

Consider The Oyster (and Ocean Farming)

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There are cynics who see only catastrophic answers to Earth's population explosion: War and pestilence come to mind.

Then there are those who look a little deeper. Not even two feet deep, to be precise, into the placid tidal pools dotting the world's coastlines. Like homesteads nibbling at the wilderness, coastal flats represent humanity's creeping advance into the great, undomesticated Blue. It is on a coastal flat in the Pacific Northwest, along the quiet eastern edge of the Olympic Peninsula, that marine biologists from USC are pinning their hopes on the quest for bigger and faster-growing oysters.

Oysters? Oyster breeding is just one example of research projects at the USC Wrigley Institute for Environmental Studies in USC's College of Letters, Arts and Sciences, all related in some way to the pressing dietary needs of our crowded planet.

But oysters? For the masses? Is this not the same elite delicacy served iced on the half shell in fine restaurants, or proffered to cuddly couples on Valentine's Day? (Scientists, by the way, have not found any unusual stimulating substance in oysters: as with other alleged aphrodisiacs, the effects are in the mind.) Unlike humans, Mother Nature takes oysters seriously. They pack huge amounts of protein, along with an alphabet soup of vitamins, lots of omega-3 fatty acids and hefty doses of minerals: calcium, iodine, iron, potassium, copper, sodium, zinc, phosphorous, manganese and sulfur.

All in one low-calorie package. It's enough to arouse a nutritionist.

For marine biologists who wonder where humanity will find the next great meal, the oyster ranks high on the list of prospects.

“It’s not going to be krill,” deadpans Donal Manahan, director of the Wrigley Institute. Having tasted krill, he deems the small crustacean best left to a whale’s indiscriminating palate, along with smelt, phytoplankton and other floating detritus of the sea.

Oysters are not only more flavorful; they also exhibit a remarkable property known as hybrid vigor - possibly unique in the animal world - that could turn them into the Corn of the Sea.

And oysters are only the start, says Manahan. He calls for a Blue Revolution in all kinds of seafood to follow the Green one that boosted crop yields over the last century.

“We’re going to have to make future decisions as a society regarding how to provide enough food for a growing population,” he says. United Nations experts estimate that humans will number almost 9 billion by 2050. “If you look globally, the untapped potential of producing more food from the oceans is enormous,” adds Hauke Kite-Powell, a research specialist at the Woods Hole Oceanographic Institution who sat with Manahan on a National Academies committee studying the issue.

Yes, they are talking about farming the oceans: aquaculture, or mariculture - by either name, still a sliver of the world’s farming output, and a dirty word to those who like their fish wild.

But as Manahan points out, how many of us insist on eating only wild game? These days we are happy if the chicken was allowed to strut. Most people do not even like meat with a “gamey” flavor.

In a few years, says Manahan, the world catch of farmed fish will surpass the wild-caught total for the first time in history. The most recent statistics show that in 2007, aquaculture supplied 42 percent of fish consumed worldwide. In the next year or two, that should hit 50 percent.

Prices bear out the trend. Even high-end farmed species such as oysters have come down since 1997 when compared to lowly wild Arctic fish like haddock and pollock - once staples of cheap cafeteria food, and still major ingredients in fish sticks and McDonald's Filet-O-Fish® sandwiches.

Experiments performed by David Hutchins, another marine biologist in USC College, predict that ocean warming will shift the food web in the Arctic toward smaller organisms, reducing the food supply for the major commercial fish.

"It doesn't look good up there," Hutchins says. "It looks like the food chain is changing in a way that is not supporting these top predators, of which of course we're the biggest top predator. There is some question as to how much of that is due to over-fishing and how much of that is due to climate shifts; probably they're both involved."

Manahan's and fellow USC Wrigley Professor Dennis Hedgecock's interest in oysters was prompted by a curious observation: Unlike any farmed animal, oysters exhibit hybrid vigor.

Consumers do not know or care about hybrid vigor. But we would if corn and wheat did not have it, because then a box of cereal might cost \$20. (If we were still alive to buy it, after the food wars that would have erupted in the late 20th century as an exploding population ran out of food.) Hybrid vigor, along with expanded use of nitrogen fertilizer, greatly boosted crop yields during the 20th century, increasing the average yield of corn per acre across the United States sevenfold.

It works like this (though still, no one understands why): If different strains of corn are inbred - forced to cross with themselves - the offspring look predictably small and withered.

But cross two different inbred strains, and their offspring sometimes explode in size, outgrowing not just their inbred parents, but also their vigorous grandparents.

By trying thousands of different crosses, seed companies have developed healthy varieties that dwarf the corn farmed during the early part of the last century. And every year, new and slightly bigger or faster-growing varieties come to market.

The process has an obvious limit: No amount of hybridization can extract more than the soil's available energy. As crop improvements approach the land's maximum yield, the world's population continues to grow exponentially.

Maybe it's time to look beyond the land.

Hedgecock is sure that oysters have hybrid vigor. He has bred some to grow twice as fast as their wild ancestors.

In a 2007 paper in the Proceedings of the National Academy of Sciences, he and Manahan, along with scientists at biotech giant Solexa, identified 350 genes involved in oyster growth.

Yet even now, Hedgecock knows of no other lab working on hybrid vigor in oysters. He attributes this scientific incuriosity to the challenge of actually demonstrating hybrid vigor. To do so, a researcher must be able to breed hundreds of millions of baby oysters, and then find a commercial farm willing to grow them outside the lab.

Hedgecock has done both. His lab's research caught the eye of Joth Davis, head of research and development at Taylor Shellfish Farms, located on the bays and inlets of Washington's Puget Sound.

Few farms have their own R&D department. But Taylor, one of the world's largest growers of shellfish, is also one of the most progressive. At a December 2007 meeting with Hedgecock and Davis, owner Paul Taylor agreed to commit time and space for growing Hedgecock's hybrids.

Currently the operation is testing three varieties and focusing on one. "This particular hybrid cross is great," Davis says. Having watched the lab

specimens grow bigger faster, he expects the harvest, due in 2011, to fulfill its promise.

Taylor plans to sell the 5 to 8 million mature oysters that result from the project, keep 90 percent of the seed for in-house breeding, and offer the rest to other growers.

And there's better stuff to come.

"Almost any time we make an inbred line and we cross them, their offspring are better than their inbred parents ... and often they're better than wild," Hedgecock says.

Oysters even pack an attractive bonus for those worried about toxic algal blooms. Research on algae points to nutrient runoff from urban areas - mostly sewage and lawn fertilizer - as a possible cause.

It turns out oysters are especially good at recycling such nutrients, says Kite-Powell, Manahan's colleague on the National Academies mariculture committee.

"This is a natural filtration process that is reasonably well understood," he says, adding that "it's a piece of the answer; it's not by any means a silver bullet."

But in some cases, it seems that oyster farming "is actually an activity that pays for itself while performing this ecosystem service."

More controversial is the farming of so-called fin fish like salmon.

"They're like floating pig farms," Daniel Pauly of the University of British Columbia told the Los Angeles Times. "They consume a tremendous amount of highly concentrated protein pellets and they make a terrific mess."

But even that type of farming should not be dismissed out of hand, Kite-Powell says. It is true that farmed salmon require several times their weight

in animal feed over their lifetime. On paper, that makes farming salmon wasteful. If one thinks of fish as energy-storage vehicles, every transfer of energy from a plant to the fish that eats it, or from that fish to a bigger predator, entails some loss. It would be more energy efficient to go straight to the source.

But if we are going to eat salmon, the farmed variety may be on aggregate less energy intensive. As Kite-Powell points out, “The alternative to farming it is to catch the wild salmon, and wild salmon consume a lot more animal meat proportionately.”

We may find ways to grow food from the oceans “less destructive than many of the practices we employ on land,” he suggests. Some have even proposed giant floating cage systems that would drift with the currents.

Granted, the most ecologically friendly approach would be to eat only shellfish and vegetarian fish. But that would require certain adjustments in the American diet.

Carp, anyone?

The notion of farming the sea takes some getting used to. The National Academies committee that Manahan and Kite-Powell served on studied, among other things, a conflict between an oyster farm, visitors and residents in a wilderness area in Northern California’s Marin County. The committee’s final report exonerated the oyster farm from charges it harmed the environment, but acknowledged the aesthetic issues raised by ocean farming.

Similar conflicts might occur among residents of Malibu if sea pens were proposed for the waters off their beachfront homes.

Manahan is not unsympathetic. The crashing waves of the sea were the soundtrack to his childhood in Dublin, Ireland, where his family lived in a fort built on a rocky point during Napoleonic times, a lookout against French invasion. The world was less crowded then, the seas more

bountiful. Everything has changed, but at least the ocean outside his ancestral home seems the same.

How would it feel to look out of the stone casement and discover a domesticated bay? How would a nation whose poets rhapsodized about the ocean, but which lost millions to a potato famine, react to large-scale farming of the coastline? How would this nation?

But, Manahan says, “We can’t just sit here and do nothing. What’s going on now is an infinitesimal drop in the ocean of what will happen if there’s a climate shift. You think the cost of food is expensive now? Wait until rainfall patterns in the Midwest change.”

Manahan, who became director of the USC Wrigley Institute in 2008, plans to focus to a large degree on “food, energy and water.”

“And don’t think they’re not linked,” he warns.

He believes the generation growing up today will hear politicians talk about food the way they now talk about oil. “We need to grow our own” may replace slogans about drilling for oil, he says. “Because when it comes to aquatic foods, we have no policy.”

Manahan recalls a quote by Arthur C. Clarke, the great science-fiction writer, who wondered why we call this Planet Earth. The better name would be Planet Ocean, since seawater makes up 99 percent of the biosphere.

Someday, our descendants will wonder how we got by on 1 percent.

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