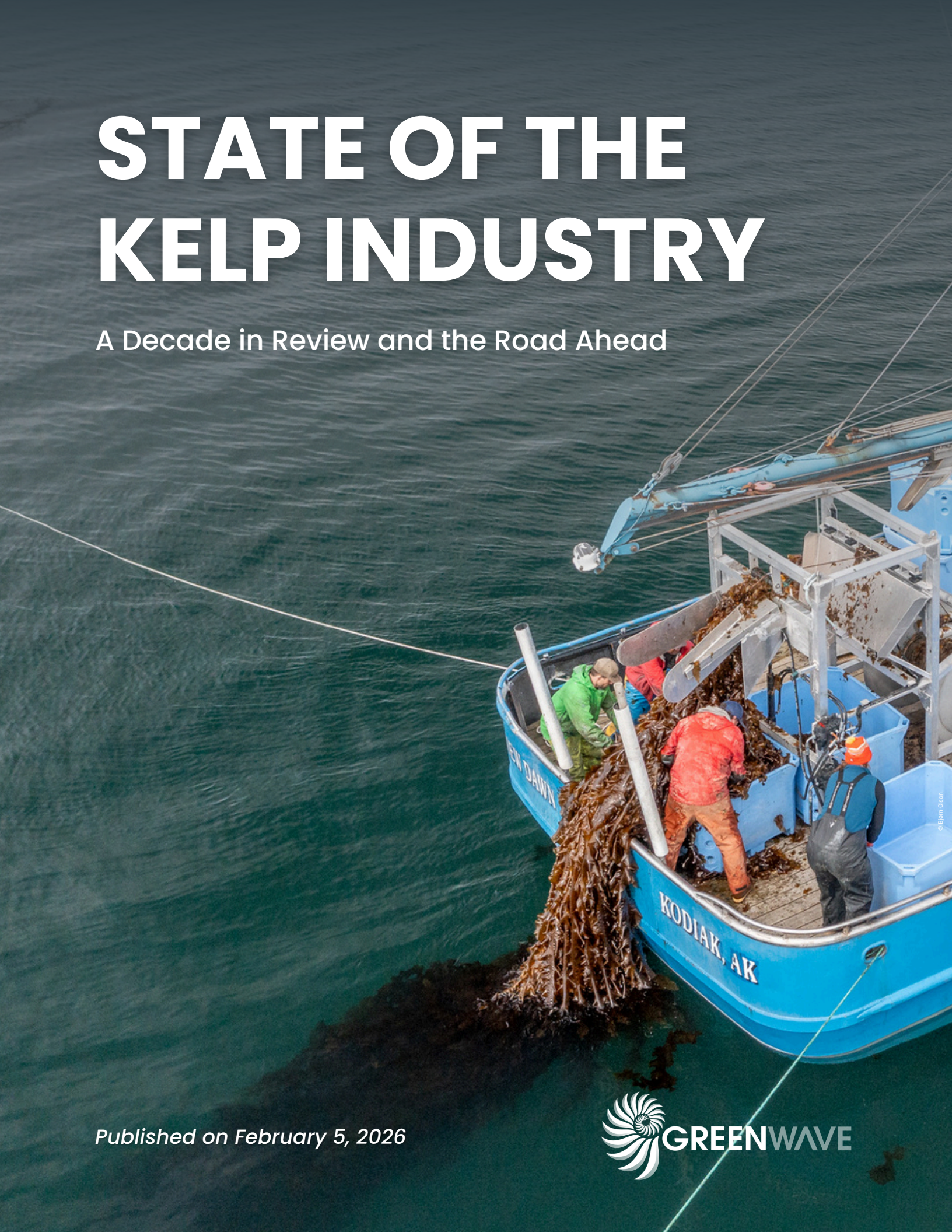
STATE OF THE KELP INDUSTRY

A Decade in Review and the Road Ahead



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GREENWAVE

EXECUTIVE SUMMARY

The commercial North American kelp industry has come a long way in the past decade, growing from scattered pilot projects into regional value chains where seed supply, farm operations, and manufacturing are now poised to meet growing demand. This report outlines recent developments and offers recommendations to overcome the remaining hurdles on the path to the industry's long-term sustainability.

Together, we've made considerable headway. Permits were issued, nurseries professionalized, and farmers built infrastructure, gained experience, and started to collaborate. Sales diversified, and manufacturers honed in on farmed kelp's competitive advantage. While the industry is still nascent, we're at an inflection point where the pieces are in place to start producing at a commodity-level scale.

Today, the U.S. and Canada have 248 permitted kelp farms covering 6,256 acres (2,535 hectares)—enough to produce tens of millions of pounds of kelp. In 2024, kelp farmers outplanted over 1.65 million feet (503 kilometers) of seedstring, while top-producing nurseries (16 out of the 56 permitted) reported capacity to grow more than double that amount. Six scaled facilities across coasts now process kelp biostimulants, at least 20 companies currently source from North American kelp farms, while another 20 report interest and capacity in sourcing as the value chain solidifies. Breakthroughs in seed production, farmer-focused subsidies, and a growing network of producer cooperatives are strengthening the foundation for scaled production.

But we've also made mistakes along the way. A decade ago, climate impact was the driving motivation for many early movers entering the kelp space. Both government and private investors poured millions into speculative biofuels, blue carbon, and offshore automation projects. Meanwhile, specialty food startups pitched kelp to climate-conscious consumers but were unable to sell enough boutique products to scale production.

By 2025, that tide had turned. Many companies that attracted early investment went bankrupt—not because kelp markets were absent, but because the focus was misaligned. Rather than chasing climate-tech moonshots or niche foods, the industry must orient towards actionable markets with clear demand where kelp can directly solve real problems downstream customers face.

This shift is already reshaping the future of kelp. Businesses are zeroing in on the sweet spot where profitability and performance stand on equal footing with sustainability. As of 2025, three market segments account for a growing share of contracted volume: agriculture, biomaterials, and functional ingredients for food and personal care. This demand is driven by real problems faced by real industries: detoxifying ingredients in food and cosmetics, helping land-based farmers adapt to extreme weather and rising fertilizer prices, and reshoring supply chains with domestically produced raw materials.

Now well beyond the hype, kelp is hitting its stride: moving towards productivity by relieving specific pain points within various market sectors, and generating impact by embedding itself in the value chains that underpin our daily lives.

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INTRODUCTION

Over the past decade, commercial kelp farming in North America has transformed from a handful of intrepid seaweed farmers and companies to a budding regenerative industry.[1,2,3] Collectively, we've tinkered, toiled, and innovated, giving shape to a new blue economy.

The industry's early development has not been without setbacks. Riding the momentum of the broader climate-mitigation narrative, more than $100 million in public and private capital was funneled into high-concept "moonshots." This influx of speculative capital pulled the nascent industry away from its roots in farmer ownership, regional economic development, and ecological stewardship, and toward a low-value, technology-driven model of seaweed production.

This speculative turn took several forms. The Department of Energy invested $22 million in seaweed biofuels and offshore automation;[4] Kelp Blue raised tens of millions in venture capital, positioning Alaska as a North American testbed for planetary-scale kelp ambitions;[5,6] and Running Tide sold $30 million in carbon-removal credits to Shopify, Microsoft, and Stripe based on plans to sink millions of biodegradable "seaweed pucks" to the seafloor.[7]

While these moonshots yielded some technical advances—several of which we highlight in this report—they ultimately failed to deliver durable value or the foundations for a viable industry.[8] The drive towards speculative markets diverted millions of dollars away from building infrastructure, processing capacity, and actionable business models—the pillars required for commercial scale. It also distorted industry culture, encouraging hyper-competition, secrecy, and aggressive IP protection at a time when collaboration was essential to address shared early-stage industry bottlenecks.

Meanwhile, a more modest but durable trajectory was taking shape from the ground up: Farmers, scientists, processors, buyers, and non-profits incrementally built the early-stage scaffolding of a domestic kelp industry. This created a foundation that moonshot programs could not deliver.

But this journey, too, has had its setbacks. Kelp farmers grappled with seed quality issues and processing and permitting bottlenecks. They also contended with forces out of their control—warming waters,[9] powerful winter storms,[10] tariffs, and staff cuts at U.S. federal agencies.[11] On the buyer side, first-movers like Atlantic Sea Farms, 12 Tides, and AKUA built their businesses around specialty food products, marketing kelp to consumers as a "climate hero ingredient." While sustainability claims attracted investments, sales did not follow. These three companies have since closed or contracted, and others are sitting on stranded inventory. Boutique food products played an important role in advancing early-stage local supply chains, but they were not positioned to carry the industry to scale.

Terms like “rollercoaster” and “hype cycle” have surfaced repeatedly in discussions about the North American kelp industry in recent years.[12,13] And yet, heading into 2026, we don’t see a floundering industry. We see a maturing sector, moving past the hype, towards productivity, with a renewed sense of purpose, strategy, and direction. A look back at some recent achievements underlines just how far we’ve come.

1. **Nursery and farm expansion:** Kelp nurseries grew from just a handful in 2015 to more than 50 facilities in 2025 across the U.S. and Canada. 248 kelp farming licenses cover approximately 6,256 acres (2,535 hectares).[14]
2. **Gametophyte breakthroughs:** New nursery protocols and modular containerized systems have dramatically increased seed viability, extended growing seasons, and improved yields, while cutting labor costs in half and doubling output.[15,16,17,18]
3. **Cooperative formation:** Alaska's first producer-led kelp cooperative, Kodiak Ocean Growers, launched in March 2025.[19]
4. **Right-sized finance:** GreenWave’s Kelp Climate Fund—which has distributed over $1.6 million to more than 70 farmers since 2021—along with debt financing from community development financial institutions (CDFIs) well-versed in kelp farming, provides farmers with the financial stability needed to purchase essential infrastructure and optimize production.[20,21,22,23]
5. **Yield achievements:** Southern New England achieved sample weights of up to 11.6–29.5 pounds per foot (17.3–43.9 kilograms per meter) in 2024,[24] demonstrating the industry's production potential when optimal conditions are met.
6. **Infrastructure innovation:** Semi-automated harvest equipment like the Harvest Buddy,[25] with a capacity of 6,000 pounds per hour (2,722 kilogram per hour), has improved harvesting efficiency. Much-needed processing capacity has been added, including a new 30,000-pound-per-day (13,608-kilogram-per-day) dehydrator in Maine[26] and a 3,000-pound-per-hour (1,361-kilogram-per-hour) shredder in Connecticut.[27]
7. **Data-driven knowledge growth:** Implementation of the *My Kelp* app enabled systematic data collection from 70 farms,[28] with early data supporting certification audits, loan applications, and improved yield forecasting.[29]
8. **Market diversification:** The industry has moved away from highly speculative sectors like biofuel and blue carbon and is diversifying beyond food into biostimulants, cosmetics, functional ingredients, and biomaterials.
9. **Follow-on investment:** Macro Oceans, Cascadia Seaweed, and Ocean Rainforest raised more than $17 million between 2023 and 2025, indicating continued investor confidence in a variety of end markets.[30,31,32]
10. **Supply chain coordination:** Forward contracts established for the 2026 season represent increased coordination between farmers and buyers. GreenWave’s value chain coordination program and app, *Seaweed Source*, is connecting supply with demand, with 39 buyers reporting purchasing potential approaching 5.5 million pounds (2,495 tonnes) wet weight across diverse market segments.[33]

Based on these findings, GreenWave estimates that the U.S. and Canada now have the capacity to produce over 10 million pounds (4,536 tonnes) of kelp per year if current operations are fully optimized and mobilized. The fact that our industry can now meet demand at scale is one of the major success stories of the past decade. The questions now are sharper: What level of growth is truly right-sized? Where is real product-market fit emerging? How do we scale shared regional processing infrastructure? And what must happen to keep farmers in business as supply chains mature? The industry is at a critical inflection point, with real opportunities for alignment and scale now coming into view. The choices made in the next few years will determine whether this production capacity translates into a durable industry or remains fragmented and misaligned.

This report is intended as a resource for farmers, seed producers, buyers, support organizations, policymakers, and investors to help focus resources where they can have the greatest impact. It is organized around three topics: **Seed Production, Farm Production,** and **Market Landscape**. Within each topic, we delve into where we are now, important gains made, challenges faced, and a recommended path forward. We focus specifically on the last decade of commercial activity in the U.S. and Canada and on the brown kelps (order Laminariales), the only group of species currently proven to scale in northern temperate waters. While we acknowledge the decades of scientific work that laid the foundation for today's industry,[34,35,36] this report centers on the commercial developments and actors shaping the sector's future.

We are entering an exciting phase of growth, as new models, partnerships, and pathways to scale begin to take shape in this rapidly evolving industry. We recognize that some developments may not yet be captured in this report and that others may disagree with aspects of our analysis. Our goal is to offer a clear, data-driven baseline that partners can refine, challenge, and build upon. **By surfacing these findings and encouraging open, sector-wide dialogue, we hope to accelerate learning and support faster, more durable progress—together.**

DATA SOURCES

GreenWave is uniquely positioned to offer insights into the state of the kelp farming industry in the U.S. and Canada. Our online programming and Regenerative Ocean Farming Hub (hub.greenwave.org) connects a global network of over 8,500 ocean farmers, seed producers, companies, researchers, and enthusiasts. Our high-touch programming—focused on addressing industry bottlenecks in the U.S. and Canada—is rooted in our experience as ocean farmers. We work alongside practitioners to adapt and scale regenerative ocean farming and the kelp value chain through our training and support, climate subsidy, infrastructure, and market development programs. Our two apps —*My Kelp* and *Seaweed Source*—support on-farm data collection and kelp value chain coordination, respectively. Our programming and tools give us an unmatched perspective on the state and trajectory of the kelp industry in North America.

The kelp industry is evolving and data is constantly in flux. To provide a comprehensive picture of the current state of the kelp farming industry in the U.S. and Canada, *The State of the Kelp Industry: A Decade in Review and the Road Ahead* draws on multiple data sources collected through December 2025. We compiled data from GreenWave digital tools, targeted surveys, publicly available datasets, and expert interviews.

- **GreenWave apps:** Combined, *My Kelp* and *Seaweed Source* users represent 159 businesses along the kelp value chain, including 107 kelp farmers, 17 seed producers, and 40 companies with capacity to purchase and/or process kelp. Many businesses participate in several value chain activities. We've drawn from user-reported data in both apps submitted between October 2023 and August 2025, including over 3,800 outplanting, growth, and harvest measurements logged in *My Kelp*, to illuminate trends and identify bottlenecks.

- **Targeted surveys:** At the end of each growing season since 2023, GreenWave has surveyed kelp farmers who use our apps and programming to assess cultivation challenges, farm-gate sales, and forecast future production. A total of 85 unique respondents have participated in the surveys over the past three years, with an average of 50 respondents per year.

- **Publicly available datasets:** Between January and August 2025, GreenWave reviewed state, provincial, and federal databases to estimate the number of kelp seed nurseries, kelp farms, and total area (acres or hectares) approved for kelp farming.

- **Expert interviews:** Database and app findings were verified through correspondence and semi-structured interviews with over 40 key stakeholders, including agency officials, seed producers, farmers, kelp buyers and processors, and representatives of industry groups.

Data were triangulated across sources where possible to validate findings. To maintain privacy and provide meaningful insights, data is anonymized and aggregated by state, province, and/or region. For the purposes of this report, regions are classified as follows:

ATLANTIC COAST

ATLANTIC CANADA	NEW BRUNSWICK, NEWFOUNDLAND AND LABRADOR, NOVA SCOTIA, PRINCE EDWARD ISLAND, AND QUEBEC
GULF OF MAINE	MAINE, MASSACHUSETTS (NORTH OF CAPE COD), AND NEW HAMPSHIRE
SOUTHERN NEW ENGLAND	CONNECTICUT, MASSACHUSETTS (SOUTH OF CAPE COD), NEW YORK, AND RHODE ISLAND

PACIFIC COAST

ALASKA	-
BRITISH COLUMBIA	-
U.S. WEST COAST	CALIFORNIA, OREGON, AND WASHINGTON

In cases where there are fewer than three datapoints (e.g., nurseries, farms, or businesses reporting in *My Kelp* or *Seaweed Source*) in a region or market segment, no data is presented for that state, province, region, or market segment. Personal and company-specific information reported through GreenWave's apps remains confidential. All monetary values reported in this document are expressed in U.S. dollars (USD) unless otherwise noted.

1 SEED PRODUCTION

FROM FRAGILE BOTTLENECK TO SCALABLE SYSTEM

A decade of industry expansion revealed the limits of wild sorus collection and ad-hoc nursery models. Controlled propagation, standardization, and regional collaboration now offer a clear path to reliable, high-quality seed at scale.

SEED PRODUCTION:
BY THE NUMBERS

56+

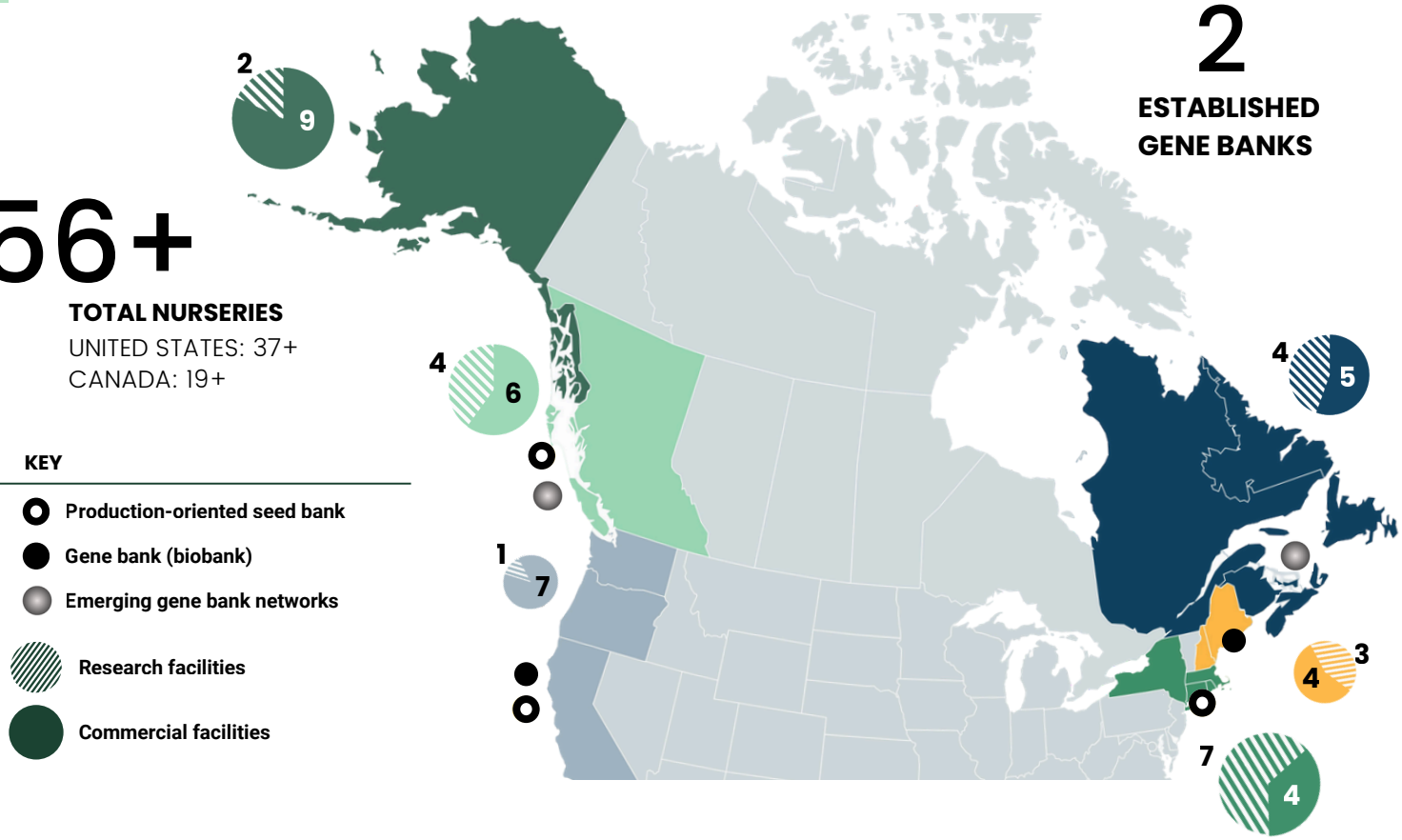
TOTAL NURSERIES

UNITED STATES: 37+

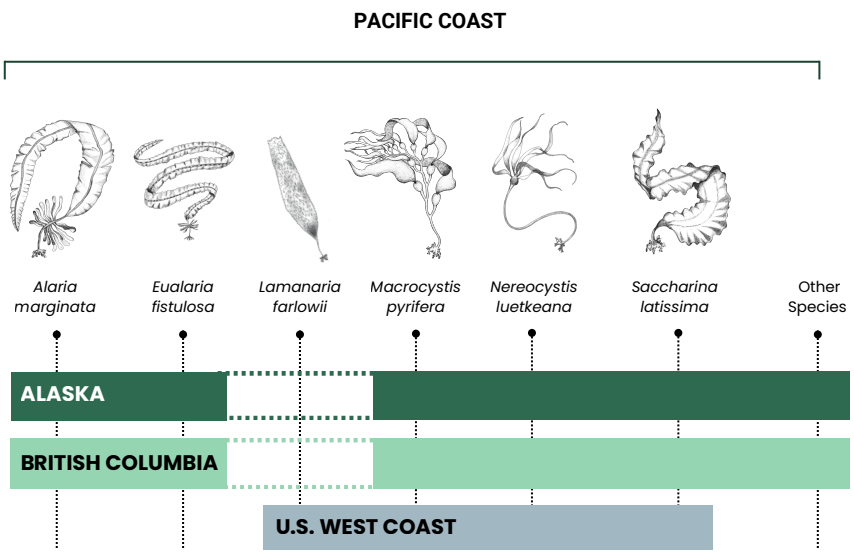
CANADA: 19+

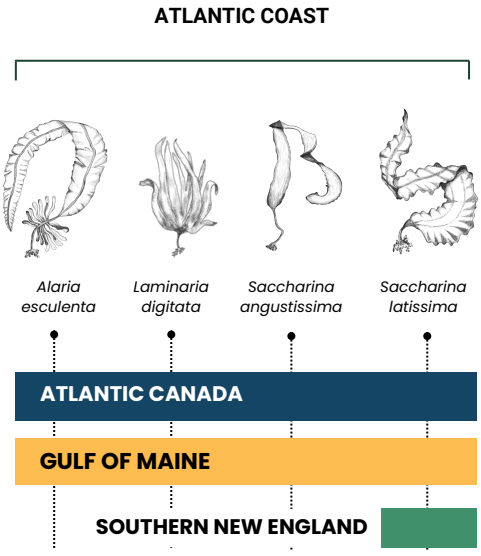
2

ESTABLISHED GENE BANKS



10+ SPECIES PERMITTED ACROSS COASTS





SEED COST RANGE USD $0.30–$2.00/ft

PRODUCTION CAPACITY (TOP 16 NURSERIES) 2.1–4.4M ft

SEED PRODUCTION: HOW WE GOT HERE

Reliable access to affordable, high-quality seed is essential to a stable kelp supply chain. Seed quality—delivered at the optimal time in the season—remains the most important lever to increase yields and, in turn, strengthen farmer profitability.

Over the past decade, kelp nurseries in the U.S. and Canada have grown from just a handful in 2015 to more than 56 as of August 2025. Yet fewer than 20 facilities still produce most of the seed for both coasts, and access, price, and quality vary widely across regions.

Three factors explain this variability:

1. **Academic methods vs. commercial demands:** Foundational nursery models, developed in academic settings, weren't designed for commercial scale.

2. **Lack of standardization:** No two kelp nurseries are alike, making it difficult to efficiently address production challenges.

3. **Dependence on annual wild sorus collection:** Yields depend on the timely collection of reproductive tissue (sorus) from wild kelp beds at the start of each season.

Below is a closer look at how each factor shapes today's seed supply challenges:

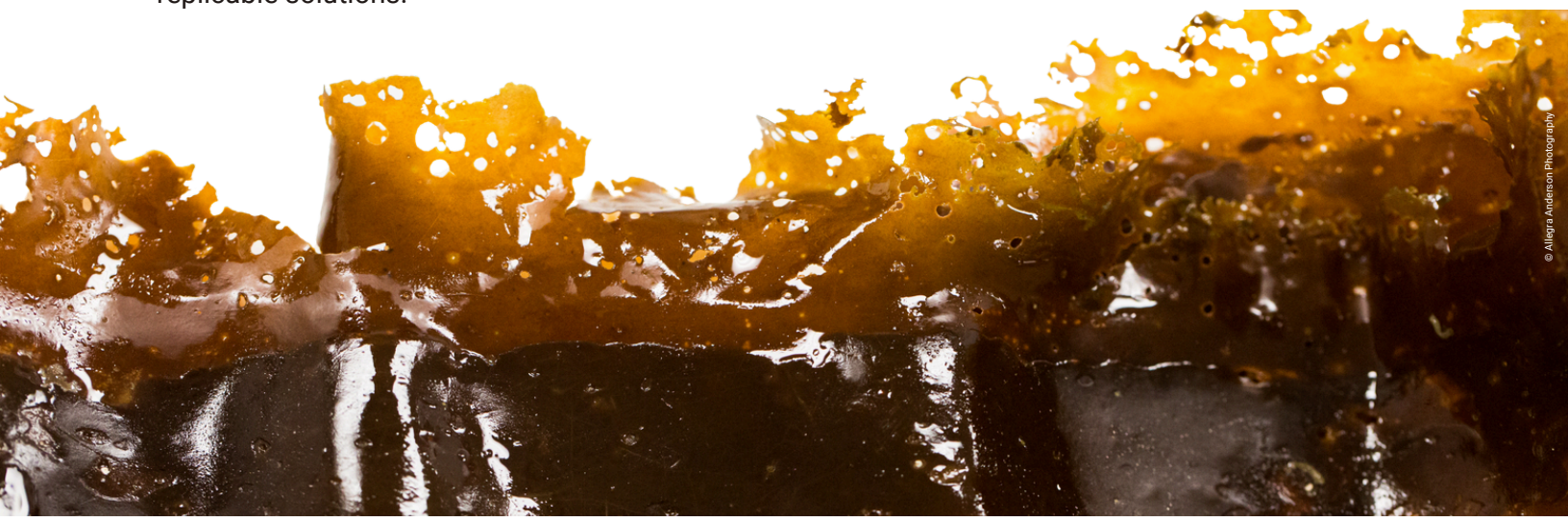
1. Academic methods, commercial demands
Foundational nurseries and seed production methods developed in university settings were invaluable in helping the industry take root, but were not optimized for commercial production.[37,38,39] Beta nurseries combined off-the-shelf accessible parts (such as water chillers and aquaria from local pet stores), now-obsolete equipment (T12 fluorescent lights), costly nutrient inputs, and labor-intensive maintenance methods. These systems produced seedstring by rearing kelp meiospores into sporophytes on seeded twine. These nurseries helped the industry find its footing, but were also energy- and labor-intensive and costly to operate.

As demand surged, systems faltered. Common challenges included bouts of biological contamination that wiped out entire production runs of seed, as well as inconsistent spore densities that left bare patches on seed spools.[40] As production scaled, the impacts were amplified. Maintenance and labor costs increased, and seed quality declined.

Spool quality directly affects seed price and availability, not because nurseries charge a premium for better seed, but because producing seed spools is costly and space-limited during time-sensitive production cycles. Nurseries often produce 20–30% more seed spools than are ordered to account for production failures. If low-quality spools occupy space or make their way to farms, they depress yields, heighten farmer risk, and increase costs across the system.[41]

2. Lack of standardization
Open-access nursery models demystified and de-risked seed production, enabling everyone from new kelp farmers to established shellfish hatcheries to launch commercial kelp seed cultivation.

Each nursery adapted the model to its own budget, operational constraints, and available resources. Permitted nurseries now range in size and setup, from a couple of aquaria on a countertop to robust commercial facilities producing seed for dozens of farms. Adaptability remains critical, but the lack of standardization means every facility has unique infrastructure, staffing, and standard operating procedures (SOPs), making it difficult to troubleshoot common challenges or develop lasting, replicable solutions.



3. Dependence on annual wild sorus collection

Few agricultural systems are so tightly bound to wild seed cycles as North American kelp cultivation. In most regions, farmers or nursery operators collect sori from wild kelps within their region at the beginning of each farming season and use meiospore release methods to produce seedstring.

This annual spore-release method is inherently risky: It encourages the proliferation and growth of microscopic kelp spores while attempting to suppress the growth of competing organisms, often leading to contamination. Nurseries using these methods face three compounding vulnerabilities: the timing of sorus formation in the wild, the health and fecundity of the spores it releases in the nursery, and the effectiveness of contamination controls.

Climate-induced stressors make wild seed dependence even riskier. Each summer, ocean temperatures rise higher and stay warmer into the fall, delaying reproductive tissue formation—and therefore the start of the farming season—by weeks or even months.[42,43]

The result: unreliable production cycles and uncertainties that discourage downstream market investment.

While regulatory complexity also contributes to production challenges, seed quality remains the dominant factor shaping supply chain stability.

Improving seed quality—and delivering high-quality seed to farmers at the right time of the season—will dramatically increase production efficiency, reduce costs, and improve outcomes for farmers and their downstream customers.

SEED QUALITY CHALLENGES ON THE PACIFIC COAST

At the beginning of each farming season, farmers and nurseries in Alaska, British Columbia, and Washington are required to collect sorus tissue from 50 different individuals per species they cultivate, within a 50 kilometer radius of their farm site. Many farmers cultivate two or more species on their farms following the 50:50 rule. In this scenario, a farmer cultivating two species will collect 100 pieces of sorus tissue or more, annually, regardless of the quantity of seed or seed spools needed for their farm, and then pass it on to their nursery operator for seed production. Kelp nurseries supplying farms across a broad geographic region may need separate sorus tissue for each farm site. The quantity of sorus nurseries must handle and process limits the number of farms they can serve.

Increased demand for kelp seed created a pressure test for nurseries operating under the 50:50 rule. Many nurseries experienced issues with insufficient water storage and treatment systems, outdated SOPs, and understaffing, which lead to contamination issues and low-quality spools. When nurseries struggle to fulfill orders, low-quality spools are passed along to farmers. Farmers then plant them despite concerns, achieve low yields, fail to meet forward contracts, and respond by over-ordering seed the following season. This reinforces a negative feedback loop that limits scalability, inflates operational costs, and blocks entry for new farmers.

SEED PRODUCTION: GAINS MADE

Infrastructure, though faulty, is fixable. Skilled operators are already in place, and production methods can be refined to reduce loss and expand consistent access to affordable, high-quality seed. In recent years, both significant and subtle improvements have been made, charting a way forward and a blueprint for scale. This progress is measurable:

- In partnership with the University of Connecticut and Woods Hole Oceanographic Institution, Bigelow Laboratory for Ocean Sciences expanded its National Culture Collection of Marine Algae to include kelp gametophytes from Southern New England and the Gulf of Maine.[44]
- A new gene bank, Kelp Ark, was established in California to support restoration and cultivation of kelp species in the eastern Pacific.[45]
- Efforts are underway to formalize gene bank (or biobank) networks in British Columbia[46] and Atlantic Canada.[47,48]
- Scientists have advanced early research in kelp genomics and breeding to prepare the industry for climate volatility and future market demand.[49,50,51]
- As of August 2025, a dozen nurseries supplying a majority of commercial kelp farmers in North America built a cumulative capacity to produce between 2.1–4.4 million feet (640–1,341 kilometers) of seedstring annually—enough to support tens of millions of pounds of kelp production.

Early movers like Ocean Approved and GreenWave replaced foundational nursery models with systems designed for energy and operational efficiency, affordability, and scalability. As with early models, new production protocols remain open-access.[52]

Advancements in LEDs phased out obsolete fluorescent lighting. Cost-effective nutrient media borrowed from the oyster farming industry replaced expensive lab-grade solutions without significantly affecting kelp nursery output. Facilities swapped water chillers for refrigeration and improved water treatment systems, reducing contamination.

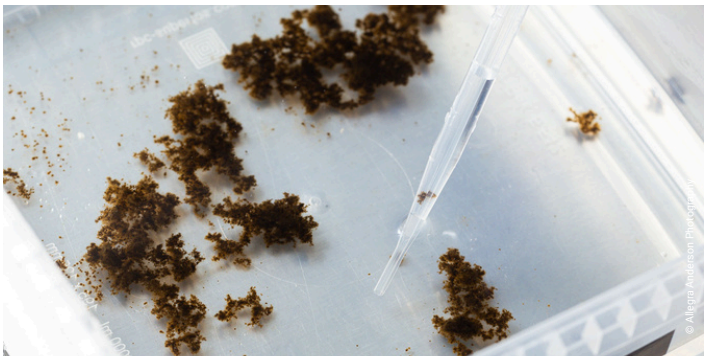
Beyond these subtle tweaks to protocols and equipment, the most significant gains in the kelp seed supply chain can be summed up in four words: **controlled propagation and collaboration.**

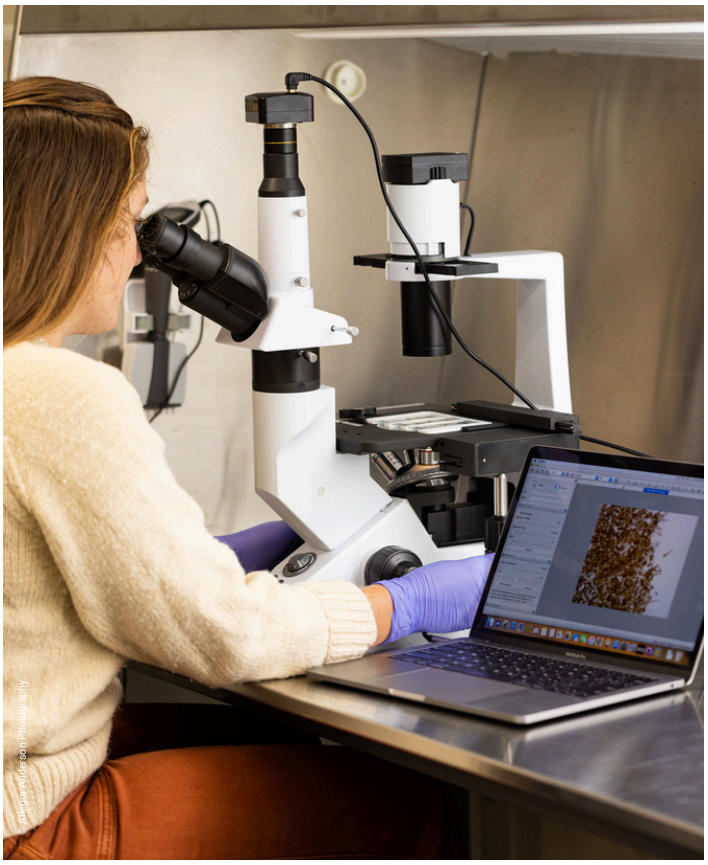
Controlled propagation

Until recently, kelp nurseries relied entirely on annual sorus collection and time-sensitive meiospore production methods to grow seedstring for farmers. Newer methods of controlled propagation decouple seed spool production from wild sorus availability by harnessing a different life stage: gametophytes.[53] Under the right light and temperature conditions, kelp gametophytes grow and persist indefinitely. They can also reproduce asexually. When a gametophyte is crushed or fragmented, it regenerates. In the nursery, fragmenting (or bulking) gametophytes increases the amount of biomass available for seed production.

Although it can take months to years to produce enough gametophytes to supply an entire nursery, this approach allows nursery operators to maximize productivity and use less wild sori. With proper safeguards in place to maintain genetic diversity, gametophyte production also reduces the strain on wild kelp beds, improves control over contamination and production schedules, and consistently delivers high-quality seed spools at optimal planting times.[54]

In 2022, GreenWave launched the first regional gametophyte production facility for kelp farmers in the U.S., with support from European seed experts at Hortimare, significantly improving seed quality and availability for farmers. In addition to using gametophytes in its own nursery, GreenWave supplies gametophytes to other permitted nurseries in the northeastern U.S., which then produce final seed spools near farm sites. This hub-and-spoke approach reduces operational bottlenecks and accelerates farmers' access to high-quality seed.





HUB AND SPOKE IN PRACTICE: NEW YORK
Nurseries operated by Hart Lobster and Shinnecock Kelp Farmers demonstrate how controlled propagation can be shared across a regional network. During the 2025 nursery season, both incorporated gametophytes into their seed production, sourcing starter material from GreenWave's production-oriented seed bank in New Haven, Connecticut. GreenWave propagated and bulked gametophytes using locally collected sori, then supplied that material back to the nurseries when they were ready to complete final seedstring production at their facilities in New York. By centralizing gametophyte propagation while keeping final seed string production closer to farms, this approach shortened production timelines, reduced reliance on annual wild sorus collection, and improved the consistency of seed produced locally.

Collaboration

Regenerative ocean farming, as it stands today, is full of risk and uncertainty. Open-access production models help to mitigate risk, but access to information alone does not ensure success. To facilitate adoption, collaboration is essential. For seed producers, cohort learning models and peer-to-peer networks have been especially effective at accelerating knowledge transfer and fostering collaboration.

The growing culture of collaboration has not only sped up the pace of problem-solving, improved infrastructure standardization, and increased efficiency and effectiveness within individual nurseries, but also created inter-nursery coordination that helps prevent issues such as seed shortages or oversupply. Increased collaboration has built a robust foundation for scale.

REGIONAL COLLABORATION NETWORKS FOR SEED SECURITY

Seed security—reliable, timely access to high-quality, regionally appropriate seed—is foundational to scaling kelp farming. Regional nursery networks are transforming seed production from a fragile, facility-by-facility effort into coordinated systems built for resilience and growth.

In 2024, GreenWave launched regional nursery cohorts in Maine and Alaska to address persistent seed bottlenecks by pairing technical support with peer learning. In Maine, farmers replicated GreenWave's next-generation nursery model to establish a reliable local seed supply, producing high-quality seed for multiple farms in their first season. In Alaska, nursery operators across regions formed a peer network and community of practice to troubleshoot production challenges and accelerate the development of shared solutions.

Also in Alaska, Native Conservancy is empowering Indigenous communities to produce kelp seed, build local mariculture expertise, and steward regenerative ocean farming from the ground up through their Community Kelp Seed Nursery program.[55]

Complementary efforts are strengthening seed security in Canada as well. In British Columbia, a decentralized network of research institutions, community organizations, and commercial partners—including Hakai Institute, North Island College, The Kelp Rescue Initiative, Canadian Kelp Research, Cascadia Seaweed, West Coast Kelp, University of Victoria, and Simon Fraser University—is coordinating efforts to protect, preserve, and provide culturally and economically important seaweed species for research, restoration, and commercial cultivation. Meanwhile in Atlantic Canada, Nova Scotian non-profit Ecology Action Centre,[56] Quebecois research institution Merinov,[57] and the Canadian National Research Council[58] are working together to establish a gene bank, improve understanding of local species and access to kelp seed, and provide critical workforce training across provinces. With additional support from Cascadia Seaweed, these organizations are applying their cultivation skills to enhance kelp restoration in the Maritimes.[59]

Together, these regional collaboration and support networks are bolstering seed security, improving seed quality, reducing shortages, and ensuring farmers have access to seed close to home—an essential foundation for scaling regenerative ocean farming.

SEED PRODUCTION: THE WAY FORWARD

Key Takeaways:

- More efficient and productive systems are replacing old nurseries.
- Gametophyte cultivation is a proven method of controlled propagation, offering nurseries greater control over seed production cycles and improving outcomes for nurseries, farmers, and downstream buyers.
- Regional cohorts and peer-to-peer networks are creating a culture of collaboration and building a community of practice that speeds the adoption of new models and methods.

The scaffolding for a stable seed supply is in place. For example, to hit a target of 10 million pounds (4,536 tonnes) of kelp sold per year, nursery output must increase to at least 2.5 million feet (762,000 meters) of high-quality seedstring per year (about 40% more than was delivered to kelp farmers during the 2024–25 farming season[60]), and operators must ensure consistent and timely delivery of seed to farmers. New open-source nursery models and gametophyte production methods offer a pathway to achieve scale and quality demands.[61,62]

To achieve production targets, we need to optimize a hub-and-spoke seed production model that includes these three core components:

1. **Seed banks:** Above and beyond genetic seed banks, the kelp industry needs centralized, production-oriented seed banks to maintain and grow gametophyte biomass.
2. **Standardization:** Uniform infrastructure and operating procedures will increase efficiency, reduce risk, and expedite troubleshooting.
3. **Training:** Enhanced, standardized training and shared learning opportunities will bolster the community of practice and speed the adoption of improved models and methods.

1. Seed banks

Gene banks (also called biobanks), such as The National Culture Collection of Marine Algae at Bigelow Laboratory for Ocean Sciences in Maine, Kelp Ark in California, and decentralized networks in Canada, maintain genetic material from seaweed species collected over a broad geographic area and play a critical role in research, restoration, and commercial applications.[63] Over the past decade, significant progress has been made to establish kelp gene banks, expand kelp gametophyte collections, and deepen understanding of kelp populations across the U.S. and Canada. Together, these efforts provide scaffolding for future industry growth.

By contrast, production-oriented seed banks, such as GreenWave in Connecticut, grow and maintain large quantities of gametophyte biomass for commercial kelp farms within a specific region. Production-oriented seed banks resemble scientific labs—with cold storage for gametophyte collections, seawater storage and water treatment equipment, fume hoods, assorted microscopes, and other lab-grade equipment and supplies—and require year-round staffing.[64] Once the infrastructure, workforce, operating procedures, and biosecurity measures are in place, production-oriented seed banks can scale to supply a broad geographic region.

In a hub-and-spoke model, gene banks preserve genetic diversity and provide redundancy to production-oriented facilities. Production-oriented seed banks produce and supply gametophytes to a decentralized network of kelp nurseries. Nursery operators use gametophytes to produce seed spools, which they supply to farmers. Seed spool production is seasonal, and nurseries are often run by kelp farmers or producer co-ops located on-shore, near the kelp farms they supply. While this model lengthens the supply chain, it also reduces variability and creates redundancy and resilience that benefit nurseries, kelp farmers, and downstream buyers.

SEED SECURITY IN A SCALING SYSTEM

As seed production capacity expands, how seed systems are structured matters as much as how much seed they produce. Hub-and-spoke models must be built to scale without narrowing access or concentrating control.

In practice, this means ensuring that gene banks, production-oriented seed banks, and nurseries can grow output while remaining open, regionally anchored, and accountable to the farmers they serve. Systems that prioritize redundancy, transparency, and shared standards are better positioned to withstand biological, climatic, and market shocks.

Embedding these systems design considerations into seed infrastructure helps ensure that scale strengthens resilience across the supply chain, rather than introducing new points of fragility.

© Allegra Anderson Photography

2. Standardization

Uniform infrastructure improves operational efficiency. To get there, the industry must adopt and share standards of practice through open-access resources such as blueprints, equipment lists, and standard operating procedures covering everything from spore density measurements to contamination controls.

GreenWave took a major step forward with the *Kelp Nursery Operations Manual*,[65] an open-access resource released in 2025 that standardizes protocols for infrastructure, water-processing systems, seed spool preparation and maintenance, sorus handling, and contamination control. Widespread adoption and continued refinement of such standards will be critical for consistency, infrastructure investment, and the shift toward more advanced cultivation techniques.

Improved nursery models are now compatible with both meiospore and gametophyte production methods. Adopting standardized infrastructure allows operators to build capacity while gradually shifting toward more advanced cultivation methods.

PRODUCTION-ORIENTED SEED BANKS: A BLUEPRINT FOR SCALE

In Southern New England, GreenWave's foundational production-oriented seed bank supplies high-quality gametophytes to its own nursery along with five others from New York to Maine. This system shortens and streamlines seed production cycles, improves seed quality, and enables nurseries to provide high-quality seed to dozens of kelp farms in the region—months earlier than was possible with meiospore production methods. When GreenWave revamped its nursery to a 20-foot refrigerated shipping container for gametophyte-seeded spools, we reduced our nursery footprint and energy costs by a third, cut maintenance and labor costs in half, and more than doubled production from 32,000 to 75,000 feet (10 to 23 kilometers) per year. GreenWave transitioned from producing meiospore-seeded spools with 80% meeting quality standards to consistently producing high-quality spools with a 100% success rate. On the farm, outplanting high-quality seed when water conditions are optimal for production significantly increases yields. On GreenWave's kelp farm in Connecticut, for example, gametophyte-seeded spools outplanted in mid-October and early November 2023 produced yields of 11.6–29.5 pounds per foot (17–43.9 kilograms per meter) by harvest time in April and early May 2024. Meiospore-seeded spools, however, were not ready to outplant until December due to delayed wild sorus development. This delay depressed production, and meiospore spools produced yields of 0.9–6.5 pounds per foot (1.3–9.7 kilograms per meter) within the same harvest window, 2–10 times lower than gametophyte-seeded lines. Find more details about the nursery model and production methods on GreenWave's Ocean Farming Hub.

3. Training

Standardized training programs are essential for equipping kelp nursery operators and gametophyte seed producers with the knowledge and skills required for efficient and high-quality production. Training can be delivered via hands-on workshops, online courses, and mentorship programs to foster a collaborative learning environment and accelerate the adoption of improved infrastructure and operating procedures.

Optimizing production will improve seed quality, drive down operational costs, and increase access to reliable seed for current and future kelp farmers.

The success of the model in southern New England offers a clear blueprint for scaling high-quality kelp seed production across coasts in the U.S. and Canada. Combining controlled propagation, standardization, collaboration, and continuous learning will be essential to meeting scaled demand while increasing resilience.

GreenWave's work with seed producers and farmers across the East and West Coasts provides insight into supply chain pain points and the key interventions needed to stabilize and scale seed supply to meet scaled demand. Based on this experience, we recommend providing standardized training on gametophyte production methods, establishing regional and bi-coastal peer-to-peer learning cohorts, and implementing the following interventions:

Atlantic Canada:

- Formalize and secure long-term funding for at least one gene bank at an academic institution or NGO to maintain long-term culture collections across multiple provinces
- Establish one to two production-oriented seed banks and provide standardized training on gametophyte production methods
- Evaluate existing nursery infrastructure, implement upgrades, and update standard operating procedures
- Convert at least two research-only nurseries into commercial operations as market demand grows

Gulf of Maine (U.S. from MA north of Cape Cod to ME)

- Expand capacity of GreenWave's production-oriented seed bank to support the region
- Evaluate existing nursery infrastructure, implement upgrades, and update standard operating procedures
- Establish an additional commercial nursery as downstream markets develop

Southern New England (CT, RI, NY, and MA south of Cape Cod)

- Upgrade nursery infrastructure and standard operating procedures for seed producers in Rhode Island and New York
- Establish a commercial nursery in Rhode Island to support farmers in Rhode Island and Massachusetts

Alaska

- Establish at least one gene bank at an academic institution or NGO best poised to maintain long-term culture collections from sites across the state
- Acknowledge Alaska's current requirement for a 100% annual replenishment rate for kelp seed stock and the prohibition on controlled inter-annual gametophyte production under current regulatory interpretation
- Identify actions needed to ensure reliable seed supply within these regulatory constraints
- Establish at least one production-oriented seed bank to develop intra-annual gametophyte cultures
- Prioritize production seed bank facilities near major transportation hubs, such as Juneau or Anchorage, to support nursery operations across Southeast (Metlakatla to Haines), Southcentral (Yakutat to Kachemak Bay), and Southwest (Kodiak Archipelago to the Alaska Peninsula)
- Evaluate and update nursery infrastructure in key regions

British Columbia

- Formalize the Decentralized Seaweed Seed Bank network
- Establish a production-oriented seed bank to supply commercial nurseries with intra-annual gametophyte cultures
- Evaluate existing nursery infrastructure, implement upgrades, and update standard operating procedures

U.S. West Coast (CA, OR, and WA)

- Establish a production-oriented seed bank to develop intra-annual gametophyte cultures to supply nurseries as demand increases
- Upgrade existing nursery infrastructure and train operators to produce high-quality seed

2 FARM PRODUCTION

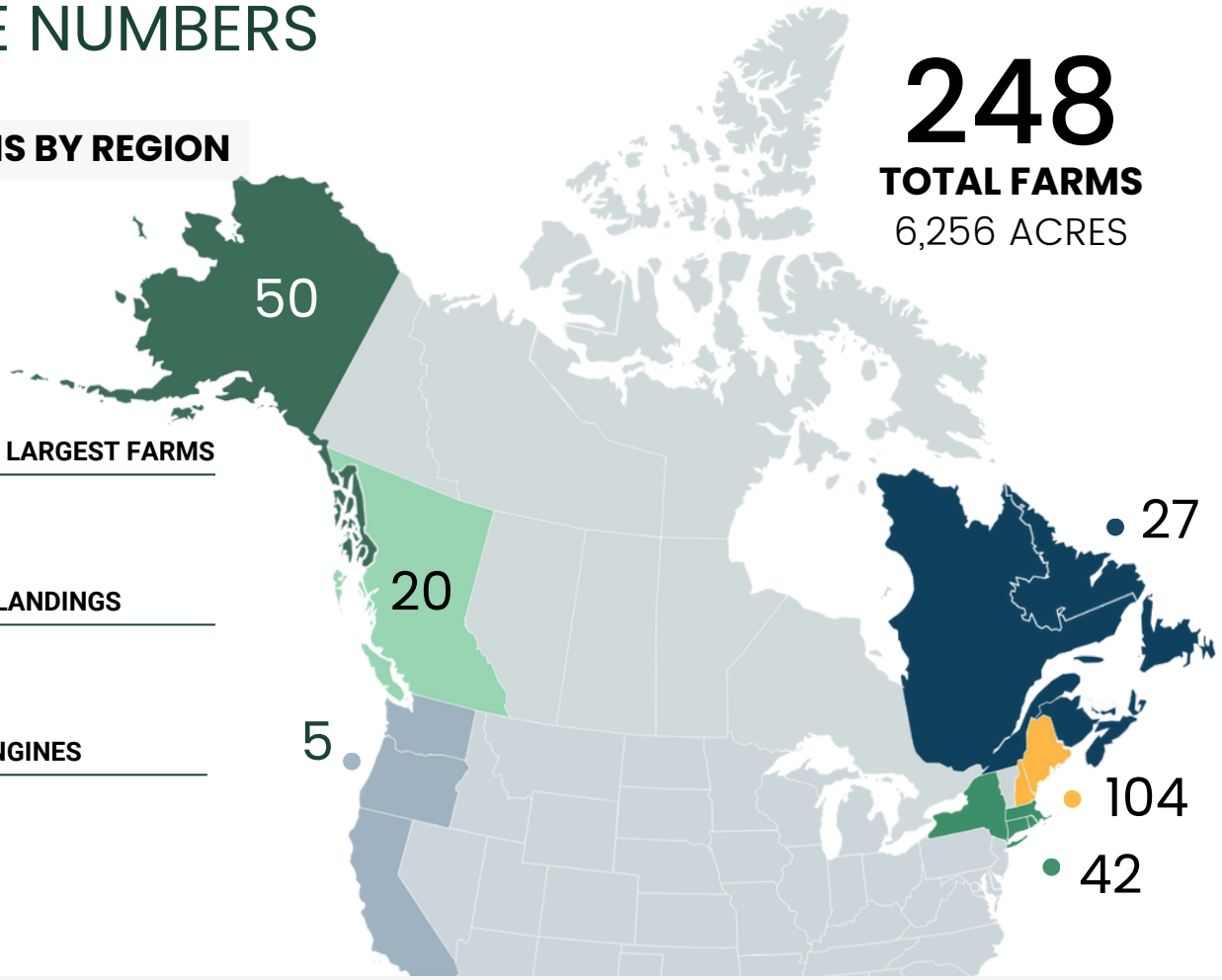
CAPACITY EXISTS. MOBILIZATION IS THE CHALLENGE.

North America has the permits, acreage, and technical capability to produce millions of pounds of kelp. As demand shifts from low-volume food products to higher-volume ingredient and agricultural markets, cooperation and shared infrastructure will determine whether existing capacity is activated.

FARM PRODUCTION:
BY THE NUMBERS

248
TOTAL FARMS
6,256 ACRES

NUMBER OF FARMS BY REGION



MOST AREA PERMITTED & LARGEST FARMS
- Atlantic Canada

MOST FARMS & HIGHEST LANDINGS
- Gulf of Maine

CURRENT PRODUCTION ENGINES
- Gulf of Maine
- Alaska
- British Columbia

AVERAGE FARM SIZE
32 ACRES

FARMS ≤10 ACRES
53%
(EXCLUDING LPAs)

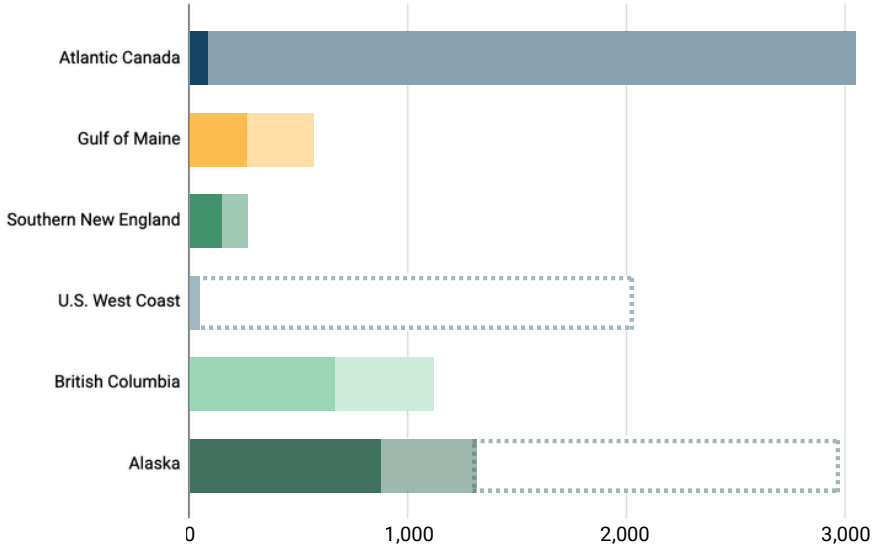
MEDIAN FARM SIZE
7 ACRES

AVERAGE YIELD
2.14 LBS/FT

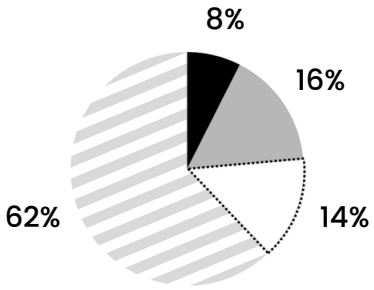
AVERAGE SEEDSTRING OUTPLANTED/ACRE
1.8k FT

FARM PRODUCTION:
BY THE NUMBERS

PERMITTED AREA BY REGION:
CULTIVATED, NOT CULTIVATED, AND PENDING ACREAGE



TOTAL FARMABLE AREA

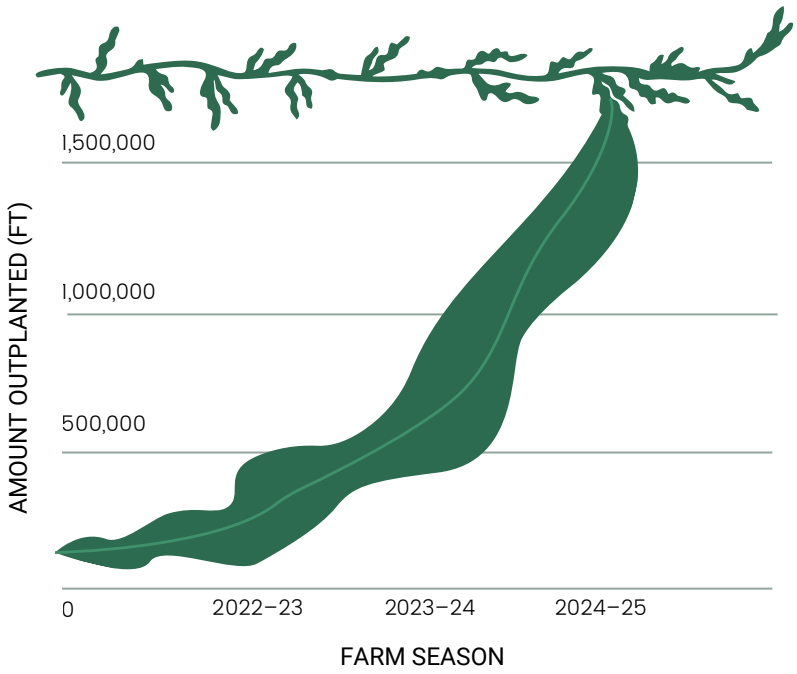


ADDITIONAL POTENTIAL ACREAGE
Separate from permitted and pending acreage, the Southern California Bight Aquaculture Opportunity Area and Nova Scotia's Argyle Aquaculture Development Area represent nearly 16,500 additional acres (~6,680 hectares) with potential for commercial kelp cultivation.

FARM SNAPSHOT:
THE PROFITABLE 27%

- FARM SIZE: **4–8 acres**
- SEED: **Free/subsidized**
- SEED/ACRE: **4k feet**
- AVERAGE YIELD: **3.5 lbs/ft**
- HARVEST + SALES: **~70k lbs/season**

CUMULATIVE SEED OUTPLANTED
AS REPORTED IN *MY KELP*



FARM PRODUCTION:
HOW WE GOT HERE

There's a common misconception that kelp cultivation in the U.S. and Canada isn't scalable—that securing leases and permits is too costly and slow,[66] and that existing farms (most under 10 acres or 4 hectares) are too small to supply markets at meaningful volumes and price points. While bottlenecks persist in some regions, a closer look at the numbers tell a different story. The capacity for scale is in place. The challenge now is mobilizing it.

Over the past decade, the number of leases and permits for kelp cultivation in the U.S. and Canada has increased significantly. In 2015, only a handful of kelp farms dotted the Atlantic and Pacific coastlines. By August 2025, that number had surged to nearly 250 sites approved for commercial kelp cultivation or research covering approximately 6,280 acres (2,541 hectares). Dozens more, representing an additional 3,000 acres (1,214 hectares), are in the permitting pipeline. Approximately 50% of approved sites are permitted for kelp and shellfish polyculture.

THE PERMITTING PARADOX

Kelp farming has expanded most rapidly in regions where permitting is well-defined and lease costs align with revenue potential. Alaska and Maine have seen the greatest increase in new farm sites over the past decade. However, even in these "growth" regions, significant bottlenecks persist.

- **The Scaling Trap:** In Maine, while tiered licensing and leasing[67] has attracted over 100 small- to medium-scale farms, limited agency capacity means the transition from a startup Lease-Purchase Agreement to a full commercial lease can be a years-long process.[68]
- **Regulatory Uncertainty:** Recent instances of non-renewal in New Brunswick without cited cause[69] and multi-year permitting processes in the Maritimes and British Columbia highlight a lack of predictable long-term security for emerging farmers.
- **Prohibitive Entry Barriers:** In California, the high cost and complexity of environmental reviews—sometimes exceeding $500,000—have prevented any new farms in state waters for over 30 years.[70] This has pushed investment-backed companies toward larger offshore sites in federal waters.[71]

NEW PATHWAYS TO ACCESS

Emerging efforts to establish Aquaculture Opportunity Areas[72] in Southern California and Alaska, alongside port and harbor-district planning projects[73] and a newly established Aquaculture Development Area pilot project in Nova Scotia,[74] represent a proactive shift to streamline access. Simultaneously, Indigenous-led initiatives—such as those by the Shinnecock Kelp Farmers in New York[75] and Native Conservancy in Alaska[76]—are leveraging kelp cultivation to assert sovereignty and reclaim water rights in traditional and unceded territories. These models do more than just grow kelp; they ensure that Tribes and First Nations directly influence the industry's values and structure as it scales.

Mobilizing the capacity already permitted on the water would send the strongest possible signal to policymakers that improving review processes is a necessary investment for a durable kelp industry.

The area approved for permitting is a good measure of industry growth. However, since many farms are permitted for kelp and shellfish, and site depths, array configurations, and other factors impact the amount of cultivable area within a site, the amount of kelp a farmer outplants within that area (measured in feet or meters of seedstring) is a better measure of production capacity. Until recently, the industry has lacked widespread data on site-level outplanting trends. *My Kelp* data is changing this.

Based on data from 70 farms in the U.S. and Canada between 2022 and 2025, kelp farmers outplanted an annual average of 1,800 feet of seedstring per acre (1,356 meters per hectare) that they lease. While outplanting densities vary based on site conditions, depth, array design, and market demand—with regional differences detailed in the **Appendix: Regional Snapshots**—this seedstring per acre average is a valuable baseline for assessing production potential.

For example, if all active farms were outplanting 1,800 feet of seedstring per acre (1,356 meters per hectare) and consistently producing 3 pounds per foot (4.5 kilograms per meter) of seedstring outplanted, ocean farmers in the U.S. and Canada could produce tens of thousands of tons of kelp wet weight per year.

However, a substantial portion of this capacity remains untapped. Following a comprehensive review of state and provincial databases, conversations with government agency officials, kelp farmers, and nurseries, and GreenWave's first-hand insights, we estimate that less than 35% of the area approved for kelp farming is being used for commercial cultivation. Average landings across all farm sites reporting in *My Kelp* were just over 2.14 pounds per foot (3.18 kilograms per meter) of seedstring outplanted.[77] Cumulative landings in spring 2025 remained below 3 million pounds (1,361 tonnes) wet weight.

So why isn't more of this capacity in use? The limiting factor is not access to space, but market readiness. In several regions, including Quebec—where more than 1,800 acres (728 hectares) are approved for kelp cultivation, more than anywhere else in North America—production remains low due to limited and inconsistent demand. As one provincial agency official put it, "If kelp were suddenly gold, the space could be reserved for seaweed." In 2025, 27% of the 53 farms surveyed by GreenWave reported profitability. As a result, many farmers maintain permits and infrastructure while prioritizing higher-value crops such as mussels or oysters until reliable demand and price signals emerge. Farmers and policymakers alike note that if this latent capacity is not activated within the next three years, there is a real risk it will be lost altogether.

Beyond the issue of market pull, which we'll discuss in the next section, several bottlenecks limit farmers' ability to mobilize production:

1. **Financing gaps:** Ocean farming is an unattractive space for traditional investment, and kelp farmers have limited access to financing to offset the costs of starting, scaling, or diversifying their businesses.
2. **Limited supply coordination:** A majority of kelp farms operate independently with no coordinated way to aggregate supply.
3. **Variable and unpredictable yields:** Variations in seed quality, site conditions, and marine weather have led to unpredictable yields and harvest timelines, making it difficult for farmers to secure forward contracts from buyers who need consistent supply.
4. **Infrastructure bottlenecks:** A lack of purpose-built infrastructure and regional variations in harvest, transportation, storage, and stabilization logistics limit harvest efficiency on kelp farms, as well as access to downstream markets.

Let's take a closer look at these issues.

1. Financing gaps

Ocean farming is risky and unpredictable, making it unattractive to traditional investors. Banks and traditional lenders are not well-versed in the nuances of ocean farming, including its non-traditional collateral and seasonal cash flows, which don't align with standard underwriting models. Limited historical data and uncertain market pricing make lenders reluctant to offer flexible, affordable financing tailored to the realities of kelp farming. Since the sector is still small, it doesn't attract government subsidies, and crop insurance for kelp remains largely unavailable. As a result, many kelp farmers lack reliable and right-sized financing options to help them get started and scale and instead take on risks independently.

2. Limited supply coordination
Roughly 20% of kelp farms in the U.S. and Canada are vertically integrated or affiliated with vertically integrated companies, such as Atlantic Sea Farms and Cascadia Seaweed. These companies provide seed and technical support to farmers, guarantee the purchase of their kelp harvest, and develop value-added products. The other 80% of kelp farms operate entirely on their own, from seed to sale.

Without support from peers or capital-backed operations, independent farms struggle to aggregate supply, share the cost of seed, or build common infrastructure. Lacking coordination, valuable market opportunities are more challenging to come by. At the same time, the capacity shortfall pushes potential buyers abroad (see **The Midstream Gap in the Market Landscape** section).

3. Variable and unpredictable yields
As outlined in the Seed Production section, improved seed quality and earlier outplanting windows enhance production efficiency, reduce costs, and improve outcomes for farmers and downstream customers. But even when seed quality is optimized, yields can be challenging to predict.

For example, high-quality gametophyte seed led to improved yields in southern New England in 2023 and 2024 (4.5 pounds per foot, 6.7 kilograms per meter), but production dipped below average in 2025 (<1 pound per foot, 1.5 kilograms per meter) despite meeting optimal quality and timing targets. While farmers hypothesize that drought conditions—such as reduced precipitation, leading to lower nutrient runoff—affect primary productivity in estuaries such as the Long Island Sound, a firm link has not been established between drought and declines in kelp growth on the region's farm sites.

Site conditions (depth, current, salinity, and nutrient levels), marine weather, and other dynamic factors impact kelp growth. However, many kelp farmers lack historical benchmarks for production on their sites. They are still learning which environmental signals and patterns (extreme storms notwithstanding) are the strongest indicators of localized crop productivity. This data gap hinders market stability. Inaccurate yield forecasts lead to unmet buyer commitments or surplus kelp, complicating forward contracting and deterring scaled demand.

CONNECTING THE DOTS: SEED QUALITY AND FARM PRODUCTION COSTS
How do variable yields impact a farmers' operational costs? When yields swing widely from year to year, the financial risks fall heavily on farmers. Seed costs become the first and most visible pressure point. At $0.30–$2.00 per foot, even the lowest cost kelp seed is relatively high compared to other forms of agriculture. While nurseries are working to improve seed quality and drive down seed costs with more reliable production methods, most kelp farmers still pay high up-front costs for seedstring (from hundreds to thousands of dollars per acre per season) with no guaranteed production outcome. The less kelp a farmer produces per foot or meter outplanted—whether due to low-quality seed, late-season outplantings, or other factors—the higher their per pound cost of production, cutting into already slim profit margins. Conversely, as yields increase, the relative cost of seed decreases on a per-pound (or kilogram) basis, leaving farmers with more profit margin.

4. Infrastructure bottlenecks

Kelp is highly perishable and must be stabilized within hours of harvest to maintain quality. Until recently, farmers sold fresh, wet kelp at the farm gate and left stabilization to the buyer. When markets were primarily focused on food, buyers often dictated harvest timing to match processing capacity. Farmers could harvest more quickly than buyers could process and stabilize the kelp, limiting them to just-in-time sales. Sometimes kelp would be harvested weeks before peak production, lowering profits, while in other cases it would sit on lines well into the harvest season, increasing the risk of loss from weather or biofouling.

As demand shifts away from fresh food products and towards functional ingredients and biostimulants, this is changing. Increasingly, buyers prefer kelp that has been processed into specific formats (e.g., chopped, flaked, or powdered) and stabilities (e.g., dried, frozen, fermented, or ensiled) that meet their end-product needs. This shift offers farmers a chance to diversify their customer base, time their harvests, and add value through primary processing.

However, bottlenecks remain. Many farmers still cut kelp from their growlines by hand, lacking purpose-built vessels and equipment to improve harvest efficiency. Regional processing and stabilization capacity is still minimal, and there isn't much clarity about who should own and manage this critical infrastructure. As the industry matures, kelp farmers are reaching a decision point: Do they take on post-harvest processing and stabilization themselves to meet the needs of downstream buyers and capture more value, coordinate with middle value chain businesses who can offer these services, or partner with downstream businesses to invest in this primary processing/stabilizing step to meet their end-product needs?

DECISION POINT: BUILD, BUY, PARTNER?

What are the pros and cons of building, buying, or partnering on processing infrastructure?

1. **Build:** In this scenario, farmers take on the work and capital investment of processing themselves. This approach is rarely viable at the individual farm level, making collaboration and aggregation key. The challenge is that processing requires a distinct skillset and business model, separate from farming.
2. **Buy:** By contracting with a processor, farmers are paying for a service rather than doing the work themselves. For producers moving beyond selling fresh, wet kelp, working with a specialized business that has the necessary equipment and expertise can create efficiencies and cost savings over time. The tradeoff is reduced margins, as farmers pay another party to manage processing and associated infrastructure.
3. **Partner:** Convincing a buyer to take on the expense and work of either doing the processing themselves or handling the "Buy" arrangement frees up a lot of liability and headspace for the farmer but also means they lose out on the value-added margin.

FARM PRODUCTION: GAINS MADE

Despite infrastructure bottlenecks, financing shortfalls, and other production challenges, kelp farmers in the U.S. and Canada have made substantial progress towards scaling and stabilizing the supply of regeneratively farmed kelp. The gains are numerous:

- Kelp farmers have waded through complex and costly leasing, licensing, and permitting processes to secure new farming sites and have developed designs and operational standards that lay a solid foundation for regenerative cultivation.
- Farm designs have largely stabilized around three core concepts: single-line arrays, multi-line arrays with spreader bars, and multi-line arrays (catenary or grid[78,79,80]), which can be adapted to a variety of sites and species and replicated to meet scaled demand.
- Farmers have demonstrated that they can scale production within their existing operations when they have access to high-quality seed at the optimal time and guaranteed contracts with downstream buyers.
- Kelp farmers are beginning to cultivate new and regionally appropriate species, laying the groundwork for diversification beyond the limited species that dominate global supply chains.

Beyond scaling and stabilizing supply, the most significant gains for the kelp farming industry come down to **cooperation, creative capital**, **data**, and **infrastructure**.

Cooperation

Kelp farmers across coasts are increasingly well-connected through training programs, peer-to-peer networks, and other local and cross-regional collaborations. These relationships help farmers shorten their learning curve, improve their operations, and build a resilient industry from the bottom up.

Historically, farmer co-ops and collaborative structures have allowed farmers to pool resources, access financing, increase redundancy, spread risk, and ensure a steady, more predictable supply chain. Drawing on expertise from land-based agricultural co-ops, GreenWave and other organizations are working with cohorts of kelp farmers across coasts to help them navigate the structure and decision-making involved in meaningful cooperation.

As a result, farmers are increasingly formalizing how they work together: producer cooperatives that grow their own kelp seed and aggregate supply from member-owners, marketing cooperatives that build brand awareness and reach customers through special events, and regional networks of growers collaborating to address shared challenges. Through cooperation, farmers are transforming a decentralized network into a cohesive supply chain and capturing more value from their crops.

EMERGING COOPERATIVES STRENGTHENING ALASKA'S KELP INDUSTRY
In March 2025, the Kodiak Ocean Growers Cooperative (KOGC) became Alaska's first producer-led kelp cooperative. The co-op unites five Kodiak Archipelago farmers who together manage over 300 acres (120 hectares) of ocean leases with the capacity to farm more than one million pounds of kelp (~453,600 kg). KOGC centralizes aggregation, processing, product stabilization, and market development to meet rising demand from premium buyers. By pooling resources, sharing labor and equipment, streamlining logistics, and leveraging collective bargaining power, their goal is to strengthen Alaska's mariculture industry and deliver consistent, high-quality kelp while maximizing benefits for their Kodiak community.

Elsewhere along Alaska's southern coastline, nonprofit organization Native Conservancy is supporting the development of Native-owned kelp cooperatives to strengthen sovereignty, increase food security, and build economic resilience. In addition to focusing efforts on Kodiak, Native Conservancy aims to mobilize cooperatives in Cordova and in the southeast communities of Kake and Metlakatla to reduce costs and risk through shared permits, infrastructure, and collective purchasing power.[81]

Creative Capital

As traditional finance has lagged behind the needs of a young and volatile sector, progress has come from within the community itself. Organizations and lenders that understand the realities of kelp farming have stepped in with finance tools tailored to the industry's risks, seasonal cycles, and asset profiles—helping farmers stabilize operations, invest in infrastructure, and weather early volatility.

Community development financial institutions (CDFIs), nonprofit lenders, and regional partners are leading this work, offering flexible terms, wrap-around support, and de-risked loans through collateral or blended financing. Examples include GreenWave's Kelp Climate Fund (KCF), Maine's Coastal Enterprises Inc. (CEI) Sea Farm Loan, Alaska's Mariculture Revolving Loan Fund, and emerging models such as Ecotrust's Upwell Community Capital—all of which demonstrate how community-based finance is filling gaps that traditional lenders have been unable or unwilling to address.

RIGHT-SIZED CAPITAL FOR KELP FARMERS

In 2021, GreenWave launched the Kelp Climate Fund to address these gaps with a model that combines three core components: financial incentive, training, and tools. The program paid farmers $1 per foot of seedstring outplanted (up to $25,000), offsetting seed costs, strengthening environmental literacy, and building a culture of data collection through the *My Kelp* app.

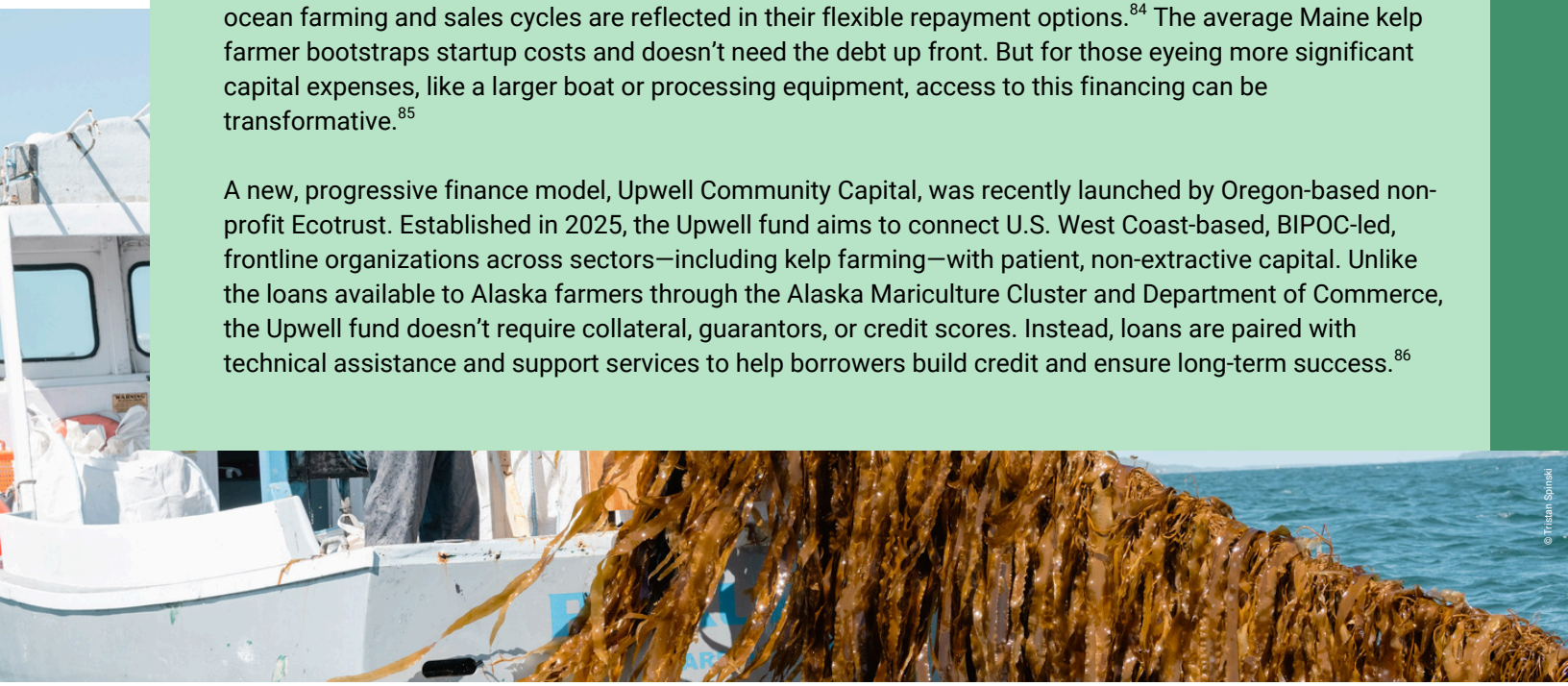
The results have been clear. As an investment tool, KCF has allowed farmers to improve and optimize production, invest in critical infrastructure such as anchors, and, importantly, provide financial stability when seed fails, storms damage crops, and buyers back out. It reduces risk for farmers and brings them closer to profitability. Since 2021, the KCF has distributed over $1.6 million to more than 70 farmers, boosting supply, keeping farms in business during market volatility, and bridging the gap while downstream bottlenecks are addressed.

In 2025, GreenWave restructured the program to blend the seed subsidy (now capped at $10,000) with a sales incentive—offering farmers a matching payment of $1 per pound of kelp sold or stabilized, up to 15,000 pounds. This new model is designed to promote better yields and improved market connections—helping farmers grow more efficiently and build a stronger, more sustainable industry.

While GreenWave's KCF remains the only philanthropically-backed crop subsidy that is accessible to kelp farmers on both coasts of the U.S. and Canada, a handful of community finance options have emerged for kelp farmers in recent years. Kelp farmers in Alaska have access to the greatest diversity of funding options, including the Mariculture Incentive Grant Program—a 1:1 matching grant where KCF dollars have been leveraged to accelerate industry growth; the Alaska Mariculture Cluster's Revolving Loan Fund, a loan administered by the Southeast Conference which provides collateral support on loans originating from participating CDFIs[82]; and a state Department of Commerce-run Mariculture Loan Program,[83] with loan amounts not to exceed the value of collateral.

Maine's CEI launched its Sea Farm Loan in 2019 to support growing kelp and shellfish farmers who have had difficulty accessing more traditional loans and investments. CEI reports that the realities of seasonal ocean farming and sales cycles are reflected in their flexible repayment options.[84] The average Maine kelp farmer bootstraps startup costs and doesn't need the debt up front. But for those eyeing more significant capital expenses, like a larger boat or processing equipment, access to this financing can be transformative.[85]

A new, progressive finance model, Upwell Community Capital, was recently launched by Oregon-based non-profit Ecotrust. Established in 2025, the Upwell fund aims to connect U.S. West Coast-based, BIPOC-led, frontline organizations across sectors—including kelp farming—with patient, non-extractive capital. Unlike the loans available to Alaska farmers through the Alaska Mariculture Cluster and Department of Commerce, the Upwell fund doesn't require collateral, guarantors, or credit scores. Instead, loans are paired with technical assistance and support services to help borrowers build credit and ensure long-term success.[86]



Data

Using GreenWave's *My Kelp* app, farmers log their kelp species, seeding dates, amount of seedstring outplanted, in-season growth measurements, harvest yields, and pictures with time and date stamps. The app's records help farmers predict their harvest and compare year-over-year yields. Farmers report that *My Kelp*'s simple protocols and easy-to-access digital records have improved their data collection routine and smoothed communication with buyers.

Beyond sales planning, these records can support certification audits, loan applications, and insurance claims, streamlining processes that otherwise require time-consuming documentation. In one example, a kelp farmer in Alaska compiled their three-year data set from *My Kelp* to complete the majority of the data required for an organic certification audit.

The data in *My Kelp* has shed light on persistent seed quality issues, prompting GreenWave and partners to expand workshops, one-on-one consulting, and infrastructure upgrades in regional nurseries. As farmers collect and report more data, they are building and refining crop growth models. Coupled with data sets from weather buoys and other sources, this farmer-reported data could inform future site-specific and regional yield predictions for a range of kelp species and help smooth coordination between supply and demand. This data could be leveraged to replicate industry benchmarking efforts across coasts.

Infrastructure

Recent innovations in harvest and processing infrastructure are laying the groundwork for scalable production. Innovations like the Harvest Buddy,[87] a mechanized barge that can harvest kelp at a rate upwards of 6,000 pounds (2,722 kilograms) per hour, and Cascadia Seaweed's process barge, which harvests and macerates kelp into a pumpable slurry at a rate of 100 kilograms (220 pounds) per minute, are indicative of the types of equipment needed to keep pace with scaled demand. While designed for different end-markets, both systems significantly improve the speed and ergonomics of kelp harvesting over manual methods. Cascadia Seaweed's system goes a step further by integrating processing directly on the harvest vessel, reducing time, labor, and facility costs, and maximizing margins for farmers and their biostimulant products. However, without government funding or other investment, getting more efficient harvesting infrastructure into the hands of farmers won't happen overnight.

At the dock, farmers and downstream buyers have partnered on a variety of infrastructure solutions—from tapping into co-packing capacity at neighboring food and seafood facilities, to developing low-cost processing and ambient temperature stabilization methods that unlock year-round supply, save time and labor, conserve energy, and make kelp attractive to a broader set of buyers. GreenWave has compiled guides on these methods to cut out the guesswork for anyone looking to replicate these wins.[88] This open-access information means farmers and businesses can work together to solve common problems, no matter who owns the equipment or facilities.

EMERGING MODELS FOR SHARED, FARMER-FORWARD INFRASTRUCTURE

As farmers move away from dockside sales of fresh, wet kelp and towards lightly processed and stabilized products, we're seeing an emergence of shared processing infrastructure and co-packing that allow kelp to be stabilized close to harvest and aggregated across farms.

- Maine-based Ocean's Balance commissioned a dual-shaft shredder, an industrial conveyance dehydrator with a 10,000–30,000 pound per hour (4,536–13,608 kilogram per hour) throughput, and a hammer mill in its Brunswick facility in 2023.[89] While Ocean's Balance primarily uses this infrastructure for their own branded products, they also offer processing and drying services to local farmers for a fee.[90] Ocean's Balance is moving the dryer from the Brunswick facility to a new location to support operations in 2026 and beyond.
- In Connecticut, GreenWave scaled up primary processing with a dual-shaft shredder—achieving an hourly throughput of 3,000 pounds (1,361 kilograms) demonstrating a farmer-forward model for shared primary processing that can be replicated in other regions. Yellow Farmhouse Education Center received a grant from the U.S. Department of Agriculture to establish shared processing and cold-storage facilities for kelp farmers.[91]
- With financial support from the Alaska Mariculture Cluster's Mariculture Equipment Program, the Prince William Sound Economic Development District, based in Cordova, Alaska, is collaborating with kelp farmers in the region to design and install shared low-tech and high-tech processing and drying solutions.[92,93]
- With support from the Alaska Economic Development Administration, the Sun'aq Tribe is retrofitting its Kodiak Island WildSource plant with improved kelp processing and drying equipment.[94] WildSource has been collaborating with buyers, such as Blue Evolution, for the past decade. Infrastructure upgrades at WildSource are improving Kodiak Ocean Growers Cooperative crop aggregation and market reach, with Macro Oceans and Cascadia Seaweed now forward contracting processed kelp from Kodiak growers.
- Leveraging recent capital investments, Cascadia Seaweed is converting a former fish processing facility in northern British Columbia into a regional kelp processing hub.[95] Cascadia will transport minimally processed and stabilized kelp from Alaska and British Columbia to this plant for secondary processing and the manufacture of kelp-based agricultural products.

FARM PRODUCTION: THE WAY FORWARD

Key takeaways:

- Kelp farmers in the U.S. and Canada currently have the capacity to produce thousands of tons of fresh kelp, but this capacity is largely untapped.
- Production on existing active farms could be optimized to meet scaled demand—without adding new acreage.
- Independent farmers are collaborating and establishing cooperatives to spread risk, aggregate supply, capture value, and meet scaled demand.
- Farmers are collecting data to improve their understanding of site- and species-specific growth, building the scaffolding for predictive models and improved supply chain coordination.
- Philanthropic subsidies are helping stabilize supply as markets mature, but more diverse funding options are needed.

The foundation for a stable kelp supply chain is in place, but poor seed quality and high seed costs, coupled with a lack of supply coordination, continue to limit growth. As demand shifts from low-volume food products to higher-volume ingredient and agricultural markets, cooperation and collaborative solutions will enable a more resilient value chain. Mirroring the interconnected challenges and gains farmers have experienced over the past decade, four key solutions will help unlock capacity and enable a more durable, regenerative industry:

1. **Cooperatives:** Cooperation takes many forms. While formal legal co-op structures have advantages, the structure itself matters less than the active practice of working together. Relationships and trust take time to build, and no single farmer can address all challenges alone. Producer cooperatives are the most critical lever for mobilizing existing capacity, aggregating supply, and driving investment in farmer-owned and farmer-forward infrastructure that builds long-term resilience and profitability across the value chain. Optimizing active farms through well-structured cooperatives could push North America toward tens of millions of pounds of kelp production and create a more stable entry point for future kelp farmers.

2. **Flexible Finance:** Alongside forward contracts with downstream buyers, farmer-forward financing opportunities such as revolving and forgivable loans, crop subsidies, and other patient capital will be necessary to help farmers access the equipment and infrastructure needed to efficiently grow production to meet scaled demand.

3. **Improved yield tracking:** Improved yield tracking and predictive models reduce uncertainty around harvest timing and volume, helping stabilize supply and inform production decisions. Over time, this visibility supports more reliable contracts and smoother market participation for farmers.

4. **Farmer-forward infrastructure:** Improved harvest, primary processing, and stabilization infrastructure—managed by farmer cooperatives and co-created with investments from downstream buyers—will smooth sales cycles and transform raw kelp into a year-round marketable product in the right format and stability for end-customer needs.

The combined effect of cooperative models, flexible finance, improved yield tracking, and farmer-forward infrastructure is more than increased output. Together, these levers close the gap between cost of production and buyer target prices, enabling the industry to compete in higher-volume markets without eroding farmer viability.

3 MARKET LANDSCAPE

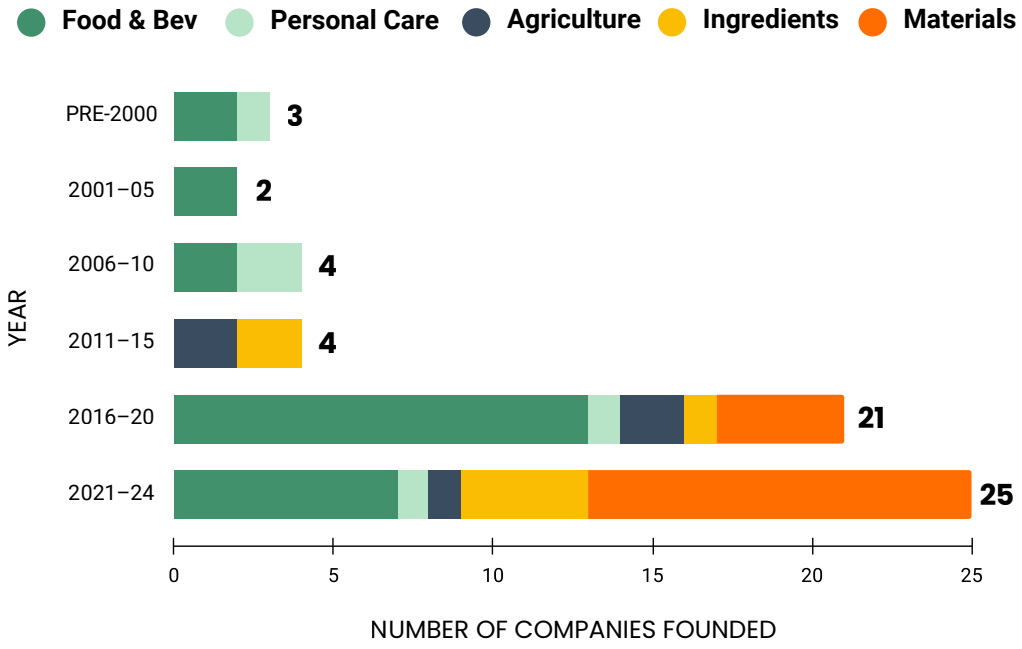
FROM SPECULATION TO PROBLEM-SOLVING DEMAND

Early kelp markets were shaped by hype rather than by clear downstream needs. Growth is now concentrating in sectors where kelp delivers measurable performance and supply-chain value—agriculture, biomaterials, and functional ingredients for food and personal care—and where long-term buyer commitments can stabilize production.

MARKET LANDSCAPE: BY THE NUMBERS

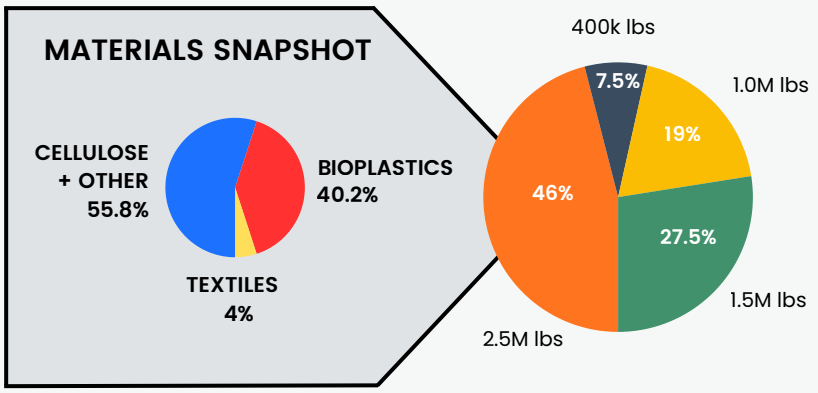
60 PROSPECTIVE BUYERS

MARKET EVOLUTION: COMPANIES FOUNDED BY SEGMENT



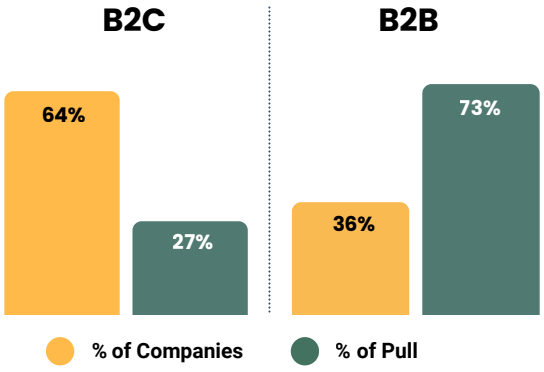
TOTAL REPORTED PULL ACROSS MARKET SEGMENTS

~5.5M lbs



Food & Bev · Agriculture · Ingredients · Materials

PERCENT OF COMPANIES SOURCING AT FARM GATE: **37%**



B2B represents a small portion of the overall buyer landscape, but those companies account for an increasing share of total kelp transactions and sales.

MARKET LANDSCAPE: HOW WE GOT HERE

Over the past decade, the North American farmed kelp industry found itself pulled between opposing market forces. On the one hand, many entrepreneurs recognized that this new industry would not be able to compete on price with incumbent materials for some time, and instead set their sights on high-value markets such as food or cosmetics. Grantmakers at the U.S. Department of Energy and investors, on the other hand, tended to see these markets as too small and directed funding towards speculative sectors with low margins and high scalability demands: plastics, carbon credits, and biofuels.

Some observers view the failure of companies like Running Tide, which raised over $50 million from venture capitalists to sink seaweeds for carbon credits—a method heavily scrutinized by scientists[96,97,98]—as inevitable.[99] A decade ago, MIT had already concluded that the venture capital model was a poor fit in cleantech, noting that over half of $25 billion in cleantech venture funding from 2006 to 2011 was lost.[100] Calls for more patient capital went largely ignored, as near-zero interest rates incentivized investors to take greater risks in search of better returns, and seaweeds were swept up in promising new investment categories like agtech and foodtech. For several years, from alternative proteins to insect farming, the promise of sustainability was enough to guide investment. However, enthusiasm alone couldn't address the flawed business fundamentals under the relentless pace of venture capital.

Away from the moonshots, the main buyers of farmed kelp in North America focused on making packaged foods that highlighted kelp's health benefits, local sourcing, and social impact: alt-protein burgers, chips, pastas, seasonings, and condiments. Venture capital played a role here, too: companies like 12 Tides and Atlantic Sea Farms raised millions to scale rapidly but ultimately failed when sales did not grow as fast as expected, while others like Blue Dot Kitchen, Ocean's Balance, and Barnacle Foods took a slower, steadier approach and are seeing continued, organic expansion.

Today, the days of kelp as the specialty foods hero ingredient are in decline. AKUA's closure in 2024 highlighted the difficulty of sustaining kelp-based food businesses in a market defined by high production costs and thin margins.[101] Post-pandemic inflation has further constrained consumers, making them less willing to pay for unfamiliar snacks when the cost of staples like eggs and milk are already high.[102]

On the Pacific Coast, 12 Tides ended operations,[103] while both Cascadia Seaweed and Blue Evolution pivoted away from food.[104,105] In the Northeast, Salaweg, a First Nation-owned kelp spice and condiment company in Quebec's Gaspé Peninsula,[106] dissolved after less than a decade in operation. The Crop Project, though recognized for putting farmer livelihoods first with forward contracts and higher prices for fresh kelp, could not sustain operations long enough to find the market. Atlantic Sea Farms oversaw a record harvest in 2024[107] and rang in 2025 with a $3.8 million fundraise,[108] but months later announced it would restructure and downsize.[109] These events left many wondering: Where next for kelp farming in North America?

The fact that farmers in the U.S. and Canada now have the capacity to ramp up supply to meet scaled demand is one of the major success stories of the past decade. But with only a handful of companies currently lining up to purchase fresh kelp at the farm gate, farmers are concerned about buyer scarcity. With food-focused companies in flux, some businesses are sitting on stranded inventory.

Concern is warranted, but change is afoot. Consumer-ready food products remain a significant part of the industry, but increasingly companies are forging an alternative path to market through agricultural products and ingredients for cosmetics, food, and material applications—including cellulose. In GreenWave's *Seaweed Source* app alone, companies report interest in sourcing nearly 5 million pounds (over 2,268 tonnes) of domestically cultivated kelp. While food and beverage companies have the widest representation in the app, their demand share is quickly being overshadowed by emerging ingredients and materials sectors.

What is needed to turn this interest into demand? In addition to the mismatch between kelp formats and stabilities at the farm gate addressed in the Farm Production section, we identified three gaps that have a significant impact on the pace and scale of domestic sourcing: a scale-up gap, a missing middle, and a price gap.

1. **The scale-up gap:** Most companies are startups, most founded since 2020.
2. **The missing middle:** The value chain for cultivated kelp in North America is short and nimble but not fully built out.
3. **The price gap:** Farmed kelp remains expensive compared to competing ingredients, pressing companies to think strategically where product-market-impact fit can be found.

Let's take a closer look at these issues.

1. The scale-up gap: a sea of startups with no anchor

Most companies sourcing domestically cultivated kelp in the U.S. and Canada are startups, a majority founded within the past five years.[110,111] This trend reveals a critical weakness: 90% of startups fail.[112] Furthermore, startups use only small volumes of kelp in the early stages of R&D and product development. Larger, well-established companies that could tap into existing production capacity, anchor the industry, and offer stability to upstream businesses are scarce, waiting for the nascent supply chain to solidify before making any moves.

What's missing is a cohort of midsized, established brands with products already on the market and clear intent to source kelp at scale. These companies can absorb higher input costs and invest in product development, while integrating kelp into existing product lines rather than relying on it as a core selling point—reducing risk, stabilizing farm sales, and generating the demand signal needed to unlock broader value chain investment.

Without this cohort in place, the result is a landscape rife with enthusiasm, but without durable, high-volume demand that matches production potential. For now, farmers remain dependent on fragmented, low-volume orders that don't provide the stability needed to scale with confidence.

2. The missing middle: a supply chain from scratch

For all of its production potential, domestically cultivated kelp is remarkably difficult to source—particularly for companies that lack direct relationships with kelp farmers. As discussed in the Farm Production section, many buyers don't want fresh, wet kelp. However, since the kelp value chain isn't fully established, there is little ready inventory in the formats and stabilities that buyers are seeking. As a result, buyer expectations and needs often aren't aligned with the current state of production.

While supply and demand exist in North America, the infrastructure and logistics needed to enable more seamless value chain coordination is still incomplete. The lack of investment in this piece of the value chain, sometimes called the "missing middle",[113] is a bottleneck that slows the path to market. Here, farmers, processors, and downstream buyers face the key question of whether to build, buy, or partner in order to get kelp to market. Efforts to address these investment gaps are underway, including $7.2 million in equipment grants distributed by the Alaska Mariculture Cluster,[114] GreenWave's $100,000 Value Chain Development Grants,[115] and various opportunities in Maine—including infrastructure funding through CEI[116] and Maine Technology Institute,[117] among others. As with the need for co-ops highlighted in the Farm Production section, expanded aggregation and brokerage services will be critical to coordinating supply, smoothing transactions, and closing the gap between farms and markets.

3. The price gap: strategic thinking to replace wishful thinking

Kelp is more expensive to grow in North America than in regions where commodity-scale production has been optimized over decades. In Quebec, an economic analysis of the macroalgae value chain found that even at small-scale production (approximately 18 tonnes or 40,000 pounds), fresh kelp production costs reached roughly $17 per kilogram.[118] Analyses and grower reporting from Maine indicate similarly high per-unit production costs for small- and mid-scale operations, reflecting shared constraints on labor, seasonality, infrastructure, and limited economies of scale.

These production costs are reflected in farm-gate pricing. In 2025, farm-gate prices across the U.S. and Canada ranged from $0.33–$13.00 per pound wet weight with a median reported price of approximately $0.67 per pound.[119] By comparison, cultivated temperate brown kelp species in China and South Korea sold for around $0.20–$0.25 per pound fresh weight at the farm gate in 2022.[120]

Domestic cultivation, however, offers a different value proposition to imports: transparency, new species and product opportunities, and short, nimble value chains with a clear pathway to scale. To leverage these strengths while keeping prices reasonable, sourcing strategies are adapting.

Multi-use strategies are also gaining ground. Agricultural and material applications—such as cellulose and nanocellulose—do not necessarily require food-grade quality, allowing lower-cost processing side streams to be used as feedstock. These side streams valorize what was previously seen as waste, raising the total value of the crop.

Higher prices do limit the range of markets where domestically cultivated kelp can compete. However, this constraint can be managed through deliberate market selection rather than price compression. By optimizing side stream uses and targeting applications where domestic cultivated kelp has an advantage over petroleum-based incumbents (such as clean beauty and PFAS alternatives) or where it can address supply constraints affecting imported or wild-harvested seaweeds (such as biostimulants), the industry can expand demand without eroding farmer success. This is the moment to identify problems that domestically cultivated kelps uniquely address and pursue those opportunities to create new market categories, rather than competing with international markets in a race to the bottom.

WHAT ABOUT BLUE CARBON MARKETS?

Not too long ago, there was considerable excitement in Europe and North America about the possibility of funding kelp forest restoration and seaweed farming with carbon credits. This enthusiasm has since waned. What happened?

First, scandals around bad accounting practices pushed buyers in the voluntary carbon market to the highest quality carbon projects.[121] As monitoring, reporting, and verification (MRV) of ocean-based carbon sequestration relies heavily on models rather than direct verification, seaweed-based projects struggled to meet rising standards and fell out of favor.[122,123]

Second, scientists highlighted persistent knowledge gaps in the complex cycle of oceanic carbon fluxes.[124] Did we really know where the carbon would go?

Finally, policy context matters. While countries such as China and Japan have issued blue carbon credits for seaweed restoration projects,[125] similar regulatory pathways have not emerged in Europe or North America.

In short: Seaweed carbon credit accounting comes with unique challenges and complexity. Could global carbon markets still accept them? It remains to be seen.[126,127,128]

MARKET LANDSCAPE: GAINS MADE

1. **Shift from hero to problem solver:** Kelp is becoming less prominently featured on the package as a hero ingredient. Instead, its role is shifting to a problem-solving functional ingredient behind the scenes, the starting point for a wide range of everyday food and personal care products, delivering health and performance benefits while often displacing legacy petroleum-based ingredients.
2. **Improved value-chain coordination and diversification:** Farmers have an improved framework for building new buyer relationships and forward contracts. Value chain coordination tools, such as *Seaweed Source*, are also helping connect buyers with the right suppliers for their end-product needs.
3. **Product development partnerships:** GreenWave has facilitated product development partnerships to forge collaboration and coordination between farmers and downstream buyers interested in growing supply in sync with scaled demand.

1. Shift from hero to problem solver

As the North American kelp industry scales and grows more resilient, the focus has shifted from kelp as the hero ingredient of niche products to kelp as a problem solver: a versatile functional ingredient that rarely appears on the front of the package, but instead adds behind-the-scenes value across food, personal care, agriculture, and biomaterials.

Moving away from sustainability as the key selling point and toward the functional benefits that kelp-derived ingredients provide is helping businesses find the right product-market fit. Products that behave like conventional ingredients—easy to substitute, reliable to work with, and nutritionally competitive—are more likely to scale than those that rely on novelty or values-based storytelling alone.

From CPG storytelling to performance-first food service

This shift helps explain the move away from consumer packaged goods (CPGs) and toward food service and institutional buyers. Here, kelp works best behind the scenes, delivering functional benefits without asking kitchens to change their workflows. College campuses and corporate dining halls, for example, are actively seeking healthier and more sustainable alternatives that drop seamlessly into existing menus and kitchens.

Institutional food service is a key entry point for kelp-based foods. North Coast Seafoods has served approximately 1 million portions of its Seaweed-ish meatballs and burgers to New England students since 2023;[129] with expanded distribution through Sysco since August 2025,[130] the products are now available in every state nationwide. AKUA sold its assets[131] and kelp burger recipe to long-time partners at Nauti Foods, who are in the process of re-formulating, re-naming, and re-launching the product as a veggie crumble designed to meet the performance-first needs of campus culinary groups.

Functional ingredients in food and personal care

Food companies are increasingly under pressure to improve the nutritional profile of their products while maintaining lean and clean labels that exclude harmful or unfamiliar-sounding ingredients. Domestically grown seaweeds can be leveraged for their functional benefits,[132,133,134] helping to reduce sodium[135] and fat while enhancing flavor, maintaining texture, and adding fiber[136,137] in applications such as plant-based proteins[138,139] or baked goods.[140,141]

Personal care products like cosmetics are often rife with microplastics and harmful chemicals from petroleum-based compounds.[142] Precision-engineered to deliver high performance at low cost, petroleum-based compounds have historically been difficult to replace with bio-based alternatives. Kelp, with its unique chemical composition and cellulosic structure, can meet both the functional requirements of beauty brands and the health standards of clean beauty customers. While kelp extracts like fucoidan can find high-value markets as a hero ingredient, the most promising growth is in novel bioactives that deliver functionality and wellness benefits integrated quietly into formulations rather than marketed front and center.[143,144,145,146]

Here's a snapshot of recent functional ingredient activity in the U.S. and Canada:

- After launching two cosmetics ingredients, Macro Oceans completed a $7.5 million seed round to build a multi-product alginate factory by 2027.[148]
- Through its MacroLink platform, Marine Biologics combines AI discovery with standardized seaweed inputs to accelerate the development of new seaweed-derived functional materials, including clean-label protein stabilizers, egg replacements, baking texturants, bioactives, and biopolymers for packaging.[149,150]
- Cold Current Kelp aims to harness bioactive compounds like fucoidan and alginate to enhance its skincare products made from New England-grown kelp.[151]

While these companies are working on a range of ingredients for food and personal care, they are all laying the foundation for scalable biorefinery technology in North America.

Biostimulants

Biostimulants offer another growing market for cultivated kelp. For centuries, farmers have turned to the sea to harvest seaweed to boost soil health and farm productivity.[152,153] Recently, seaweed biostimulants have received increased attention among the kelp farming industry in North America and abroad.[154] Today, about 0.5% of farms globally currently utilize these products,[155] but the sector is growing. Globally, the biostimulant sector is projected to maintain a strong compound annual growth rate of 10% between 2022 and 2030,[156] with seaweed biostimulants alone estimated to grow to a $1.8 billion industry by 2030.[157]

However, since incumbent products rely heavily on wild-harvested sources—many of which have reached or exceeded the threshold for sustainable extraction[158,159]—sector growth will depend on cultivated inputs.[160]

One near-term pathway to market is incorporating cultivated kelp into existing formulations, as Pacific Northwest Organics has done by diversifying their feedstock with Alaska-grown bull kelp[161] in response to California's kelp forest decline.[162] Rather than retrofitting existing supply chains by replacing legacy feedstocks, the immediate market opportunity may be in the creation of new products and formulations using cultivated kelp.

Expanded cultivation capacity in the U.S. and Canada, coupled with low-cost infrastructure and open source methods, has spurred an uptick in kelp biostimulant production across coasts. The industry is now on the cusp of a production capacity breakthrough, offering a reliable, regenerative alternative to at-risk wild seaweed stocks and the opportunity to grow a sector with significant climate and economic benefits.[163] While companies in the kelp biostimulant sector are underrepresented in *Seaweed Source*—suggesting they are effectively cultivating kelp, well-connected to farmers, meeting supply demands through other channels, or a combination of these—there are numerous indicators of sector expansion.

Here's a snapshot of recent biostimulant activity in the U.S. and Canada:

- Cascadia Seaweed closed a CAD $4 million Series-A round in 2024[164] and sold 26,000 gallons (100,000 liters) of biostimulant in 2025.[165]
- GreenWave advanced a partnership with Māori-owned company AgriSea[166] to produce a biostimulant with cultivated *Saccharina latissima* under the AgriSea brand. The flagship product was introduced to land-based farmers in 2024.[167]
- HoldFastNL Seaweed Company produced biostimulants from cultivated kelp at a commercial-scale production facility in 2025 and initiated multiple efficacy trials.
- Kachemak Kelp Hub in Alaska initiated pilot-scale processing of kelp for biostimulant for the first time in spring 2025.
- Ocean Rainforest built a processing plant in Goleta, California,[168] launched two biostimulant products in 2025,[168] and acquired a 60% stake in Mexico-based biostimulant company Alamarsa, also known as Algamar.[170]
- In Ketchikan, Alaska, Pacific Kelp Company has built up several hundred thousand gallons of annual production capacity. The company has signed up its first paying customers and will plant its first scaled-up kelp farm in 2026.

The critical challenge moving forward is ensuring these new products demonstrably meet the specific needs of downstream customers. While the agronomic benefits of kelp-based inputs is widely acknowledged, scaling from greenhouse trials to field applications to full-scale farm implementation with cultivated inputs—and building the body of data to support efficacy claims and show clear bottom-line results for land-based farmers—will be paramount to the next stages of growth and long-term viability.

Biomaterials

While seaweed-based plastic replacements and textiles have gained their fair share of media coverage in recent years, they are unlikely to significantly affect demand for farmed North American kelp in the near term. The low cost and high performance of traditional plastics is hard to beat, and these startups ultimately need to source high volumes at low prices, which pushes them to global supply chains with large-scale suppliers offering refined products from a mix of cultivated and wild-harvested sources.

Instead, nanocellulose—used in coatings, biomedical products, and other applications—appears to be the biomaterial with right-sized demand and the highest near-term growth potential for the North American industry. This trend is evident in *Seaweed Source*, where companies report demand for seaweed pulp, a byproduct of biostimulant production and other processes, for the manufacture of nanocellulose, seaweed-based polymers, and other materials applications.

The most prominent example of seaweed-based coatings at scale is UK-based startup Notpla, whose meal containers play to seaweed's problem-solving strengths (solid grease barrier properties) and circumvents its weakness (high price) by only having to add a small amount of seaweed to a commodity like cardboard. In the U.S., examples include Atlas, which makes preservative coatings to reduce food waste, and Soarce, which uses nanocellulose to improve the performance of industrial materials.

Like in other emerging sustainable markets, product-market-impact fit is found in the niches for now, rather than in commodity markets. For instance, Ocean Made's kelp-based plant pots add kelp nutrients as they naturally degrade and trade the lower-margin farm segment for more profitable home-gardening retail.[171] Canadian startup PhyCo Technologies is replacing plastic crop cover with a kelp-based alternative that delivers nutrients while biodegrading, raising profits for farmers who no longer have to pay for disposal.

Improved value chain coordination will help ensure established and emerging companies can connect with suppliers and processors that have kelp in the right format and stability to meet their product and downstream customer needs.

2. Improved value-chain coordination and diversification

Starting in 2018, Atlantic Sea Farms transitioned from a vertically integrated company that grew its own kelp to a contract farming model with independent kelp farmers.[172] In this model, the company provided kelp seed and technical assistance to farmers in exchange for a forward contract for the entirety of the crop at a price agreed to ahead of the season. With a guaranteed buyer on the line, farmers had the confidence and financial stability to invest in expanded farm permits, gear, and equipment.

The Crop Project entered the seaweed scene in 2021 and directly competed with Atlantic Sea Farms for kelp supply. This competition drove up the price per pound of wet kelp, and provided Maine kelp farmers with a choice of who they sold to for the first time. Operating without a physical infrastructure footprint in the state, The Crop Project built partnerships with local nursery operators, co-manufacturers, and logistics companies to accomplish post-harvest handling, transportation, processing, and storage. This brought additional companies into the kelp supply chain and spurred new conversations around coordination, quality control, and risk management.

In 2025, Atlantic Sea Farms restructured, and The Crop Project stopped operations, leaving a significant gap in the buying landscape, particularly in Maine. However, farmers' experience working with these two buyers provided a framework for building new buyer relationships, grounded in the importance of securing forward contracts before putting seed in the water.

Unlike earlier years, when seaweed was often grown with the hope that buyers would emerge in the spring, farmers increasingly know well in advance who their buyer is, what they want in terms of volume, format (e.g., blades, stipes, or whole), and stabilization method.

Another significant shift is the diversification of buyers, who now come from a wider range of sectors. Seaweeds are increasingly used not only in food service and food CPGs, but also in biostimulants, nutraceuticals, biomaterials, and functional ingredients for food and personal care. This diversification could be an early signal that next-generation applications of kelp are maturing out of bench- and pilot-scale research and into a commercialization stage. Farmers benefit not only from the increased number of buyers, but also from working with multiple buyers who each seek different—and ideally complementary—formats or fractions of kelp, helping to maximize the value of each harvest.

Value-chain coordination has also improved through companies working to build deep, collaborative relationships with their farmers. In addition to the examples of Atlantic Sea Farms and The Crop Project described above, companies such as Cascadia Seaweed, Macro Oceans, and Blue Dot Kitchen work with farmers as equal business partners rather than owning or controlling the entire supply chain, creating mutual growth through coordinated planning, shared resources, and aligned long-term goals. This direct-trade approach emphasizes genuine two-way communication and shared decision-making while maintaining separate business operations. The approach contrasts with the industrial model of vertical integration in that efficiencies and cost savings are achieved through transparency and win-win negotiations, rather than consolidation—ensuring both parties can thrive independently while working together closely.[173]

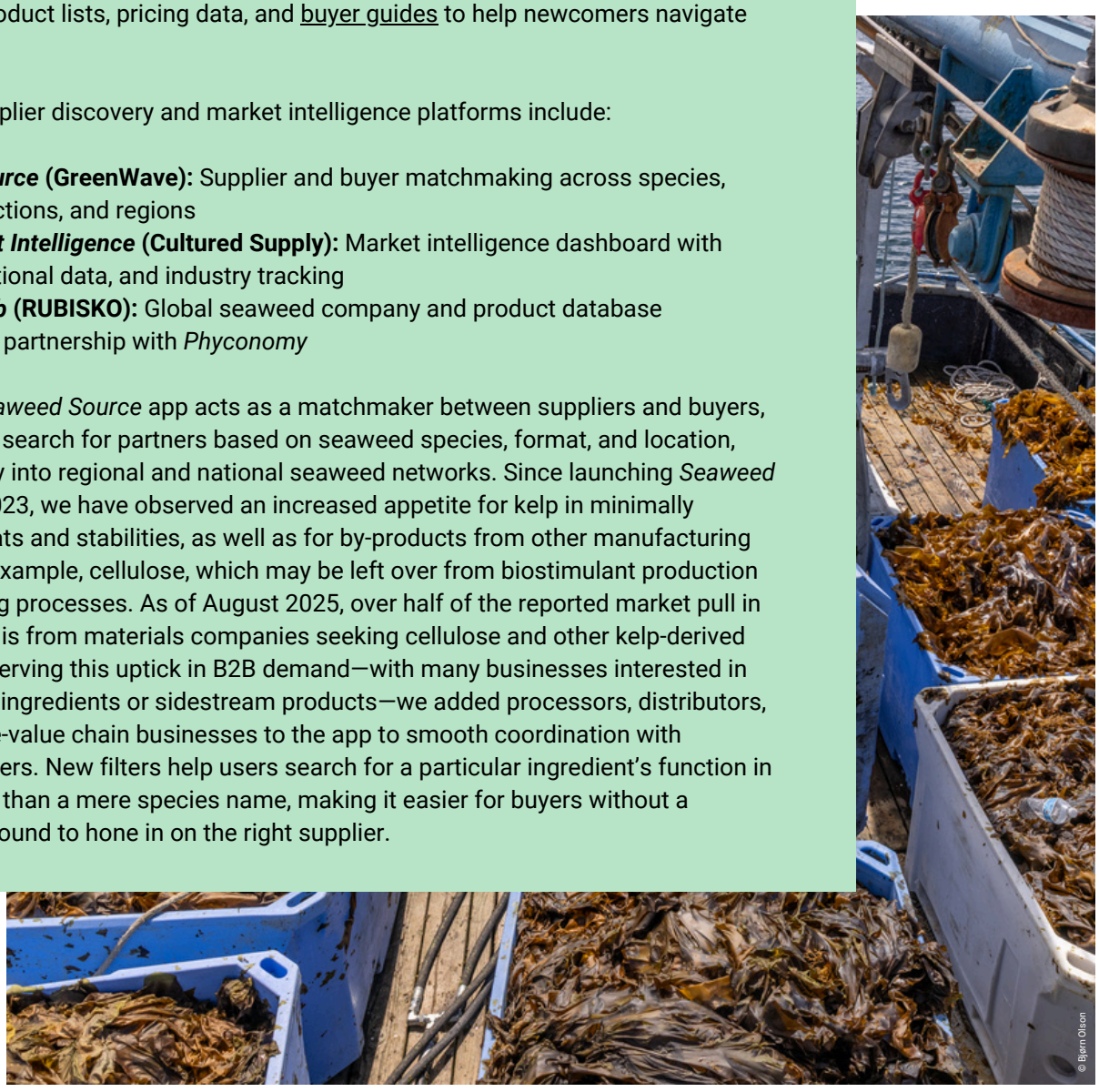
TOOLS FOR MARKET INTELLIGENCE & BUYER–SUPPLIER DISCOVERY

Supplier discovery has improved thanks to a number of new online resources that have increased visibility to the North American kelp supply chain, compiling exhaustive company and product lists, pricing data, and buyer guides to help newcomers navigate the landscape.

Examples of supplier discovery and market intelligence platforms include:

- ***Seaweed Source* (GreenWave):** Supplier and buyer matchmaking across species, formats, functions, and regions
- ***Algae Market Intelligence* (Cultured Supply):** Market intelligence dashboard with pricing, nutritional data, and industry tracking
- ***Seaweed Hub* (RUBISKO):** Global seaweed company and product database developed in partnership with *Phyconomy*

GreenWave's *Seaweed Source* app acts as a matchmaker between suppliers and buyers, where users can search for partners based on seaweed species, format, and location, and gain visibility into regional and national seaweed networks. Since launching *Seaweed Source* in July 2023, we have observed an increased appetite for kelp in minimally processed formats and stabilities, as well as for by-products from other manufacturing processes—for example, cellulose, which may be left over from biostimulant production and other refining processes. As of August 2025, over half of the reported market pull in *Seaweed Source* is from materials companies seeking cellulose and other kelp-derived inputs. After observing this uptick in B2B demand—with many businesses interested in sourcing refined ingredients or sidestream products—we added processors, distributors, and other middle-value chain businesses to the app to smooth coordination with downstream buyers. New filters help users search for a particular ingredient's function in a product, rather than a mere species name, making it easier for buyers without a technical background to hone in on the right supplier.



3. Product development partnerships

A scaled market for North American producers is possible, but no one farmer or company can move the needle alone. Since launching *Seaweed Source*, we have identified a number of bottlenecks as presented in this report. At the same time, we have also seen an opportunity to break down silos and connect stakeholders across the value chain for mutual benefit.

Most successful thus far have been those companies collaborating with farmers and cooperatives on processing and logistical challenges, starting small and iterating rapidly while working toward scale.

To accelerate these efforts, GreenWave uses product development partnerships to forge collaboration and coordination between farmers and downstream buyers around specific problems kelp can solve, aligning supply, processing, and product development with real demand. In these partnerships, GreenWave acts as a facilitator to streamline supply chain logistics, improve communication and coordination, and enhance outcomes for companies along the value chain. Other support organizations, like Merinov in Quebec, offer infrastructure and expertise for R&D and product development, helping kelp farming businesses achieve product-market fit.

Product development partnerships have helped farmers convert interest into demand and downstream companies solidify and diversify more reliable and scalable supply chains for their products. These partnerships started small but have resulted in steady growth and scaled demand, particularly in Maine and Alaska. A challenge now is enhancing capacity to replicate these impacts in other regions and accelerating growth from a piecemeal, one-company-at-a-time approach, to a more coordinated, higher-impact effort.

A MARKET-ANCHORED PRODUCT DEVELOPMENT MODEL

GreenWave's Kelp Innovation CoLab is an effort to catalyze this approach, translating kelp's functional potential into real market solutions. In partnership with Unilever Foundry and Macro Oceans, the program connects consumer brands, ingredient developers, and product experts to bridge R&D and commercialization, developing viable kelp-based formulations that meet company performance and sustainability goals.

By pairing applied R&D with market development, CoLab accelerates adoption across industries and builds demand for ocean-farmed kelp. The first CoLab cohort, just underway in 2026, centers on beauty and personal care as a model for cross-sector innovation.

As an early anchor partner and multinational company, Unilever Foundry helps define the functional challenges and demand signals that guide the cohort's work, providing clarity on real-world performance needs. This market validation reduces uncertainty for suppliers and accelerates adoption across sectors, while CoLab's applied R&D translates those needs into viable kelp-based solutions.

MARKET LANDSCAPE: THE WAY FORWARD

From the start, kelp farming in North America made sense from a social and environmental point of view. But uncovering the demand has proven to be a winding road. While exceedingly versatile across applications, farmed kelp was also a new feedstock that needed to be discovered. Like other new feedstocks, such as mycelium or microalgae, seaweeds can only thrive in niches where they have a competitive advantage over established, heavily subsidized commodities (like oil or soy) or other wild-harvested and/or imported seaweeds and seaweed byproducts. As we've seen in renewable energy, replacing entrenched incumbents is a battle fought over generations that starts in the margins.

At GreenWave's inception nearly a decade ago, food was the first destination for domestic farmed kelp. Early demand from food brands helped independent farmers build the experience, technology, and networks needed for markets that would require more scale but were taking longer to develop. Even as North American consumers acquire a greater appetite for homegrown kelp, it will be a mix of other applications that will take North American farmed kelp to scale.

To get there, we need more **aggregators** to coordinate the supply chain, **biorefining capacity** to increase kelp's value, **product development** to widen the market, and **multinational involvement** to anchor scale.

1. Aggregators and brokers

Regenerative systems are built from networks of smaller, diverse players that achieve scale through replication rather than monolithic growth. Aggregation is necessary to smooth out interactions between many small suppliers, such as farmers, and markets that are larger in scale and rely on commodified transactional trade.

Aggregators, including food hubs, cooperatives, logistics companies, and digital platforms, are intermediaries that combine products from many smallholder farmers into larger, quality-assured, traceable volumes. Aggregators don't just buy and sell: they organize logistics, standardize quality and pricing, and reduce transaction costs for buyers and suppliers. By coordinating supply and pooling volume, they enable more reliable market access and help justify better pricing.

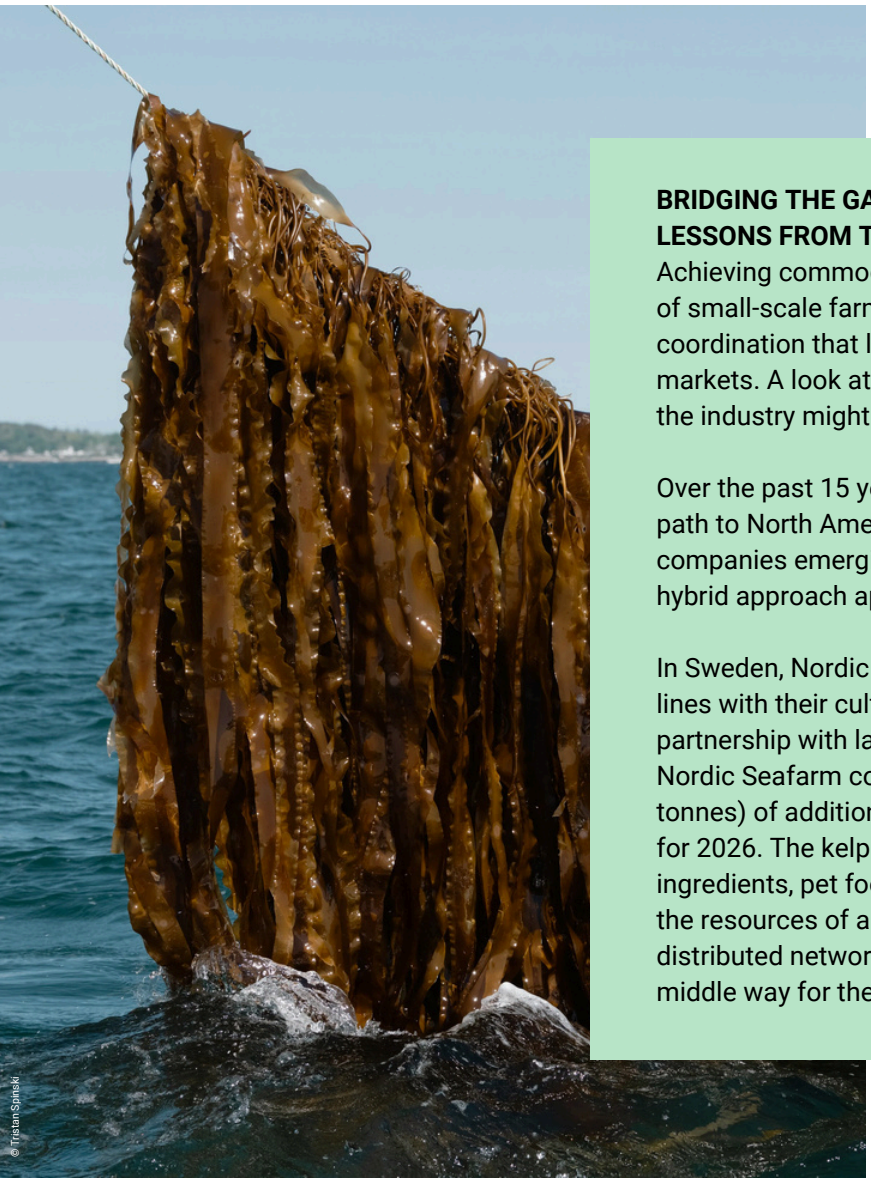
The aggregator model fundamentally reshapes how farmers engage with markets. Rather than operating as isolated price-takers in a fragmented system, producers within an aggregation network gain structured market access through shared logistics, collective bargaining power, advance purchase agreements, and economies of scale. This moves farmers from individual sellers at the edge of the market into coordinated value chains, where information and revenue flow more evenly.

In practice, aggregation transforms fragmented, high-risk smallholder sales into coordinated, scalable systems—reducing asymmetry, volatility, and inefficiencies while creating a clearer institutional link between localized production and formal markets. Aggregation is necessary to support downstream market access. Who will play that role remains an open question.

As of now, the only aggregator of cultivated kelp in North America is Kodiak Ocean Growers Cooperative, a newly formed producer cooperative in Kodiak, Alaska. However, there are signals of more aggregator networks on the horizon. Growers in Cordova, Alaska, for example, are also coordinating with regional partners to set up a collaborative of farmers, explore crop aggregation, and house and manage shared access to processing infrastructure.

In addition to aggregators who handle physical logistics, the maturing value chain requires brokers to efficiently match producers with buyers, offer advice, and negotiate on behalf of farming clients, advising when and how to sell rather than directly handling or reselling the produce. Through *Seaweed Source* and related value chain coordination efforts, GreenWave has taken on this broker role for kelp farmers, though additional coordination and capacity are needed to best serve suppliers and downstream buyers.

The challenge for the kelp industry going forward is determining the best approach to aggregation and broker relationships.



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BRIDGING THE GAP BETWEEN FARM AND MARKET: LESSONS FROM THE EUROPEAN SECTOR

Achieving commodity-level scale does not require the displacement of small-scale farmers. Instead, it requires new models of coordination that link independent producers to downstream markets. A look at the European industry offers insights as to how the industry might evolve in North America in the coming years.

Over the past 15 years, European kelp farming has charted a similar path to North America's, with a mix of larger, vertically integrated companies emerging alongside smaller owner-operator farms. Yet a hybrid approach appears to be first to achieve scale.

In Sweden, Nordic Seafarm pivoted from producing its own product lines with their cultivated kelp to co-developing products in partnership with large-scale buyers. To meet growing demand, Nordic Seafarm contracted approximately 880,000 pounds (400 tonnes) of additional kelp from small-scale farmers in the Nordics for 2026. The kelp will be used (in order of volume) for food ingredients, pet food, supplements, and biomaterials. By combining the resources of an investor-backed startup with the resilience of a distributed network of independent farmers, Nordic Seafarm offers a middle way for the kelp farming industry.

2. Biorefining capacity

Biorefining, at its most basic, involves converting a biological input into a portfolio of valuable products by separating its components, much like a petroleum refinery converts crude oil. The north star for seaweed biorefineries is a cascading extraction process, in which multiple compounds are sequentially extracted from kelp biomass and from the byproducts of each extraction step.

This approach prioritizes full utilization and valorization of the biomass for a variety of end products. The emphasis on maximizing value and minimizing waste contrasts with inefficient one-and-done processes of the past. The specific sequence of a cascade is highly variable and dictated by the primary customer's product specifications.

A critical decision for the North American industry is determining the physical supply chain model that best supports a flexible, customer-driven, cascading process. The centralized factory model offers logistical simplicity but is less resilient to fluctuations in production and requires costly long-distance transport of raw biomass. A hub-and-spoke model with smaller, decentralized hubs that handle primary processing near seaweed farms is the optimal logistical structure because it allows the kelp to be stabilized and prepared for its first use before shipment to a central facility for further processing.

The hub-and-spoke structure supports a flexible economic model. Infrastructure may vary across regions, shaped by customer demand and the specifications of buyers along the value chain. Strong partnerships and coordination between farmer cooperatives and downstream processors—who define the optimal cascade sequence—will be paramount for aligning the supply chain with end-customer demand.

As the industry matures and businesses increasingly seek refined kelp-based ingredients, the valorization of byproducts will become more necessary and more efficient. With capacity for production in place on the supply side, the industry is at an inflection point where biorefining capacity is likely to move from bench to commercial scale in the coming years. Continued coordination of the supply chain will be critical to meeting emerging demand for refined ingredients.

EMERGING DEMAND FOR KELP BIOREFINERIES

In addition to the aforementioned efforts by Cold Current Kelp, Macro Oceans, Marine Biologics, and others, there are a range of current and emerging companies and products for which scaled biorefining capacity could unlock demand:

- A range of material startups are already working with minimally processed kelp formats and processing byproducts to produce agricultural crop covers (PhyCo), plastic pot replacements (Ocean Made), acoustic panels (Seacork Studio), and bioactive bandages (Miha Biotech).
- Alternative proteins (Umaro), ag inputs (AquaSteady), nanofibers (Soarce), and functional coatings (Atlas) are among other up and coming applications.
- In the event we reach scaled biorefining capacity, then companies like Sway (circular, compostable biopackaging), Loliware (seaweed-based straws), and Keel Labs (seaweed-based fibers), which currently source refined forms of seaweed from global suppliers, could benefit from scaled domestic biorefining capacity.

3. Multinational companies to anchor the value chain

Kelp farmers in the U.S. and Canada are poised to meet scaled demand. Functional ingredients for food, cosmetics, biomaterials, and agriculture inputs are the market segments with the strongest signals for volume that match supply-side potential and offer pathways to scale. Accelerating the transition from niche, regional products to a resilient, coordinated value chain for these markets will require greater focus and investment. It will also require engaging corporations with established market penetration, regulatory sway, and substantial budgets for research and development.

The next phase of growth will depend on rapid, targeted innovations that address real challenges faced by downstream customers. While GreenWave has only recently launched our first Kelp CoLab cohort—focused on functional ingredients for beauty brands—replicating this approach for other market segments could deliver additional farmer-forward growth. In the CoLab model, multinational companies guide smaller, more nimble brands toward innovation grounded in tangible market outcomes—specifically, launching new products featuring kelp-derived ingredients. Even if the industry is not yet the right size to attract multinationals as buyers, their engagement in the value chain now helps de-risk the sector for mid-supply chain businesses and set the stage for deeper integration in the future by ensuring kelp-based ingredients and products can seamlessly integrate into scaled supply chains. In other words, looking downstream is essential to building out the missing middle.

Commitments from multinationals also send a positive signal to prospective investors and offer stability that filters up to the farm level. Together, multinationals and catalytic capital, including venture philanthropy, debt capital, and blended finance, could transform mid-stream businesses—such as aggregators and biorefineries—into bankable projects, bridging the gap that currently prevents the industry from fully mobilizing its production potential.

CONCLUSION

Until recently, North American kelp farmers were growing at pilot scale. Unable to produce at a volume or price point that would interest established corporations with global supply chains, we served startups and novel markets.

However, the industry has now reached an inflection point. Seed producers have improved nursery infrastructure and operating procedures to consistently deliver high-quality seed at the optimal time of season. Kelp farmers have proven they can produce significant quantities of kelp and are collaborating and cooperating to reduce supply-side bottlenecks. Processors and product developers are becoming more sophisticated in their understanding of which pain points kelp uniquely addresses.

What is emerging are the contours of a future ocean farming industry that allows both the seas and the people who work in them to thrive. But challenges remain, and success is not a given. **If we act strategically now, we can move beyond fragmented, one-off projects to build a coherent supply chain that operates at true scale.** Each sector has a critical role to play, but success depends on genuine collaboration, trust, and transparency.

After a decade of feeling our way forward, the path ahead is finally coming into view. We've learned what works, what doesn't, and where the real opportunities lie. Now is the time to narrow our sights on a few clear targets: functional ingredients for food and cosmetics, biomaterials, and agricultural inputs. By channeling funding, innovation, collaboration, and the infrastructure required to support these three areas, the industry can build something lasting and truly impactful.

This is an exciting time for our industry, when we move from experimentation to mainstream adoption, from the feel-good story at the end of the nightly news to the business section. We write this in the knowledge that change doesn't happen overnight. Transformation takes time. Solar cells were invented in the 1950s. Electric vehicles were common around 1900. What we label a revolution, a moment of rupture or innovation, is, in hindsight, just the beginning of a much longer wave of adoption, resistance, refinement, and integration. The dramatic event is merely the moment when change becomes visible. Full systemic change requires institutions to adapt, people to adjust their mindset and behaviors, and competing interests to be resolved or neutralized.

Mired in the day-to-day struggle of trying to build a new, sustainable industry from scratch, it can be hard to gain perspective and see the kelp forest for the blades. We hope this report has helped point a path forward in a way that acknowledges the struggle, celebrates the wins, and tracks the distance to see just how far we have come and how far we still want to go.

APPENDIX: **REGIONAL SNAPSHOTS**

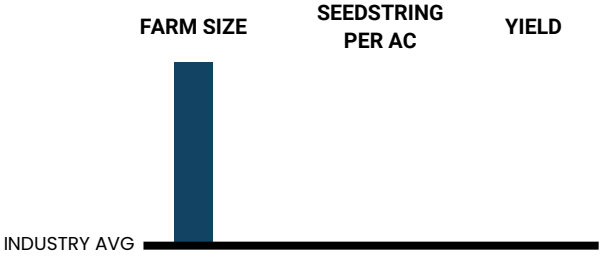
REGIONAL FARM PRODUCTION AT A GLANCE

Region	Number of Permitted Farms	Permitted Acreage	Average Farm Size (acres)	Seedstring Outplanted (ft/acre)	Average Yield 2023–25 (lbs/ft)	Highest Reported Landings (lbs)
Industry Benchmark	248	6,256	32	1,800	2.14	N/A
Atlantic Canada	27	3,086	136.65	**	**	<110,000
★ Gulf of Maine	104	534	7.82	2,132	2.74	1,503,758
Southern New England	42	255	7.89	1,833	3.29	>152,000
★ Alaska	50	1,272	25.44	1,883	0.93	872,288
★ British Columbia	20	1,090	54.48	1,879	2.86	>165,000
U.S. West Coast	5	19	3.87	733	3.77	**

** not enough data to report
★ current production engines

REGIONAL SNAPSHOT: **ATLANTIC CANADA**

SPECIES CULTIVATED



27+ FARMS

PERMITTED AREA: **1,249 HECTARES**

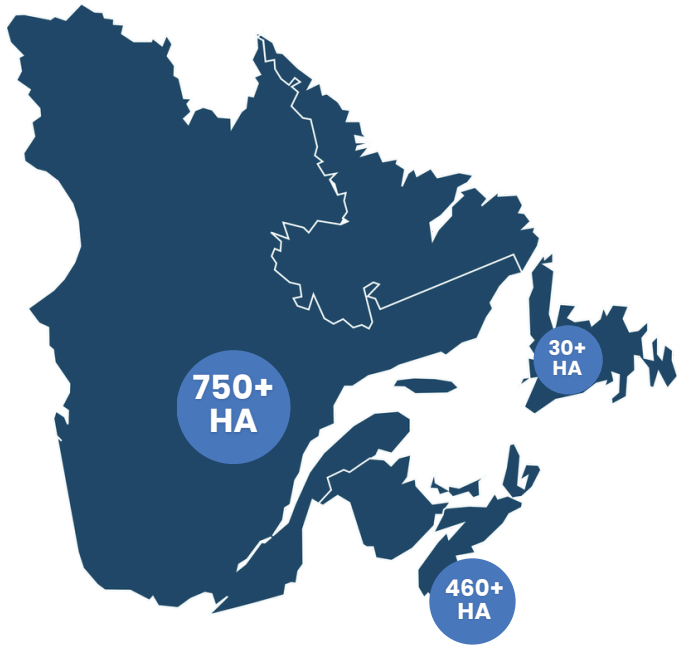
% OF AREA UTILIZED: **< 5%**

AVERAGE FARM SIZE: **55.3 HECTARES**

AVERAGE SEEDSTRING OUTPLANTED: NO DATA

AVERAGE YIELD OVER 3 SEASONS: NO DATA

REPORTED ANNUAL LANDINGS: **< 50,000 KG**



Atlantic Canada—including New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island, and Quebec—has more area and larger farms approved for kelp cultivation than any other region in the U.S. or Canada. Specifically, farm sites in Quebec are significantly larger than those permitted in other regions.

Production capacity

Only a small number of permits or licenses have been issued for commercial cultivation and/or research in Atlantic Canada, including 12 in Nova Scotia[R1,R2] according to the provincial database, with up to seven more licenses in varying degrees of approval as of August 2025;[R3] 10 in Quebec;[R4,R5] and approximately five in Newfoundland and Labrador.[R6,R7] There are no active kelp farms in Prince Edward Island.[R8] One commercial lease and license in New Brunswick, Magellan Aqua Farms, was recently non-renewed by the province;[R9] and no other licenses were active as of August 2025. However, Atlantic Canada has more approved area (1,249 hectares or 3,086 acres) than any other region, nearly matching the approved area of all other regions combined (1,324 hectares or 3,271 acres).[R1,R4,R6] Most farms are over 40 hectares (100 acres) in size.

While a large area has been approved for cultivation, most of this area is also permitted for shellfish cultivation. Only one farm in Quebec is exclusively permitted for seaweed cultivation. Many farmers in the province have piloted kelp cultivation but are not actively growing it until markets develop. Sources in Nova Scotia report that 10 of the 12 operations were not actively cultivating kelp during the 2024–25 farming season.[R2] We estimate that less than 5% of the permitted area across Atlantic Canada is actively being utilized for kelp cultivation.

REGIONAL SNAPSHOT: **ATLANTIC CANADA**

Although only a small proportion of the permitted area is currently being utilized for kelp cultivation, sources suggest that there are opportunities for market growth, and as market opportunities develop, leasing, licensing, and permitting processes will need to be streamlined to foster industry growth.[R3,R10] The Argyle Aquaculture Development Area in Nova Scotia, which designated 53 sites for shellfish and marine plant (e.g., kelp) aquaculture,[R11] may provide an entry point for new kelp farmers.

QUEBEC

***Average farm size*:** 122.58 ha (302.91 ac)
Median farm size: 115.55 ha (285.53 ac)
Range of farm sizes: 70–183.5 ha (172.97–453.44 ac)

NOVA SCOTIA

Average farm size: 38.59 ha (95.36 ac)
Median farm size: 14.53 ha (35.90 ac)
Range of farm sizes: 4.96–135.77 ha (12.26–335.49 ac)

**excluding research-only sites*

Species cultivated

Kelp farmers across provinces are approved to cultivate a variety of species, including *Saccharina latissima* (sugar kelp), *Alaria esculenta* (winged kelp), *Saccharina angustissima* (skinny kelp), and *Laminaria digitata* (finger or horsetail kelp).

Landings

Farmers in Nova Scotia report cultivating at a pilot scale.[R3,R12] Cultivation in Quebec has also been constrained by a lack of market opportunities.[R5,R13] Cultivation was only recently commercialized in Newfoundland and Labrador. As a result, landings data is not widely reported for this region.[R7,R14] Based on communications with NGOs, agency officials, and businesses across these three provinces, we estimate that annual landings have not exceeded 50,000 kilograms (110,000 pounds).

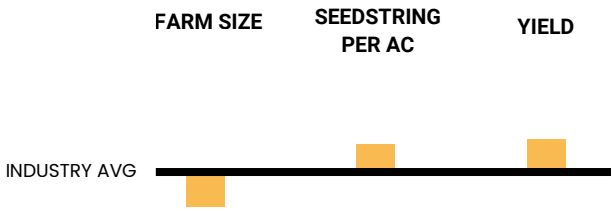
There are not enough farms reporting data in *My Kelp* to provide outplanting or yield statistics for Atlantic Canada.

Key support organizations and institutions

Canadian Seaweed Industry Network, Dalhousie University, Ecology Action Centre, GreenWave, IndigenousWorks, Memorial University's Marine Institute, Merinov, and Université Sainte-Anne.

REGIONAL SNAPSHOT: **GULF OF MAINE**

SPECIES CULTIVATED



100+ FARMS

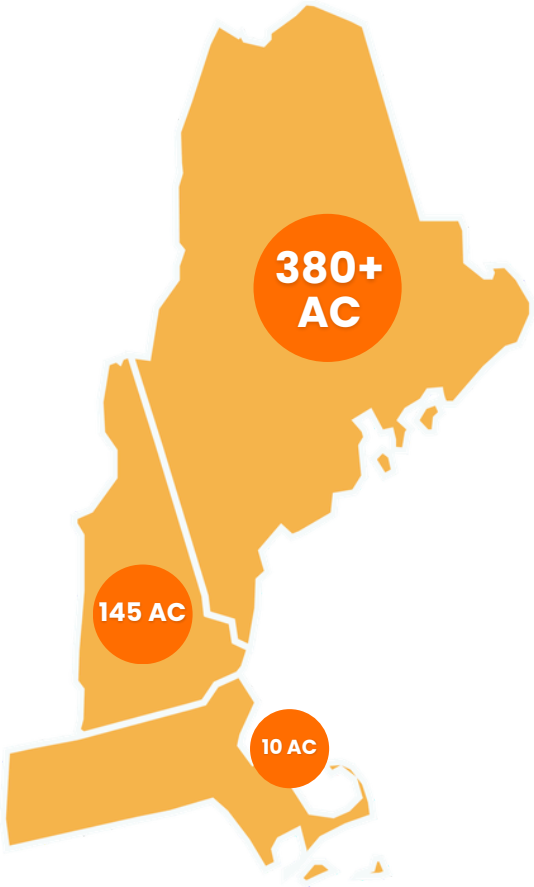
PERMITTED AREA: **534 ACRES**

AVERAGE FARM SIZE: **7.82 ACRES**

AVERAGE SEEDSTRING OUTPLANTED: **2,132 FT**

AVERAGE YIELD OVER 3 SEASONS: **2.74 LBS/FT**

REPORTED ANNUAL LANDINGS: **1,503,758 LBS**



Maine leads all states and provinces in the number of approved kelp cultivation sites and individual kelp farmers, totaling over 100 across all license and lease types, though this number is constantly in flux.[R15]

Since the start of the commercial industry, Maine has maintained the most well-established value chain and has the highest number of farmers reporting profitability.[R16] Many Maine kelp farmers are lobstermen diversifying their income during the off-season.[R17] However, the market landscape is in transition, and farmers are facing uncertainty over future sales opportunities.

Production capacity

Approximately 534 acres (216 hectares) are leased for kelp cultivation across ~104 sites across the Gulf of Maine region—encompassing Maine, Massachusetts north of Cape Cod, and New Hampshire —with about 380 acres (154 hectares) across 100+ sites in Maine,[R15,R18] one inactive site in Massachusetts,[R19,R20] and 145 acres (59 hectares) across three permitted sites in New Hampshire.[R21]

In New Hampshire, one business holds a majority of the leased area (144.9 acres or 58.6 hectares), which is primarily used for shellfish cultivation.

REGIONAL SNAPSHOT: **GULF OF MAINE**

Farm operations in Maine are considerably smaller and distributed across a larger number of farmers. Most new kelp farmers in Maine begin by operating on one or more Limited Purpose Aquaculture (LPA) licenses (entry-level sites of 400 square feet or 37 square meters). They later transition to experimental leases (up to 4 acres or 1.6 hectares, for up to 3 years) or standard leases (up to 100 acres or 40.5 hectares, for up to 20 years). As of August 2025, more than 110 LPAs, covering just over an acre, have been issued to between 40 and 50 unique license holders.[R18] Approximately 50 kelp farming businesses held a cumulative 36 experimental and 28 standard leases, covering 378.81 acres (153.3 hectares).[R18] Many kelp farmers hold multiple licenses, multiple leases, or a combination thereof. We estimate that about 70% of leaseholders in the state were active in the last farming season (2024–25).

Maine kelp farmers commonly use single-line arrays spaced 20–30 feet (6–9 meters) apart and reinforced with perpendicular cross-lines. Due to the relatively shallow Atlantic shelf, helical anchors can be used. The anchors' minimal scope allows farmers to lease areas that are about the same size or only slightly larger than their cultivable acreage. As a result, the seedstring:acre ratio in Maine is higher than the industry average: over 2100 feet per acre (850 meters per hectare) for sites between 1–30 acres (0.4–12.1 hectares), with the most productive sites even outplanting two to three times that amount.

MAINE
(EXCLUDING LPAS)

Average farm size: 5.92 ac (2.40 ha)
Median farm size: 3.88 ac (1.57 ha)
Range of farm sizes: 0.83–40.39 ac (.34–16.35 ha)

NEW HAMPSHIRE

Average farm size: 48.36 ac (19.57 ha)
Median farm size: 68.76 ac (27.83 ha)
Range of farm sizes: 0.16–76.14 ac (.06–30.81 ha)

Species cultivated

Kelp farmers in the Gulf of Maine are approved to cultivate a variety of kelp species, including *Saccharina latissima* (sugar kelp), *Alaria esculenta* (winged kelp), *Saccharina angustissima* (skinny kelp), and *Laminaria digitata* (finger or horsetail kelp); however, sugar kelp and skinny kelp are the most widely cultivated varieties.

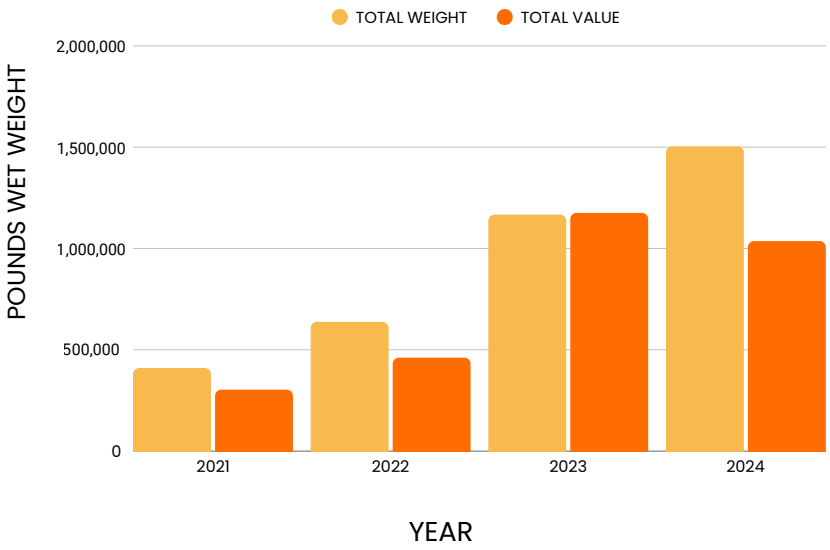
Between 40–45% of license and leaseholders are permitted for both kelp and shellfish. Numerous license and leaseholders are also permitted for other types of seaweed, including *Gracilaria sp.*, *Palmaria palmata* (dulse), *Ulva lactuca* (sea lettuce), and *Pyropia* (nori).

REGIONAL SNAPSHOT: **GULF OF MAINE**

Landings

Maine dominates U.S. kelp production, accounting for about 80% of national landings.[R18] In 2021, Maine kelp farmers harvested over 410,000 pounds (~186,000 kilograms) of kelp. By 2024, Maine kelp farmers more than tripled production, with landings exceeding 1.5 million pounds (~680,400 kilograms) of kelp. Sugar kelp made up just over half of this production (788,565 pounds or 357,687 kilograms), with the remainder being skinny kelp.[R22]

MAINE CULTIVATED KELP LANDINGS 2021–24



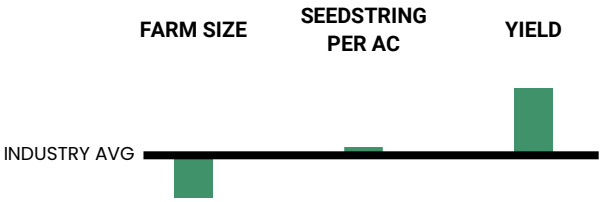
No landings data were available for other states in the Gulf of Maine region.

Key support organizations

Bigelow Laboratory for Ocean Sciences, Coastal Enterprises, Inc., GreenWave, Gulf of Maine Research Institute, Island Institute, Maine Aquaculture Association, Maine Aquaculture Innovation Center, Maine Center for Entrepreneurs, Maine Sea Grant, Maine Seaweed Council, Maine Seaweed Exchange, Marine Technology Institute, New Hampshire Sea Grant, University of Maine, University of New England, University of New Hampshire.

REGIONAL SNAPSHOT:
SOUTHERN NEW ENGLAND

SPECIES CULTIVATED



42 FARMS

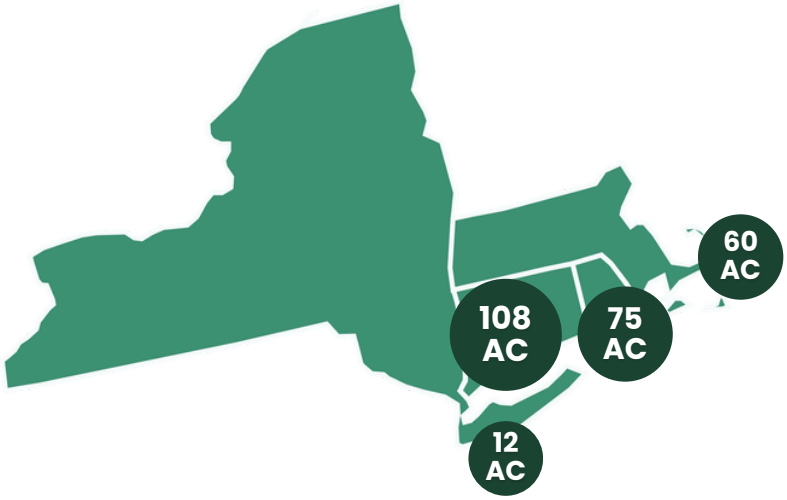
PERMITTED AREA: **255 ACRES**

AVERAGE FARM SIZE: **7.89 ACRES**

AVERAGE SEEDSTRING OUTPLANTED: **1,833 FT**

AVERAGE YIELD OVER 3 SEASONS: **3.29 LBS/FT**

REPORTED ANNUAL LANDINGS: **< 152,000 LBS**



Kelp farms in Southern New England—encompassing Connecticut, Massachusetts (south of Cape Cod), New York, and Rhode Island—are in the southernmost range for kelp cultivation along the U.S. Atlantic coastline. Warming waters have impacted the abundance of wild kelp populations throughout the region. Controlled propagation of gametophytes is helping reduce pressure on wild populations while stabilizing seed and farm cultivation.

Production capacity

There are approximately 42 sites covering 255 acres (103 hectares) approved for kelp cultivation across Southern New England.

Single-line arrays are the most common cultivation systems used by kelp farmers in Southern New England. Farmers in New York's shallow-water bays (<4 feet or 1.2 meters at mean low water) are fine-tuning low-cost high-volume production on a small footprint using single-line arrays.[R23] On these sites, there are mere feet or meters between longlines, which are attached to helical anchors and staked at a fixed distance (~1 foot or 0.3 meters) from the bottom. While there are not enough *My Kelp* farmers in New York to report data for that state, a 2023 Stony Brook University study in the same region outplanted 2,400 meters (over 7,800 feet) of seedstring per acre and observed yields exceeding 10 kilograms per meter (over 6 pounds per foot) wet weight, hinting at the production potential.[R24]

REGIONAL SNAPSHOT: **SOUTHERN NEW ENGLAND**

The tight spacing and lack of anchor scope enables high-volume production on a small footprint, with seedstring: acre ratios that dwarf industry averages. With proper siting and optimization, these low-cost systems could rival or surpass per-acre yields observed in Maine, though space and carrying capacity may be limited.

Species cultivated

The only commercially cultivable kelp in Southern New England is *Saccharina latissima* (sugar kelp). Many farmers in the region are cultivating kelp and shellfish, including over 75% of lease and permit holders in Rhode Island and New York.

Landings

Landings data for Southern New England is thin: According to the Connecticut Bureau of Aquaculture, 10 kelp aquaculture companies grew a total of 69,246 pounds (31,409 kilograms) of sugar kelp in 2024.[R25] No landings data were available online from state sources in New York, Rhode Island, or Massachusetts as of fall 2025. However, farmers from across the region who are using *My Kelp* reported harvesting over 152,000 pounds (~69,000 kilograms) of kelp that same year.

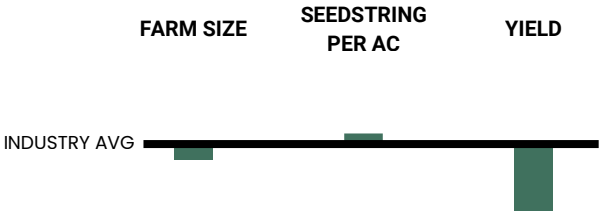
Key support organizations

Farm Fresh Rhode Island - Harvest Kitchen, GreenWave, Lazy Point Farms, Sea Grant (CT, MA, NY, RI), Stonybrook University, University of Connecticut, University of Rhode Island, Yellow Farmhouse Education Center.

REGIONAL SNAPSHOT: **ALASKA**

SPECIES CULTIVATED

+OTHER



50 FARMS

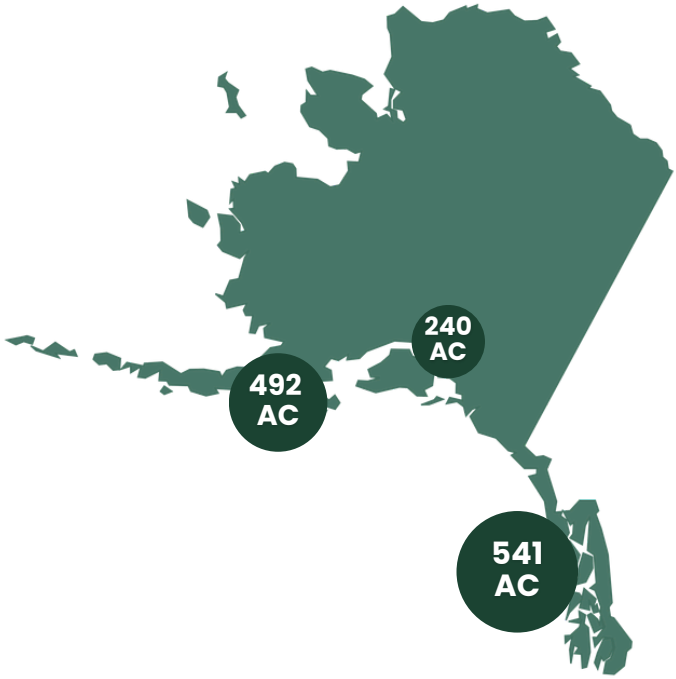
PERMITTED AREA: **1,272 ACRES**

AVERAGE FARM SIZE: **25.44 ACRES**

AVERAGE SEEDSTRING OUTPLANTED: **1,883 FT**

AVERAGE YIELD OVER 3 SEASONS: **0.93 LBS/FT**

REPORTED ANNUAL LANDINGS: **872,288 LBS**



Alaska has seen a significant increase in kelp farming capacity over the past decade, but most of this capacity remains untapped. Among other challenges, seed quality issues have hampered production over the past several years. Recent improvements to nursery infrastructure and standard operating procedures,[R26,R27] coupled with a robust peer-to-peer support network among seed producers and farmers stand to improve production outcomes for the 2025–26 kelp farming season.

Production capacity

As of August 2025, there were 50 permitted farm sites covering over 1,200 acres (~486 hectares) of coastal waters.[R28,R29] More than half of these were established after 2016. We estimate that about 30 farms (covering approximately 850 acres or 344 hectares) are actively cultivating kelp, and that most are not producing to full capacity while markets develop and value chains solidify. Farm sizes across the state range from less than one acre (0.4 hectares) to over 130 acres (52.6 hectares) in size, with an average size of 25.44 acres (10.3 hectares) and a median size of 15.01 acres (6.07 hectares).

Farming activity is clustered around three key geographies: Southeast (Metlakatla to Haines), Southcentral (Yakutat to Kachemak Bay), and Southwest (Kodiak archipelago to the Alaska Peninsula).

REGIONAL SNAPSHOT: **ALASKA**

DISTRIBUTION OF PERMITS AND ACREAGE ACROSS REGIONS AS OF JULY 2025

LOCATION	SOUTHWEST	SOUTHCENTRAL	SOUTHEAST
NUMBER OF PERMITS	14	17	19
AREA PERMITTED (ACRES)	492	240	541

U.S. National Oceanic and Atmospheric Administration and the State of Alaska are collaborating on a multi-year process to identify Aquaculture Opportunity Areas (AOA) in state waters.[R29] Aside from the AOA process, as of October 2025, there were approximately 1,700 acres (~690 hectares) in the permitting pipeline for kelp and mixed kelp and shellfish farms.[R31]

Many farmers in Alaska use five-line arrays and multi-line catenary arrays that were designed with remote, high-energy offshore sites in mind. These systems afford high-density production on closely spaced cultivation lines, but require leases that are many times larger than the cultivation area, to accommodate robust anchoring systems and mooring line. The deeper the water on these sites, the greater the scope, the larger the permitted area. This results in a seedstring:acreage ratios that's about average (1,883 feet per acre or 1,418 meters per hectare), in spite of close spacing between longlines (typically ranging between 2–10 feet or 0.6–3 meters) within multi-line arrays.

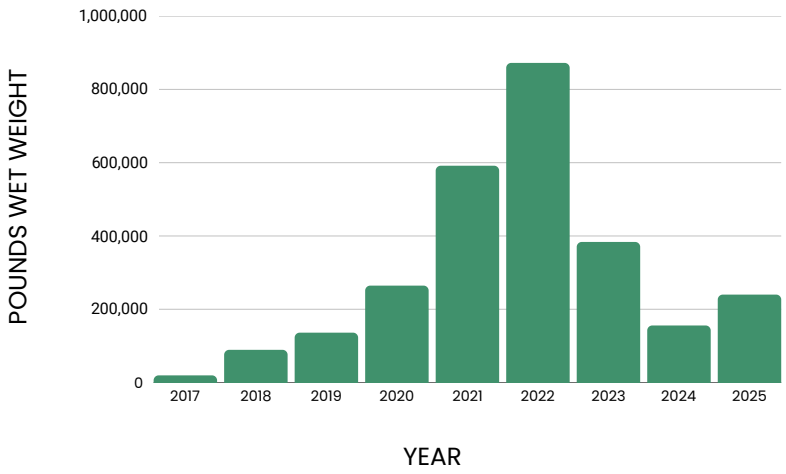
Species cultivated

Farmers in Alaska are cultivating a wider range of kelp species than in any other region. *Saccharina latissima* (sugar kelp) and *Alaria marginata* (winged or ribbon kelp) are the most widely cultivated. Over the past few years, farmers have also begun cultivating floating kelps—including *Nereocystis luetkeana* (bull kelp), *Macrocystis pyrifera* (giant kelp), and *Eualaria fistulosa* (dragon kelp). Some farmers are also permitted to cultivate other species—including *Hedophyllum nigripes* (split kelp), *Cymathaere triplicata* (three-ribbed kelp), and *Costaria costata* (five-ribbed kelp)—are included in many farm permits but are not widely cultivated. Many farms in Southeast and Southcentral Alaska are also permitted for shellfish cultivation, while only one in the westward region is permitted for seaweed and shellfish.

REGIONAL SNAPSHOT: **ALASKA**

Landings

Landings in Alaska peaked at over 870,000 pounds (>390,000 kilograms) wet weight in 2022 before declining to under 160,000 pounds (~73,000 kilograms) in 2024.[R32] However, landings are again on the rise; in spring 2025, farmers harvested approximately 240,000 pounds (~109,000 kilograms) of kelp.[R31]



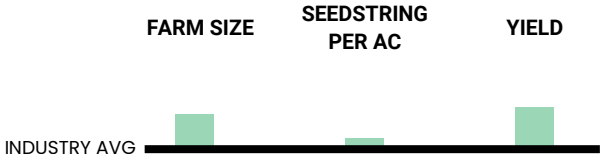
Key support organizations

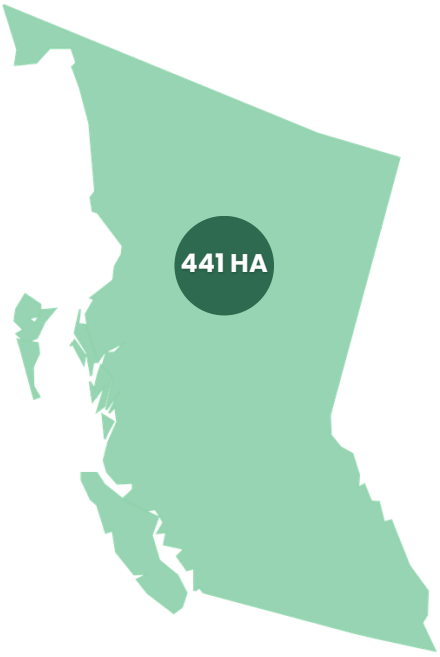
Alaska Fisheries Development Foundation, Alaska Mariculture Alliance, Alaska Mariculture Cluster, Alaska Sea Grant, Chugach Regional Resources Commission, Ecotrust, GreenWave, Kodiak Archipelago Leadership Institute, Native Conservancy, Native Village of Eyak, Pew Charitable Trusts, Prince William Sound Economic Development District, Prince William Sound Science Center, Southeast Conference, Spruce Root, Sun'aq Tribe of Kodiak, University of Alaska Fairbanks College of Fisheries and Ocean Sciences, University of Alaska Southeast - Sitka.

REGIONAL SNAPSHOT: **BRITISH COLUMBIA**

SPECIES CULTIVATED

+OTHER





20 FARMS

PERMITTED AREA: **441 HECTARES**

AVERAGE FARM SIZE: **22 HECTARES**

AVERAGE SEEDSTRING OUTPLANTED: **573 M**

AVERAGE YIELD OVER 3 SEASONS: **4.26 KG/M**

REPORTED ANNUAL LANDINGS: **> 75,000 KGS**

A significant share of kelp cultivation sites in British Columbia are held by First Nations and are operated by First Nations and/or First Nation partner businesses—reflecting an emerging pattern of First Nation leadership and partnership in kelp aquaculture and coastal economic diversification. Examples include Nation-owned or co-managed operations and partnerships with companies such as Cascadia Seaweed,[R33] as well as Indigenous-led entrepreneurial initiatives.[R34,R35,R36] Across these initiatives, First Nations emphasize stewardship, local benefit, and marine governance grounded in community values rather than purely commercial objectives.

Research on kelp mariculture in British Columbia further shows that First Nations envision kelp farming within frameworks of relational stewardship and ancestral governance principles, integrating Indigenous knowledge into decisions about how kelp farming should develop.[R37]

Production capacity

The first kelp farm in North America was established in British Columbia in 1982.[R38] This site—operating as Canadian Kelp Resources, Ltd.—is still in operation today.[R39]

As of August 2025, there were 20 ocean farm tenures (or leases) licensed for kelp cultivation in British Columbia, covering approximately 441 hectares (~1090 acres).[R40] These farms range in size from 2 to 71 hectares (~5 to 175 acres), and many are permitted for both shellfish and kelp (or marine plants, in permitting language).

REGIONAL SNAPSHOT: **BRITISH COLUMBIA**

Species cultivated

S*accharina latissima* (sugar kelp) and *Alaria marginata* (wakame or ribbon kelp) are the most widely cultivated in British Columbia. But like other regions along the eastern Pacific coast, farmers have also begun cultivating floating kelps, including *Macrocystis pyrifera* (giant kelp) and *Nereocystis luetkeana* (bull kelp) to meet buyer demand and support restoration efforts. A small number of farmers are also cultivating other species, including *Cymathaere triplicata* (three-ribbed kelp).

Landings

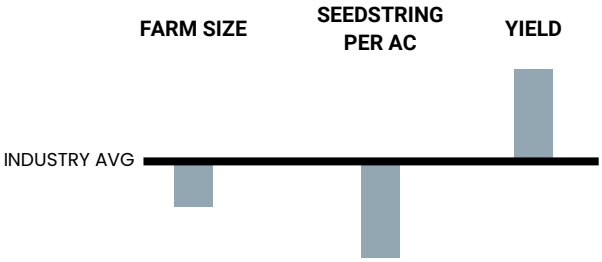
Most recent landings data available from the provincial government for British Columbia were from 2022. That year, active kelp farmers reported harvesting/selling just over 49,000 kilograms (~108,000 pounds) of *Saccharina latissima* and *Alaria marginata* combined.[R41] In 2023, Cascadia Seaweed reported outplanting 20 kilometers of kelp seedstring and producing 75 tonnes (over 165,000 pounds) of kelp.[R36] There are not enough farms in British Columbia reporting harvest data in *My Kelp* to provide more recent aggregated landings estimates.

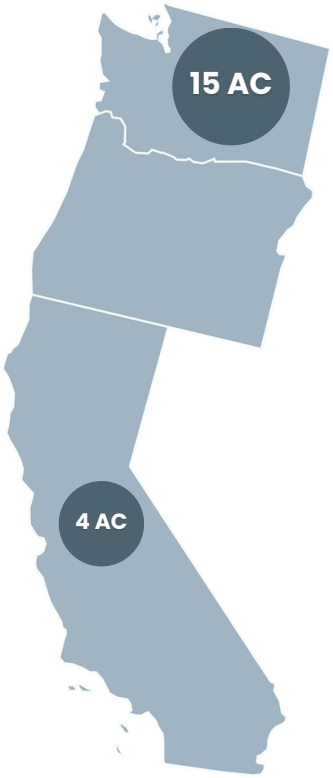
Key support organizations

Canadian Seaweed Industry Network, Centre for Ocean Applied Sustainable Technologies (COAST), Ecotrust Canada, GreenWave, IndigenousWorks, North Island College Seaweed Innovation Hub, Pacific Seaweed Industry Association, Pew Charitable Trusts.

REGIONAL SNAPSHOT:
U.S. WEST COAST

SPECIES CULTIVATED





5 FARMS

PERMITTED AREA: **19 ACRES**

AVERAGE FARM SIZE: **3.87 ACRES**

AVERAGE SEEDSTRING OUTPLANTED: **733 FT**

AVERAGE YIELD OVER 3 SEASONS: **3.77 LBS/FT**

REPORTED ANNUAL LANDINGS: NO DATA

Exposed coastlines and expensive and time-consuming leasing and permitting processes have stifled kelp farm expansion along the U.S. West Coast.

Production capacity

As of December 2025, there were five sites covering 19 acres (7.7 hectares) permitted for commercial kelp cultivation in the U.S. West Coast region, encompassing California, Oregon, and Washington. Farm sizes ranged from 0.6–10 acres (0.2–4 hectares), with an average size of 3.87 acres (1.57 hectares) and a median size of 2.72 acres (1.1 hectares). Farmers across the U.S. West Coast region have used a variety of cultivation systems, from multi-line catenaries on offshore sites to single-line and five-line arrays on farms closer to shore.

California

While state agencies in California have recently made progress in clarifying leasing and permitting processes,[R42] no new aquaculture leases have been issued in state waters in more than three decades. Ports and harbor districts with granted tidelands have also made incremental progress toward expanding access to kelp farming sites. The Port of San Diego, for example, is engaged in a years-long process to evaluate opportunities for seaweed and shellfish aquaculture within its jurisdiction and surrounding areas.[R43] The Humboldt Bay Harbor, Recreation, and Conservation District pre-permitted 21 acres (8.5 hectares) for shellfish and seaweed aquaculture.[R44]

REGIONAL SNAPSHOT: **U.S. WEST COAST**

Farmers are approved to cultivate kelp on four sites,[R45] but lease fees—ranging from $300–$600 per acre per month—are prohibitively expensive for most startup kelp farmers.[R46] There is no fast track to ocean-based kelp cultivation in the state.

Farther offshore in federal waters, the NOAA identified 10 locations suitable for seaweed cultivation in the Santa Barbara Channel and Santa Monica Bay as a part of the development of an Aquaculture Opportunity Area (AOA).[R47] The suitable locations within the AOA range in size from 500–2,000 acres (202–809 hectares), cumulatively covering 16,500 acres (6,677 hectares) of offshore waters.[R48] The final Programmatic Environmental Impact Statement for the AOA was completed in September 2025.[R49]

A 16-acre (6.5-hectare), demonstration-scale, giant kelp multi-line catenary array within an 86-acre (35-hectare) site in federal waters was decommissioned in 2025. Ocean Rainforest, the owners of the demonstration project, is seeking permits for a 2,000-acre (809-hectare) commercial site in the AOA.[R50] If permitted, Ocean Rainforest's proposed farm site in the NOAA AOA will significantly expand production capacity along the U.S. West Coast, and will nearly double the total permitted area within the United States.

Oregon and Washington

There are no commercial kelp farms in Oregon and planning for future mariculture expansion is in its nascency.[R51,R52] As of December 2025, there were only two active commercial kelp farms in Washington State.

Species cultivated

While kelp cultivation activity is limited in California and Washington, growers there have produced a range of species. In Southern California, research and demonstration farms have grown *Macrocystis pyrifera* (giant kelp). There is a push to commercialize other species, including *Laminaria farlowii* (golden kelp), but trials have been limited to lab and tank (i.e., raceway) cultivation.[R53]

In Northern California, farmers in Humboldt Bay are approved to cultivate *Nereocystis luetkeana* (bull kelp) and *Saccharina latissima* (sugar kelp), though bull kelp is the only kelp that has been commercially cultivated. Cultivation efforts in Northern California have focused on commercial cultivation and value creation for bull kelps, while supporting restoration of bull kelp habitat along the North Coast.[R54]

REGIONAL SNAPSHOT:
U.S. WEST COAST

Permitted farms in Humboldt Bay also have approvals for red algae cultivation, including five native species of *Chondracanthus*, *Gracilaria*, *Palmaria*, and *Pyropia* (or *Porphyra*).

Commercial kelp farmers in Washington state are only approved to cultivate sugar kelp, but current and prospective kelp farmers are exploring pathways for bull kelp cultivation to support market demand and restoration goals.[R55] Additional restoration-oriented bull kelp cultivation efforts are underway in California,[R56] Oregon,[R57] and Washington.[R58]

Although *Alaria marginata* (wakame or ribbon kelp) is present along the U.S. West Coast, farmers are not actively cultivating this species.

Communications with farmers, nursery operators, and other industry affiliates in Washington suggest that improved seed production capacity is necessary to support existing and future operations there.

Landings

State-level landings data for this region is unavailable. Currently, there are not enough farms reporting harvest data in *My Kelp* to provide aggregated landings.

Key support organizations

Bellingham Technical College, California State Polytechnic University (Cal Poly) - Humboldt, Ecotrust, GreenWave, Kelp Ark, Maritime Blue, Oregon Coast Mariculture Collaborative and Oregon Mariculture Network, Oregon Aquaculture Association, Puget Sound Restoration Fund, Santa Monica College, Sea Grant (CA, OR, WA), Washington Seaweed Collaborative.

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