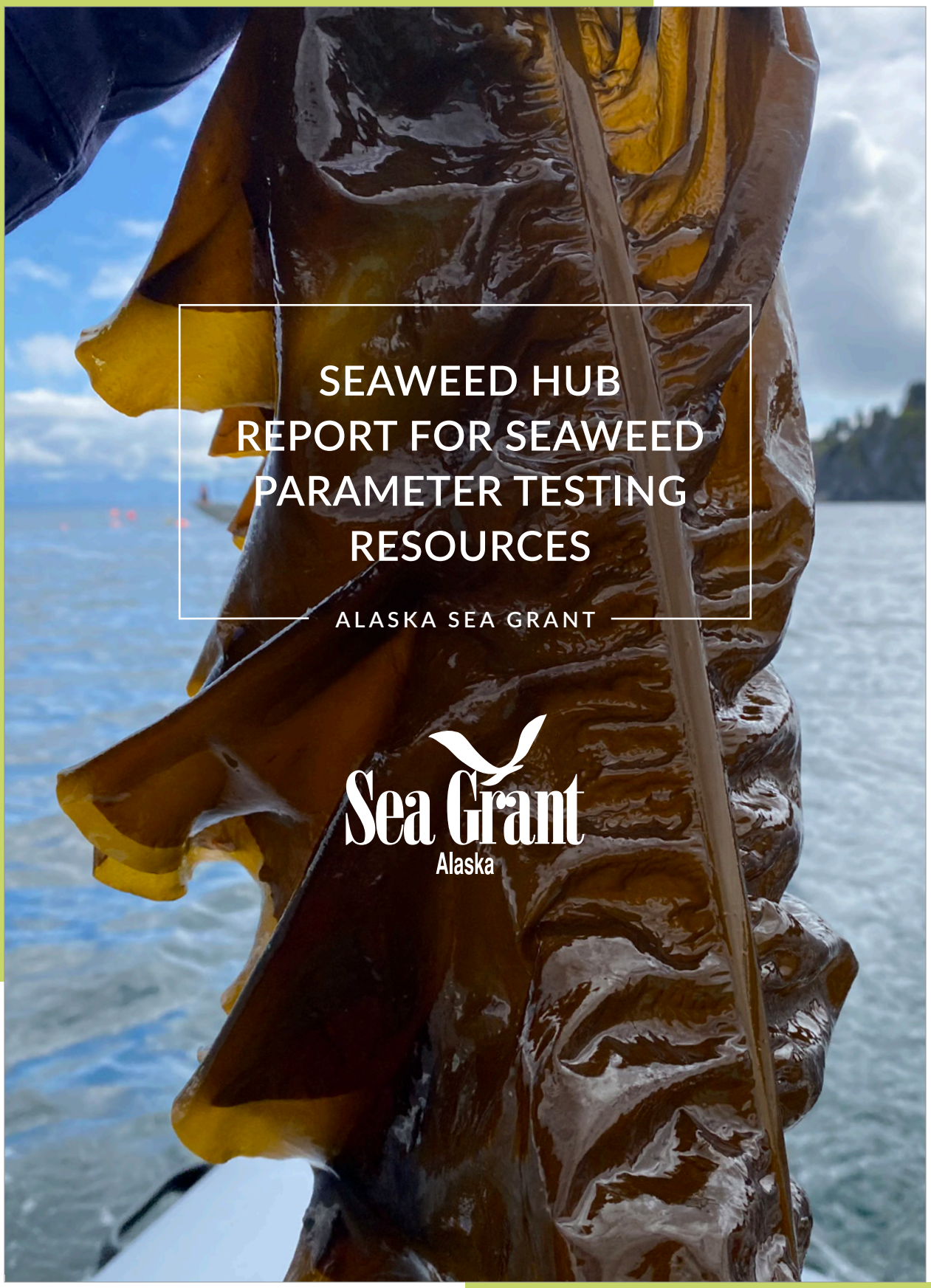
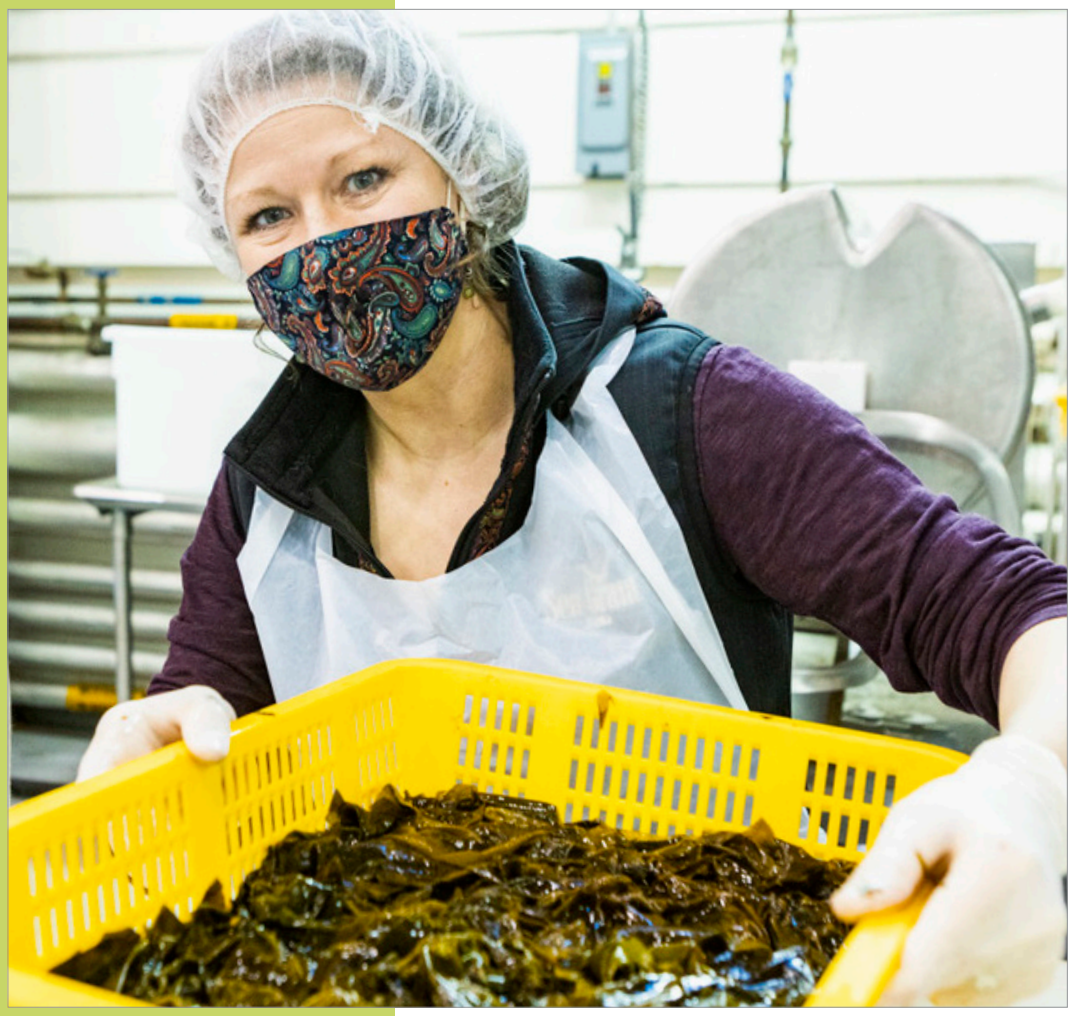


SEAWEED HUB REPORT FOR SEAWEED PARAMETER TESTING RESOURCES

ALASKA SEA GRANT

Sea Grant Alaska

MELISSA GOOD/ALASKA SEA GRANT



JR ANCHETA/UAF/ALASKA SEA GRANT

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INTRODUCTION

This guidance document is intended to help seaweed producers better understand seaweed tissue testing, environmental laboratories that conduct such testing, and how to approach these laboratories. It is the responsibility of the reader to verify that these guidelines are appropriate for their operation, and that their procedures meet with the current requirements.

While seaweed is generally viewed as an ingredient in value-added products, there is interest and the potential to expand manufacturing of products that capitalize on the nutritional benefits of seaweeds while maintaining food safety. In addition, non-food commodities such as supplements require large volumes and consistency in production and post-harvest techniques. Post-harvest opportunities and lack of processing infrastructure have been identified as barriers to the expansion of the domestic seaweed aquaculture industry, as indicated by responses to a National Seaweed Hub's needs assessment, and by the Seaweed Hub's Post-harvest Opportunities and Infrastructure working group consisting of producers, regulatory authorities, and processors. One way to address this barrier is to improve understanding of the importance of specific seaweed parameters in its form as a raw agricultural commodity (RAC), which can impact potential end-uses (i.e., food vs. non-food). Due to the lack of seaweed processing infrastructure in many states, most producers sell their crop as RAC, with very little or no stabilization of the crop. Standardizing production and harvesting practices to promote continuity in the quality of the crop was also identified as a way to increase access to different seaweed markets, and requires consistency when purchasing in large quantities.

There are different standards established for specific seaweed markets, and producers are responsible for ensuring that their seaweed products meet these standards. Seaweed producers need to know which key parameters (e.g., compounds, nutrients) to measure, why it is important to measure these key parameters (e.g., seafood safety), and what acceptable levels have been established for different seaweed markets. Figure 1 shows several chemical, microbiological, and physical hazards that can pose a risk to consumers. Knowing that there are risks, it is important to understand these hazards and develop standardized testing within the industry, which will help inform industry, regulators and

Figure 1. SOME POTENTIAL FOOD SAFETY HAZARDS ASSOCIATED WITH SEAWEED

POTENTIAL FOOD SAFETY HAZARDS IN SEAWEED

CHEMICAL HAZARDS	MICROBIOLOGICAL HAZARDS	PHYSICAL HAZARDS
» Heavy metals (e.g. lead, arsenic, mercury, cadmium) » Iodine » Pesticide residues » Radionuclides (e.g. ^{210}Polonium, ^{7}Beryllium, ^{234}Thorium, ^{228}Radon, ^{90}Strontium, ^{137}Caesium, ^{238}Plutonium) » Persistent organic pollutants (e.g. dioxins and polychlorinated biphenyls) » Allergens » Biotoxins	» Pathogenic bacteria (e.g. Salmonella, Bacillus, pathogenic Escherichia coli, Listeria, Staphylococcus aureus, and Vibrio parahaemolyticus) » Viruses (e.g. norovirus, hepatitis E virus) » Biotoxins » Dinoflagellate toxins » Cyanobacteria	» Metal pieces from harvesting and/or processing » Glass splinters » Micro- and nanoplastics » Small crustaceans/invertebrates

Note: This list is not exhaustive

Sources: Based on information from Banach, J.L., Hoek-van den Hil, E.F. & van der Fels-Klerx, H.L. 2020a. Food safety hazards in the European seaweed chain. *Comprehensive Reviews in Food Science and Food Safety*, 19: 332–364. https://doi.org/10.1111/1541-4337.12523; Food Safety Authority of Ireland (FSAI). 2020. *Safety considerations of seaweed and seaweed-derived foods available on the Irish Market*. Report of the Scientific Committee of the Food Safety Authority of Ireland (FSAI). Dublin. https://fsai.ie/SafetyConsiderations_SeaweedAndSeaweedDerivedFoods_IrishMarket; and Concepcion, A., DeRosia-Banick, K. & Balcom, N. 2020. Seaweed production and processing in Connecticut: A guide to understanding and controlling potential food safety hazards. Groton, Connecticut, USA. https://seagrant.uconn.edu/wp-content/uploads/sites/1985/2020/01/Seaweed-Hazards-Guide_Jan2020_accessible.pdf

consumers of the risks and benefits of seaweed use.

While this report does not go into detail on the intrinsic properties of the different edible seaweed species, it is generally understood that edible seaweeds can be a rich source of macro- and micro-nutrients (Paul Cherry et al. 2019). In a review, Yong-Xin & Se-Kwon (2011) concluded that seaweed-derived functional ingredients play a vital role in human health and nutrition, and the antioxidants derived from seaweed can increase food product shelf life.

Furthermore, seaweed has potential for providing many additional benefits, including supporting global ecosystems and food security.

However, prospective risks need to be accounted for, such as excessive iodine ingestion or bioaccumulation of heavy metals (see Table 1). Seaweed producers must take specific risks and vulnerable populations into account when making nuanced decisions such as seaweed species, growing site, type of processing (raw, dried, blanched, etc.), and more. For example, some

Table 1. RANKING OF FOOD SAFETY HAZARDS IN SEAWEED

HAZARD	LITERATURE LINKING HAZARD TO FOOD	LITERATURE LINKING HAZARD TO FEED	RASFF REPORT THAT SHOW >2% OF TOTAL REPORTS	CONCERN FOR ≥ 25% OF STAKE-HOLDERS	SCORE	ASSIGNED HAZARD CATEGORY
Arsenic	Possibly	Yes	Yes	Yes	1.67	Major
Cadmium	Possibly	Possibly	Yes	Yes	1.59	Major
Iodine	Yes	Yes	Yes	Yes	1.5	Major
Salmonella	Yes	Yes	No	Yes	1.5	Major
Lead	Possibly	Possibly	No	Yes	1.34	Moderate
Mercury	Possibly	Possibly	No	Yes	1.34	Moderate
Aluminium	Possibly	Possibly	Yes	No	1.34	Moderate
Bacilus	Yes	Limited Data	No	Yes	1.33	Moderate
Norovirus	Yes	Limited Data	No	Yes	1.33	Moderate
Dioxins and Polychlorinated Biphenyfs	Limited Data	Limited Data	No	Yes	1.17	Minor*
Brominate Flame Retardants	Limited Data	Limited Data	No	Yes	1.17	Minor*
Polycyclic Aromatic Hydrocarbons	Limited Data	Limited Data	No	Yes	1.17	Minor*
Other Pathogenic Bacteria	Limited Data	Limited Data	No	Yes	1.17	Minor*
Hepatitis E Virus	Limited Data	Limited Data	No	Yes	1.17	Minor*
Fluorine	Possibly	Possibly	No	No	1.09	Minor
Pesticide Residues	Limited Data	Limited Data	No	No	0.92	Minor*
Pharmaceuticals	Limited Data	Limited Data	No	No	0.92	Minor*
Marine Biotoxins	Limited Data	Limited Data	No	No	0.92	Minor*
Allergens	Limited Data	Limited Data	No	Yes	0.92	Minor*
Micro- and Nanoplastics	Limited Data	Limited Data	No	No	0.92	Minor*
Radionuclides	No	No	No	No	0.75	Minor

Note: Not all hazards ranked in the referenced study have been discussed in this text. The authors (i.e. Banach et al., 2020a) developed a scheme to rank the hazards based on four factors: occurrence of the hazard in food, occurrence in feed, RASFF alerts and survey responses from stakeholders in the seaweed value chain. In the survey, respondents indicated which hazards they considered to be of concern (the more respondents who selected a hazard, the greater the concern considered to be associated with that hazard). Scores were assigned to each factor, the final scores aggregated, and the hazards ranked into major (score 1.75 to 1.50), moderate (score 1.49 to 1.25), or minor (score 1.24 to 0.75).

*Authors indicated data gaps on the assessed hazard

Source: Adapted from Banach et al. (2020a).

kelp species bioaccumulate iodine above safe intake levels, with several regulatory bodies applying guidance to vulnerable population groups (e.g., pregnant or breast-feeding women, people who have thyroid dysfunction, and people who have heart or kidney disease). However, some processing practices have been shown to reduce edible seaweed iodine levels (Stévant et al., 2018, Teas et al., 2004), and other methodologies may have similar effects. Therefore, with proper understanding, testing and nutritional labeling, growers, processors and consumers will be able to make educated decisions.

In the United States, seaweeds currently have limited guidance from the U.S. Food and Drug Administration (FDA), which regulates the safe handling and processing of seafood. The FDA has classified seaweed as GRAS (Generally Recognized as Safe) as a food additive, although further regulations are still in development. Seaweed producers and processors can be proactive by following available national and international guidance. For example, Connecticut Sea Grant and the Connecticut Department of Agriculture, Bureau of Aquaculture (DABA) have set seaweed guidance and regulations for the state of Connecticut to address food safety practices. In 2021, the Food and Agriculture Organization of the United Nations (FAO) published a report of the Expert Meeting on the Food Safety of Seaweed. This report looks at the international seaweed industry, food safety, current regulations, and breaks down the individual hazards associated with seaweed production and processing. From the FAO report, adapted from an article by Banach et al., 2020, Table 1 shows ranked seaweed food safety hazards.

Finally, there are nutritional facts labeling (NFL) requirements that must be met. The objective of NFL, mandated by law, is to provide consumers with honest and accurate labeling of the product so they can understand and make informed decisions. Edible seaweeds have been shown to be an excellent source of micro- and macro-nutrients, including important minerals and vitamins, driving increased interest in seaweed consumption (Paul Cherry et al., 2019). Accurate testing and nutrition labeling of seaweeds is important given increased consumer interest in the nutritional makeup of their food and associated risks, and because seaweeds naturally absorb and bioaccumulate nutrients from their environment.

In 2016, the FDA updated NFL requirements for packaged foods to better reflect the current science. The testing laboratory will assist with the process of developing labels. Refer to FDA food labeling and nutrition and check for state-specific guidance in advance.

ENVIRONMENTAL LABORATORIES

In this report, *environmental laboratory* (EL) refers to any facility that performs analyses on environmental samples to determine the quality of food, milk, public water supplies, surface water, ground water, recreational waters, wastewater, air, or land.

ISO 17025 General requirements for the competence of testing and calibration laboratories is a standard published by the International Organization of Standardizations. *Certification* occurs when a third-party assessment body certifies that a company meets certain ISO standards, while an *accreditation* grants the ability for an assessment body to formally evaluate and certify that a company meets ISO standards. Accreditation is considered a superior qualification to certification. Although not mandatory, ELs will generally have an *ISO 17025* certification and/or accreditation to verify their competency to undertake testing to the highest standard.

For this guide, we reached out to several ELs nationwide to learn about their capacity to test for certain factors relevant to seaweed-related food safety and distribution:

- Microbes: total bacteria counts, coliform bacteria and pathogenic *E. coli*, food borne pathogens (e.g., *vibrio, salmonella* and *staphylococcus*, mold and yeasts)
- Petrol residues: polychlorinated aromatic hydrocarbons (PAH)
- Heavy Metals: cadmium, lead, mercury, inorganic forms of arsenic, iodine
- Radionuclide
- Nutritional labeling

Table 2 provides a breakdown of the ELs contacted. These ELs and their details are provided solely as examples for understanding a range of offerings among a subset of available companies; the authors of this report are not endorsing or disapproving of any particular laboratory, whether listed or omitted, for any particular service. Figure 2 provides an example correspondence when contacting an EL.

Table 2. EXAMPLE OF ENVIRONMENTAL LABORATORIES THAT CAN DO TESTING

LAB NAME	LOCATION	EMAIL	NUTRITIONAL LABELING	ACCREDITATION	RELEVANT TESTING*
Exact Scientific Services Inc.	1355 Pacific Pl #101, Ferndale, WA 98248	lab@exactscientific.com	YES	ELAP, ANSI, AOCS	SOME
Brooks Applied Labs	13751 Lake City Way NE Suite 108, Seattle, WA 98125	info@brooksapplied.com	NO	Florida Primary NELAP, ANAB ISO 17025, Alaska CS-LAP, Virginia DCLS, Washington DoE	SOME
Midwest Laboratories	13611 B St, Omaha, NE 68144	contactus@midwestlabs.com	YES	ISO/IEC 17025:2017	SOME
EMSL Analytical, Inc.	Nationwide	cs@emsl.com	YES	AAR, AIHA EMLAP/ IHLAP/ELLAP, AIHA EMPAT/IHPAT/ ELPAT, A2LA, NVLAP	ALL
Northeast Laboratory Services	Maine and Massachusetts	info@nelabservices.com	YES	A2LA ISO/IEC 17025:2017	SOME
IEH Laboratories	Nationwide	info@iehinc.com	YES	ANAB ISO/IEC 17025	ALL

* The seaweed-relevant services examined include tests for select microbes, food borne pathogens, petrol residues, heavy metals, radionuclides, and nutritional labeling. Information as of October 2022.

Figure 2. EXAMPLE INQUIRY FOR LABORATORY SERVICES FOR KELP/EDIBLE SEAWEED TESTING

To whom it may concern,

My name is ……., and I am a …… (kelp farm owner, processor, etc.). I am inquiring about your services for testing seaweed products. Below are some questions, and parameters for testing I would like to have conducted.

1. Are you able to conduct each of the tests listed below, on raw kelp/seaweed?
2. Could you provide guidance on sampling, packaging, and shipment to your laboratory, possibly from remote locations?
3. What are your test result timelines and lead times?
4. Is there anything else I should know, including tests that could be unnecessary, or things that I might be overlooking?.

Specific tests

Microbes

- Total bacteria counts
- Coliform bacteria & pathogenic *E. coli*
- Food borne pathogens e.g., *Vibrio, Salmonella and Staphylococcus*
- Mold and yeasts

Petrol Residues

- Polychlorinated Aromatic Hydrocarbons (PAH)

Heavy Metals

- Cadmium
- Lead
- Mercury
- Inorganic forms of arsenic
- Iodine
- Radionuclides

Nutritional Labeling

- Are you able to provide this service?
- Are you able to advise and guide me through the correct procedures?

Thank you for your time and consideration.

Regards,

…….

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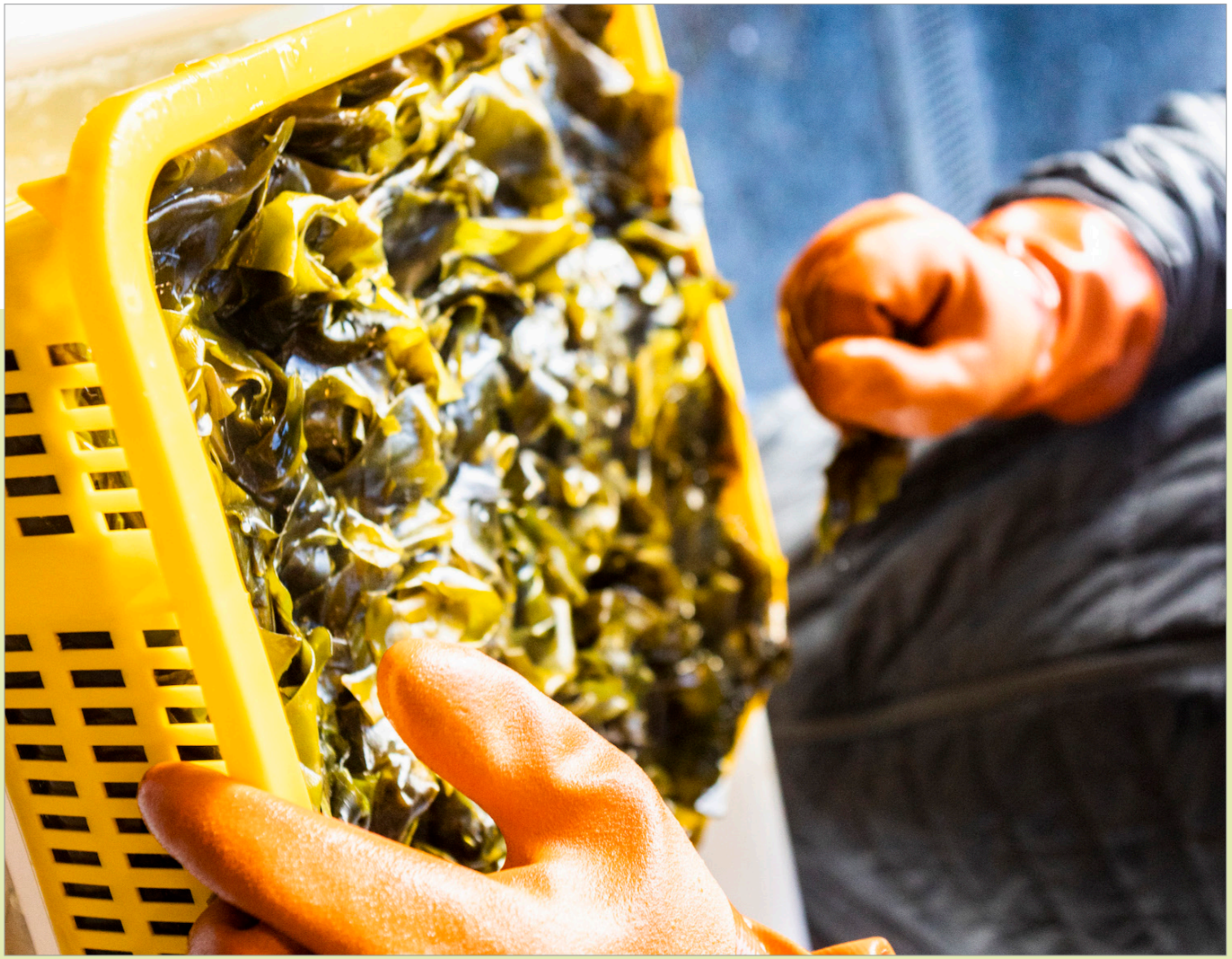

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