Could Eelgrass Be the Next Big Bio-Based Building Material?

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Anna Fiorentino

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Freelance writer

Henning Johansen used both hands to twist a pile of silver, ribbony eelgrass into a boa fit for the Little Mermaid. On this late August afternoon on Laeso, an island 12 miles off the northeast coast of Denmark, he walked his new plant rope over to a nearby mushroom-shaped hut and laid it on top, repeating the process until it began to resemble a roof.

In three years, this seagrass, which washes up in droves along Denmark's endless shoreline, will harden and form air pockets like papier-mâché to retain its structure, repel rain, and resist fire and rot. This centuries-old eelgrass thatching technique will restore and protect the historic windswept home framed with the wood of shipwrecks for another 350 years.

Thirty-six homes—the world's last topped with a traditional eelgrass roof—all sit here in the North Sea on this Danish island. They'd be straw if Johansen hadn't spoken up a decade ago—that's how time-consuming this lost art is. A single roof takes three people two months to complete. That's 90 tons of eelgrass spun into rope, wrapped around the top of each timber frame and piled on. The roofs are also why Laeso made the short list for UNESCO World Heritage Site status last fall.

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The former king of Denmark Frederik IX would've been proud—in 1962, he advised the small community of Laeso to preserve these roofs, Johansen recalls. "Eelgrass was once used all over [the world] to build houses, but the only women in the world who did it lived on Laeso," he says.

This isn't your average building material. Eelgrass has superpowers. The endangered and seriously declining saltwater plant is capable of removing carbon dioxide from the environment up to 35 times faster than rainforests (sequestering up to ten times as much as an equivalent area of forest), according to a 2023 Environmental Protection Agency report. This "blue carbon" storage is crucial to maintaining healthy marine ecosystems and reducing acidification to keep the climate stable. Producing seed by photosynthesis on the sunlit shallow seafloor, the saltwater blades absorb marine minerals, filtering water and removing nitrogen, and provide a critical habitat and nursery for sea creatures, supplying food and stabilizing sediment to prevent erosion.

And, as it turns out, when naturally uprooted by wind, dried and used as a building material outside of the water, eelgrass continues to store carbon pollution and prevents it from entering the environment. That sure beats cement, steel and aluminum now used for building —by far the largest emitter of greenhouse gases, accounting for 37 percent of global emissions, according to the United Nations.

The roofs are why Laeso made the short list for UNESCO World Heritage Site status last fall. Fotograf Kjetil Løite

Of course, Johansen never touches the threatened eelgrass growing on the ocean floor—even in Denmark where eelgrass is more abundant than other regions. Danes are only allowed to harvest from the piles of salty strands that break away in storms and wash up on the coastline—and would otherwise be cleared off the beach and tossed out.

But before anyone can think about growing eelgrass from seed (separate from the wild population) for bio-based building materials, scientists must first restore the staggering loss of eelgrass from pollution, human activity and climate change (uprooted by invasive green crabs), after mold wiped out 90 percent of eelgrass on the East Coast of the United States and Europe in the 1930s. Seagrass, though still relatively abundant in sections of North America's West Coast in places like Alaska, Mexico and Baja California, has experienced a global decline of 29 percent since the 1700s that, after unimaginabledevastation in recent years, without intervention, could add up to a total loss of 97 percent by the end of the century.

To prevent environmental degradation and protect carbon storage, restoration projects are cropping up in tideland nurseries around the world to cultivate, replant and repopulate eelgrass in places like the Chesapeake Bay and the Gulf of Maine, where the population has decreased by 60 percent since 2005, according to a new report.

Starting from seed

Despite the hard truth that this massive eelgrass decline has harmed fish populations and biomass, a question remains: If the population one day experienced a big comeback, could eelgrass also eventually be grown separately from seed in tideland nurseries and used for building once again? Some say it's possible.

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"At the moment, the seagrass community is really looking at how we can create nurseries for seagrass to aid in the restoration of degraded meadows rather than for supplying construction or other activities," says Richard Lilley, founding director of a widespread restoration effort called Project Seagrass. "There is a rationale for commercializing seagrass production, but ecologically sustainable production needs to be at the heart of that business model, and the numbers for doing that simply don't add up at the moment."

Farming eelgrass is complicated and still in its infancy. Like eelgrass, oysters are a marine species used historically as a building material; they similarly filter the oceans and provide wildlife refuge, and oysters are now being farmed separately to help seed and restore devastated wild populations. If methods for growing more eelgrass from seed are successfully developed for bio-based building, it's possible that from it even more eelgrass could be propagated into the wild.

“There are potentially some cool parallels between how oyster farming and eating has helped oyster reef habitat restoration and how commercial seagrass farming could eventually aid seagrass restoration,” says Bowdoin Lusk, a Virginia-based coastal scientist for the Nature Conservancy.

For now, since eelgrass wrack that washes ashore can pile up into amounts relevant for building material, many agree it’s fine to use in moderation, but it’s “important to acknowledge the ecological role of eelgrass for beach communities, salt meadows and for natural shore protection,” explains Dorte Krause-Jensen, a marine ecologist at Denmark’s Aarhus University. “So the wrack should also not be overly exploited. However, where the wrack is in any way being removed to clear the beaches, it might as well be used.”

Skirting extinction

Volunteers and researchers prepare eelgrass shoots to be transplanted into the water to help restore its damaged ecosystem on the shores of Vejle Fjord. James Brooks/AFP via Getty Images

The centuries-old use of eelgrass for building materials was set back into motion in 2010 in Laeso after Johansen, a thatcher and farmer, moved from rural mainland Denmark’s Jutland peninsula back to the heather moorlands and saltmarshes of the tiny remote island home he grew up on. Shortly after arriving, he was approached about replacing the roofs of these old cottages—using straw.

We all know how that went for the three little pigs.

“The idea of replacing a 350-year-old roof with one that can last for 40 to 50 years makes one start to reflect,” says Johansen. “But no one knew how to renovate these roofs anymore.” So instead of using straw, Johansen decided to study the historic restoration practices of his ancestors dating back to the 1600s.

When dried, this lightweight and easy-to-pack material was once collected from shores all over the world. Early on, Native Americans gathered it for smoking meat—they even consumed its nutrient-rich leaves and stems. Eelgrass was later used for packing cargo (even on the *Titanic*), insulating New England homes, mitigating sound in Radio City Music Hall and Rockefeller Center, and in upholstery and mattresses (its mineral properties kept out animals).

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Today, thanks to Johansen, the world’s last master eelgrass thatcher, this lost art has skirted cultural extinction, after he raised funds to replace, so far, 25 of the island’s 36 eelgrass roofs, earning an award from the European Commission. “In the old days, you could build a roof in one day with help from up to 100 of your fellow islanders—women and children while the men were sailing,” says Johansen, adding he’ll wait for more funding to restore the remaining vacant eelgrass-topped farmhouses.

Betting on revival, Johansen passed down eelgrass roof thatching methods to his stepdaughter, Kirsten Lynge, a Danish engineer focused on sustainable design who, a few years ago, went on to invent and sell eelgrass acoustic panels for walls, design solutions and other projects as co-founder of Copenhagen's Sould. Like her stepdad, she only collects piles of eelgrass wrack that would otherwise be cleared off of Denmark's beaches.

"It's good to remove biomass that could go back into the ocean. It can cause algae blooms and, when floating on the top, also blocks the light from reaching the bottom of the sea. If the [wet] eelgrass is left to decompose on the beach, the carbon reacts with oxygen and becomes CO2," she says, adding that her eelgrass products have a negative carbon dioxide footprint in the production phase. "Of course, we are not disturbing the living meadows out there."

Henning Johansen has raised funds to replace, so far, 25 of the island's 36 eelgrass roofs. Destination NORD

Finding new approaches

Already, Lynge has designed eelgrass insulation products for a rooftop garden at an Ikea in Copenhagen and other commercial and residential projects around the world, and is now entering the U.S. market through a new partnership with a leading upholstery company, Spinneybeck. She says she just kept returning to the idea of working with eelgrass for its potential to make a difference and "create a carbon-storing building material that could be understood by a modern construction sector." And she wasn't the only one.

It’s no coincidence that Denmark is leading the planet in sustainable building practices, this year with a new law that tightens carbon dioxide emission limits and requires the use of recycled materials in new buildings. Other Danish companies producing bio-based products from seagrass and seaweed (an algae) include Normann Copenhagen, designer of eelgrass chairs, and Getama, which makes eelgrass mattresses. They’re even embracing the use of mushrooms, which have root-like strong fibers that when dried become water-, mold- and fire-resistant.

Meanwhile, the renaissance is shaping up, in the wake of the seaweed products, in other spots around the world, and for other reasons. Chef Ángel León has established a small-yield eelgrass seed cultivation at his Michelin-starred restaurant in the south of Spain, Aponiente. After conducting his own research, he found that eelgrass, which some call sea rice, is gluten-free, is high in omega fatty acids and contains more protein than rice—and he wanted to help the climate crisis, so he put it on the menu. The nutritional value also never went unnoticed by the Indigenous Comcáac community of northern Mexico, who hold an annual eelgrass festival to celebrate reviving their ancient traditions of feeding their people with eelgrass grain, which they call *xnois*. The goal is preserving their territory’s eelgrass meadows, after their ancestors spread the seed along the channel in the Gulf of California, where the saltwater strands are still in abundance.

“It’s about finding new approaches,” says Lynge. “We could really be a part of the solution to the troubles that we have gotten ourselves into.”

Anna Fiorentino | READ MORE

Anna Fiorentino is a Maine-based journalist focused on science, outdoors, adventure and travel. Her writing has appeared in *National Geographic*, *AFAR*, *Outside*, BBC, *Boston Globe*, and other outlets.

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