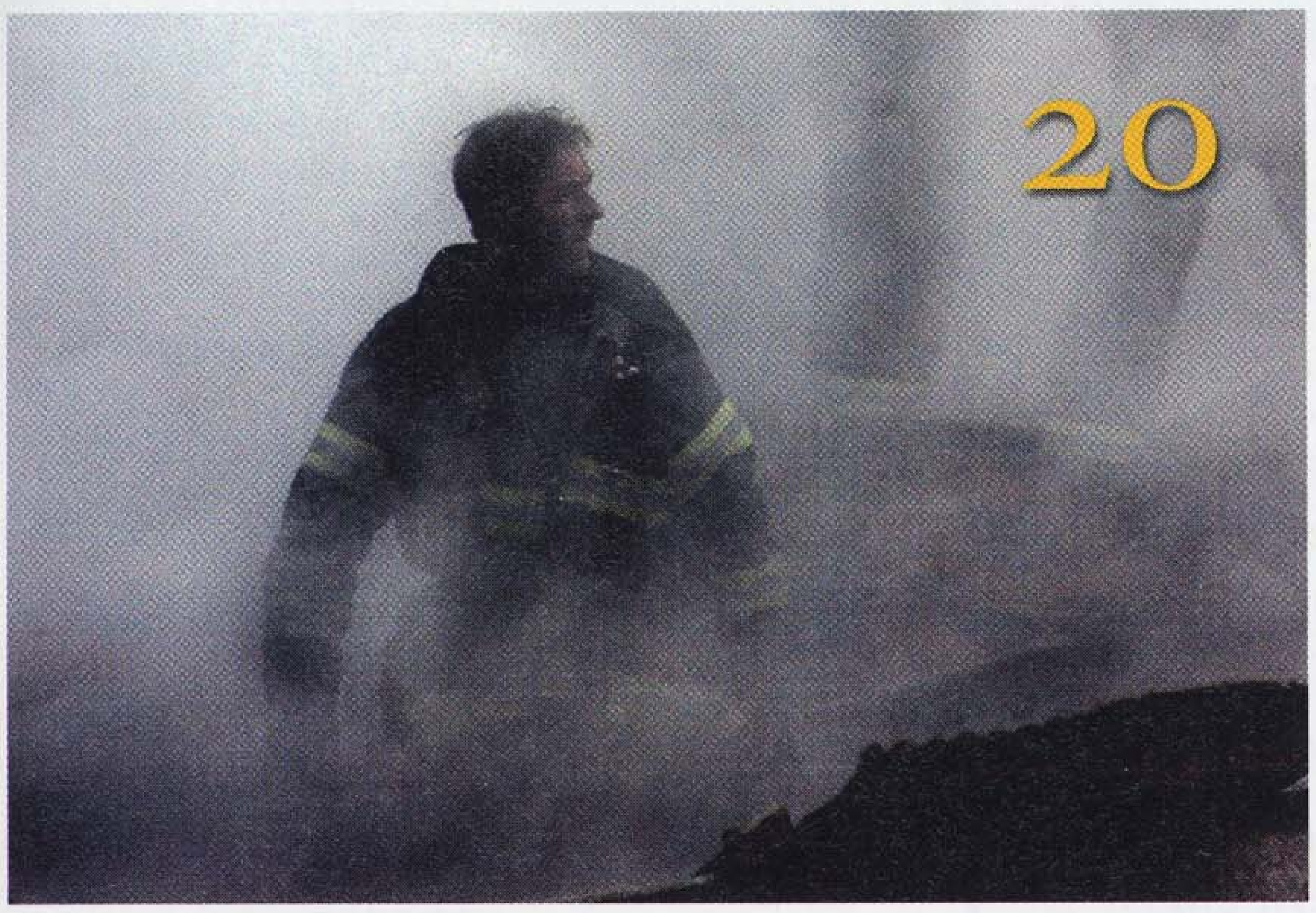

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Features

Departments

40

Green Living

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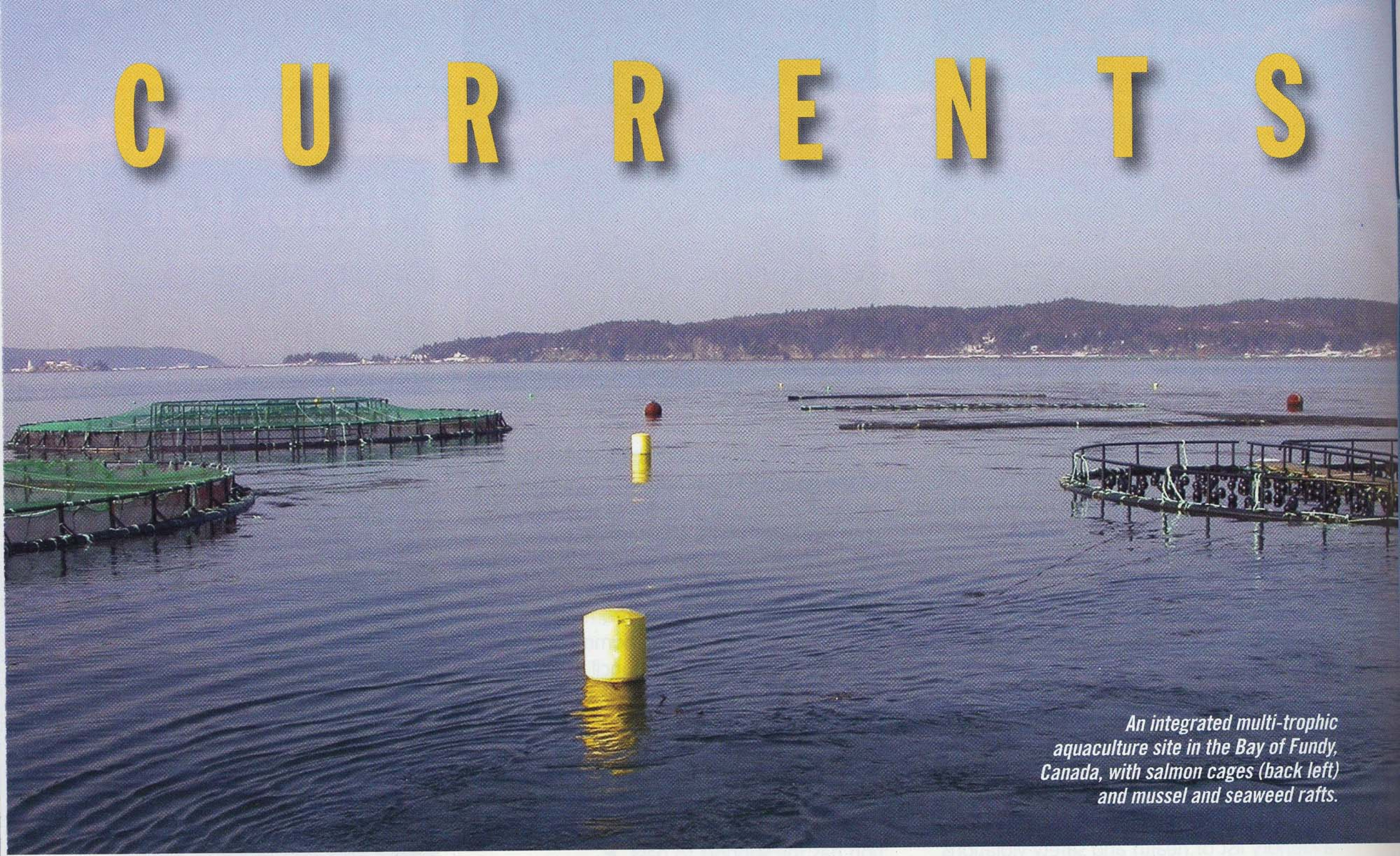

An integrated multi-trophic aquaculture site in the Bay of Fundy, Canada, with salmon cages (back left) and mussel and seaweed rafts.

© THIERRY CHOPIN

The Seaweed and Shellfish Solution

Using Nature's Filters to Help Curb Pollution and Fish Farm Waste

BY RENEE CHO

When runoff from fertilized lawns, agricultural fields and sewage treatment plants reaches our rivers and coasts, it causes a water pollution problem known as eutrophication. In other words, unhealthy levels of nitrogen and phosphorus. These excess nutrients stimulate algal blooms. And these blooms, in turn, starve the water of oxygen, creating a dead zone where no creatures can survive. Some blooms are even toxic to humans.

One way to "bioextract" these nutrients that shows promise involves the use of shellish and seaweeds. Charles Yarish, Ph.D., professor of ecology and evolutionary biology at the University of Connecticut, is one of the researchers involved in a $2.4 million project to help clean up the Bronx River in New York City using mussels and seaweeds, funded by the Long Island Sound Futures Fund (longislandsoundstudy.net).

Nitrogen and phosphorus exist in organic (plant and animal residue) and inorganic (mineralized) forms. As shellfish filter water, they remove organic nutrients, while seaweeds take up inorganic nutrients. This project will use the native red seaweed *Gracilaria* in summer and fall, and kelp, which thrives in winter. Because no large source of young seaweeds exists, Yarish and his colleagues are initially cultivating a seedstock of the seaweeds in their labs.

This summer and fall, a 20' by 20' raft of ribbed mussels and four seaweed lines will be placed at the mouth of the Bronx River in coordination with the National Oceanic and Atmospheric Administration (NOAA). Yarish estimates that the mussels will filter organic nutrients from up to 5.07 million liters of water daily;

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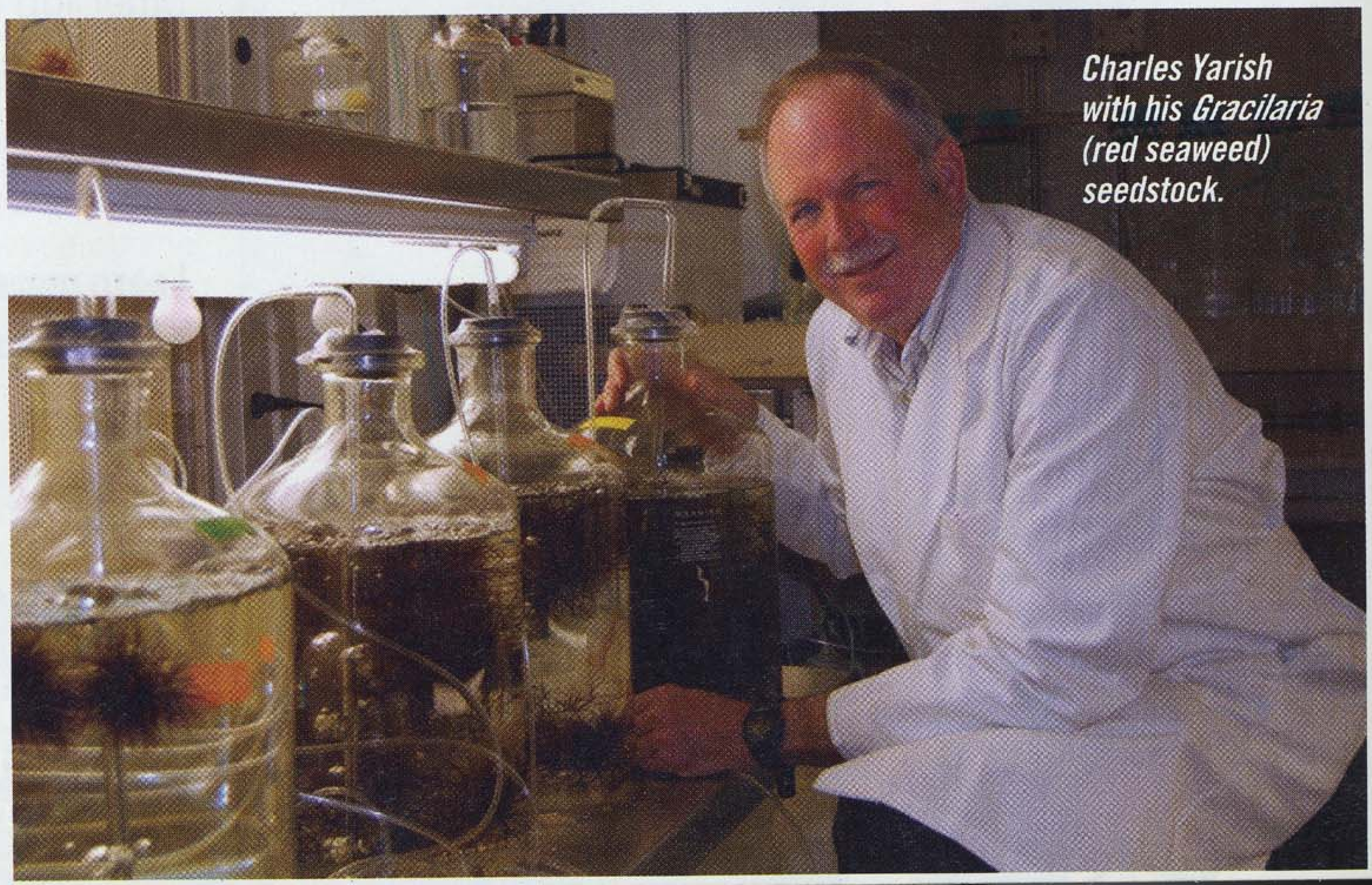

Charles Yarish with his *Gracilaria* (red seaweed) seedstock.

"[Blooms] starve the water of oxygen, creating a dead zone where no creatures can survive."

with seaweeds filtering the inorganic nutrients. Research suggests that the two species might also increase oxygen, improving water quality and fish habitats. Once the mussels and seaweeds have done their work they will be removed periodically to extract excess nutrients, and undergo extensive testing. "We want to find out what's being taken up by the shellfish and the seaweed, and what impact the system has on the local environment," says Yarish. If successful, the strategy could be used in other nutrient hot spots around the U.S.

Yarish will also be conducting a parallel *Gracilaria*-only project at an open water research site on Long Island Sound belonging to the Bridgeport Regional Aquaculture Science & Technology Education Center in Connecticut, a high school for marine science and aquaculture technology.

Both projects must yield environmental and economic benefits to be viable. Because the Bronx River site is near a wastewater treatment plant, no edible species can be cultivated there; however the ribbed mussels and seaweeds (and the Connecticut *Gracilaria*) will be evaluated for their economic potential for use as biofuels, agar (a component of red algae used in labs), biochemicals, animal feed, and nutrient extraction. The Connecticut *Gracilaria* will also be assessed as a possible food product by some of the Bridgeport students who run a seafood market at the Aquaculture school.

Thierry Chopin at an aquaculture site in Canada.

© MANAY SAWHNEY

Combining species from different food web levels to perform ecosystem services is also the basis of integrated multi-trophic aquaculture (IMTA), an ancient practice that is being revived to make aquaculture more sustainable. Farmed aquatic organisms represent the fastest growing source of animal protein, responsible for over half of global seafood consumption. But the expanding sector of industrialized aquaculture, comprised mostly of fishmeal-fed monocultures of finfish and shrimp, fouls waterways with uneaten feed and fish waste containing nitrogen and phosphorus, resulting in pollution of the sea bottom and eutrophication.

Yarish's colleague Thierry Chopin, Ph.D., professor of marine biology at the University of New Brunswick, is working on IMTA with Cooke Aquaculture (cookeaqua.com) which produces and sells millions of pounds of salmon and trout in New Brunswick, Canada. Blue mussels placed downstream from the ▸

salmon pens consume midsize organic particles, while kelp downstream from the mussels take up inorganic nutrients. Sea urchins and sea cucumbers have been added to the mix to consume larger particles on the ocean floor, and Chopin envisions eventually adding more species to the managed ecosystem according to their ability to consume different sized particles or when they flourish.

IMTA increases aquaculture's sustainability and profitability. Recently, Loblaw, Canada's largest food retailer, began selling Cooke's IMTA salmon in Ontario and Quebec as WiseSource™Salmon. Cooke's mussels are sold for food, and its seaweeds are used in restaurants and cosmetics manufacturing. Cooke is also testing seaweeds as a partial protein substitute in salmon feed, which could potentially generate more income.

IMTA can be done in marine or fresh water, temperate or tropical regions, and in tanks. "It's a theme and has variations…like music," says Chopin. "IMTA is the theme, and the variations are the


© J. KIM AND C. YARISH

Tank-grown Gracilaria.

many regions and species." Chile, Turkey, South Africa, Israel, Norway, Ireland, Scotland and China also practice IMTA, each region selecting its species according to economic potential, habitat and cultural context.

Establishing the true value of IMTA would require calculating the economic value of nutrient removal, savings in feed that would otherwise be wasted, enhanced productivity of a healthier ecosystem, crop diversification and sustainably produced food crops. Chopin won't declare IMTA the silver bullet for aquaculture's environmental problems yet, but its prospects hold promise. E

RENEE CHO *is a freelance environmental writer in New York City and a regular contributor to The Earth Institute's* State of the Planet *blog.*