National Organic Standards Board Materials Subcommittee Proposal
Marine Macroalgae[1] in Crop Fertility Inputs
August 11, 2020

Summary:
This proposal brings forward an annotation to marine macroalgae used as crop fertility inputs to provide parameters on harvesting addressing conservation areas, bottom trawling, protecting reproduction of the population and ecosystem functions, biomass and architecture, and bycatch.

Introduction and Use:
Seaweeds are classified into three broad groups based on pigmentation: brown, red, and green; respectively, *Phaeophyceae*, *Rhodophyceae* and *Chlorophyceae* (TR 2016 lines 103-4), and all three classes are used in organic fertilizers[2]. Seaweeds are also called macro-algae, distinguishing them from micro-algae (*Cyanophyceae*) which are microscopic in size and often unicellular (TR 2016 lines 108-110). Seaweeds used in synthetic aquatic plant extracts and in nonsynthetic products, namely meal, are macroalgae.

Marine macroalgae are used in extracts as foliar fertilizers or as soil conditioners. They also are used as a foliar/soil feed or transplant solution and seed treatment. The material is absorbed into the plant and acts as a growth promoter (TR 2006 lines 63-6). Marine macroalgae is widely used by producers. During the most recent sunset review of aquatic plant extracts, certifiers reported high numbers of growers listing these materials on their Organic System Plans.

Background:
In 2015, the board had a lengthy sunset review, and as part of that process reviewed marine materials in the Handling (seaweeds for human consumption), Crops (aquatic plant extracts for fertilizers), and Livestock (kelp for feed) subcommittees. In the Crops Subcommittee, the majority of initial comments were in favor of keeping aquatic plant extracts on the National List. During the fall public comment period, the Subcommittee identified concern about potential overharvesting. Extensive public comment was received on this issue. At the end of the fall 2015 meeting, the board recommended keeping aquatic plant extracts on the National List; however, the vote was divided. The board consequently prioritized review of this topic and determined that a Technical Evaluation Report (TR) was needed on all the marine plants used in organic production across the Crops, Livestock, and Handling Subcommittees.

The board received the limited scope TR on Marine Plants and Algae in summer 2016. Subsequently, the Handling Subcommittee published a fall 2016 Discussion Document for Marine Algae Listings on the National List. In it, the board stated that "it is within this context of a desire to allow use of marine plants and algae in organic production, while at the same time ensuring long term sustainability, that the marine materials on the National List must be reviewed". The board solicited public comment on addressing naming conventions as well as developing guidelines for wild harvested seaweeds. As a result, a spring 2017 Proposal on Marine Algae Listings was posted in the Crops Subcommittee, which was virtually identical to a similar proposal in Handling, and it tried to address classification and nomenclature. In the Crops section, a proposal was put forth to limit aquatic plant extracts to those

[1] For the purposes of this proposal, the term "marine macroalgae" is used to refer to marine plants, seaweed, and marine vegetation.

[2] The 2016 TR lists species used in fertilizers and their harvest regions. This list can also be found in on page 3 of the fall 2018 Discussion Document on this topic.

derived from brown macroalgae. Public comment revealed there were numerous products containing red, green, and brown macroalgae. In Handling, significant public comment was received stating stakeholders needed more time to address the classification and nomenclature issues. The Handling Subcommittee re-posted the Discussion Document for the Fall 2017 but received no significant additional public comment.

The work agenda item was moved to the Materials Subcommittee, and the board explored new approaches to addressing concerns about environmental impact. The Materials Subcommittee posted a fall 2018 Discussion Document proposing that all marine macroalgal ingredients used in organic crop production be certified organic. The spring and fall 2019 Discussion Document solicited comments on the question of organic certification or an annotation specifying harvest methods. To further explore this complex topic, the board convened an expert Panel on Marine Materials used in crop inputs at the fall 2019 meeting.

The goal of the board's work on this topic is to take a precautionary approach to ensuring that both synthetic and nonsynthetic forms of marine macroalgae used in fertilizers are not "harmful to ... the environment" by adversely impacting the ecosystem provisioning of the marine environment.

Relevant Areas of the Rule, NOP Guidance, NOP Policy Memo, and NOSB Policy and Procedures Manual:

OFPA Section 6517 [National List] (c) [Guidelines for Exemptions or Prohibitions] (1)(a)(i) and (2)(a)(i) which allows for the prohibition of synthetic or nonsynthetic substances, respectively, that would be "harmful to ... the environment."

§205.2 Terms defined.
Organic production. A production system that is managed in accordance with the Act and regulations in this part to respond to site-specific conditions by integrating cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity.

§205.601 Synthetic substances allowed for use in organic crop production.
In accordance with restrictions specified in this section, the following synthetic substances may be used in organic crop production: Provided that, use of such substances does not contribute to contamination of crops, soil, or water...
(j) As plant or soil amendments.
(1) Aquatic plant extracts (other than hydrolyzed) –Extraction process is limited to the use of potassium hydroxide or sodium hydroxide; solvent amount use is limited to that amount necessary for extraction.

§205.207 Wild-crop harvesting practice standard.
(a) A wild crop that is intended to be sold, labeled, or represented as organic must be harvested from a designated area that has had no prohibited substance as set forth in §205.105, applied to it for a period of 3 years immediately preceding the harvest of the wild crop.
(b) A wild crop must be harvested in a manner that ensures that such harvesting or gathering will not be destructive to the environment and will sustain the growth and production of the wild crop.

§205.200 General.
Production practices … must maintain or improve the natural resources of the operation, including soil and water quality.

7 U.S.C. 6518 National Organic Standards Board, 6518 (b) Board composition, (4) three shall be individuals with expertise in areas of environmental protection and resource conservation; (6) one shall be an individual with expertise in the fields of toxicology, ecology, or biochemistry.

NOP 5022, effective July 22, 2011, Guidance: Wild Crop Harvesting provides details to clarify §205.207, including:

Section 205.200 states that production practices must maintain or improve the natural resources of an operation under organic certification. This applies to all types of organic certification, including wild crops. Unmanaged, untrained and uninformed harvesting of wild products from a wild habitat without maintaining or improving the natural resources can disqualify the wild products from organic certification.

Additionally, the Guidance states:

1. A description of the proposed ecosystem management and harvesting practices, the impact of their proposed harvesting on the long-term viability of the wild species and on the area's ecosystem, and information on any equipment planned for use or being used to harvest and manage the wild-crop and ecosystem.
    a. This should include a description of the monitoring system that will be used to ensure that the crop is harvested in a sustainable manner that does not damage the environment, including soil and water quality.
2. A list of any rare, threatened, or endangered terrestrial or aquatic plants or animals that occur in the harvest area.
    a. The presence of rare, threatened, or endangered species in a wild harvest area does not automatically disqualify an operation from organic certification, but any potential or actual impacts need to be described and addressed.
    b. If there are potential or actual negative impacts resulting from the wild crop management and harvesting, actions that address and correct these impacts need to be described, implemented, and monitored.
3. The procedures employed that prevent contamination from adjoining land use or other point or non-point sources contamination.
4. The training provided and the procedures employed to ensure that all collectors harvest crops in accordance with the OSP and in a manner that does not damage the environment.

NOP 5020, effective 1/15/16, Guidance: Natural Resources and Biodiversity Conservation clarifies organic regulations at 7 CFR 205.200 that states, "to maintain or improve the natural resources of the operation….".

NOP Policy Memo 12-1, Production and Certification of Aquatic Plants, issued September 12, 2012 provides further clarification as follows:

This policy memorandum is issued as a reminder that aquatic plants and their products may be certified under the current USDA organic regulations. Certifiers and their clients may use the USDA organic regulations, including the National List of Allowed and Prohibited Substances at 7 Code of Federal Regulations (CFR) 205.601-205.602, as the basis for the production and certification of cultured and wild crop harvested aquatic plants.

While current USDA organic regulations specifically exclude aquatic animals from organic certification, no such exclusion exists for aquatic plants. Further, some parts of the USDA organic regulations specifically address aquatic plant production. For example, some aquatic plants, such as kelps and seaweeds, are listed in 7 CFR 205.606 of the USDA organic regulations, allowing their use in non-organic form when certified organic forms are not commercially available. Producers and certifiers are required to comply with the USDA organic regulations when producing or certifying cultured and wild crop harvested aquatic plants.

The use of ground and surface waters, ponds, streams, or other waterways for aquatic plant production may be regulated by Federal, State, or local authorities. Aquatic plant producers should consult with Federal, State, and local authorities to ensure compliance with all applicable laws, in addition to the USDA organic regulations, regarding the use of synthetic substances and other materials in ponds and waterways. Also, under 7 CFR 205.200, aquatic plant producers must ensure, and certifying agents must verify, that production practices maintain or improve the natural resources of the operation, including soil and water quality.

NOSB Policy and Procedures Manual, Principles of Organic Agriculture Organic agriculture, adopted 2001, 1.1 states: Organic agriculture…is an ecological production management system that promotes and enhances biodiversity, biological cycles, and soil biological activity.

Public Comments:
Public comments over the past several years have been diverse on this topic and range from support for organic certification as an appropriate tool to address environmental impacts of harvesting, to caution against setting a precedent of certifying an input ingredient, to concerns that certification could amount to greenwashing by inadequately addressing environmental impact, to sentiments that the industry does not need further regulation. A broad review of public comments can be found in the earlier discussion documents referenced above.

The 2019 spring and fall discussion document asked stakeholders to provide feedback on the possibility of requiring organic certification for marine macroalgae input ingredients, presented standards from other certifiers and third-party entities certifying sustainable seaweed, solicited numbers of crop input products approved for use that currently contain certified organic marine algae ingredients, and inquired if farmed algae is used in any products. Public comments covered all questioned posed.

Although several certifiers were skeptical about the ability to certify wild aquatic systems, it was also noted that this is already being done for handling and livestock uses of marine macroalgae. Importantly, material review organizations reported that there are some crop fertilizer products now that formulate with certified organic marine macroalgal ingredients. Farmed algae do not appear to be used, likely given the high cost of seaweed aquaculture compared with the large volumes of material needed for fertilizers[3].

While some worried about increased scrutiny of additional nonsynthetic inputs, others said some natural inputs likely deserve more scrutiny for their environmental impact. Opposition to requiring organic certification was centered on precedent setting and the inconsistency of requiring certification for one type of input but not others (though there were also some who felt marine macroalgae should not be certified organic as its harvest can never meet the standard of not destructive to the

[3] Theuerkauf *et al*. discuss the potential of seaweed aquaculture to mitigate seagrass beds and kelp forests losses globally as a result of overharvesting and other human activities (2019). See Buschmann *et al*. on the prospects of seaweed cultivation to alleviate increasing harvest pressure, particularly of *Macrocystis pyrifera* (2014).

environment). One commenter supporting certification as a tool stated that if organic certification is important for food, the organic community should also see it as viable for inputs. They noted, "we do not believe that requiring organic certification of marine material inputs would create the universal expectation that all crop inputs, such as manure and mulches, be certified organic". Another commenter shared that "sourcing of inputs, including those from natural resources, can have significant impact on the sustainability of agricultural systems, and NOSB is responsible for making recommendations for inputs on the National List that would not harm the environment".

Some public comment supported using annotations to the National List and definitions as the best means for developing clear standards rather than requiring certification. NOP guidance would provide additional information on implementation, as well as training areas for inspectors. It was felt that an annotation could specify parameters for harvesting and would be more enforceable than attempting to establish such parameters through guidance complementing an organic certification requirement. A material review organization said they could hire staff capable of reviewing an annotation and conducting on-site inspections.

One public commenter and marine biologist proposed "some key aspects to be considered within the definition of 'not destructive to the environment': a) the amount that can be harvested from an area; b) the method and timing of harvest; c) the impact of the harvest on the structure and reproduction of the plants themselves; d) the consequences of the changes in the canopy for other species; e) the direct removal of non-target species (by-catch); and the ability of the ecosystem to f) remain resilient in the face of many challenges (climate change, invasive species) and g) maintain essential functions and services". Another marine scientist emphasized the need to focus on the habitat marine macroalgae provide when considering the effects of harvesting.

Some stakeholders suggested prohibiting specific species, regions, or harvest methods might be an option. Some felt government regulations are adequate, though it was acknowledged that they do not typically involve on-site verification and enforcement varies. One stakeholder suggested that more information is needed about existing legal frameworks in countries where most marine macroalgae used in fertilizers is harvested.

The board particularly requested industry participation and heard from a number of harvesters in the fall 2019 public comments. Several harvesters stated that the harvest of rockweed, for example, is well regulated and does not negatively impact the marine environment. One harvester explained that they follow biomass assessments, closed areas, minimum cutting heights, and periodic auditing. They indicated that if the wild crop standards for organic certification as applied to marine macroalgae feed for livestock remained the same for certification of macroalgae for fertilizer products, they would support organic certification. Another harvester said that while not against organic certification, they prefer applying the commercial availability clause instead. One harvester and processor stated that annual regrowth of the seaweed extracted exceeds the amount harvested. A company based in Ireland explained its compliance process with each of its harvesters, which includes hand harvesting to preserve "the balance of the ecosystem without damaging environmental issues that could arise from this activity".

An industry task force was developed by one association to foster discussion around this topic. There was a request for more documentation of the need for monitoring harvests to avoid environmental impact. In addition, the stakeholder said that more information on global harvesting rates is needed. As noted by the Food and Agriculture Organization, "About 25 million tonnes of seaweeds and other algae are harvested annually for use as food, in cosmetics and fertilizers, and are processed to extract thickening agents or used as an additive to animal feed." Unfortunately, accurate global harvest rates for marine macroalgae across all uses is difficult to obtain. Equally, information on the impact of harvests for fertilizers is unavailable on a global level (see the review of the scientific literature below for more information).

One public commenter provided a comprehensive overview of all marine materials used in organic production across macroalgal and fish uses in Crops, Livestock, and Handling. Although some public comment suggested we look at all marine uses across all subcommittees under one work agenda item, there are practical limitations that make that challenging. Significant differences exist between fish and marine macroalgae and between Handling and Livestock uses. Each marine material on the National List represents a discreet use that warrants individual attention. If the work agenda item were too large, it might preclude meaningful progress.

Stakeholders asked the board to create standards that cover existing certified organic marine macroalgal materials. Some were concerned that the board not create a higher standard for crop fertility uses of marine macroalgae than for human consumption and livestock feed. Alternatively, it could be argued that most seaweeds used in organic handling and all used in organic animal agriculture receive some measure of oversight and protection through their certification to the wild crop standard. The inconsistency lies in using the same, unverified input in fertilizers that is certified organic in handling and livestock uses. Additionally, the wild crop standard is necessarily general to cover the wide range of crops it can include. But in its generality, it does not give guidelines for how the standard operates in complex marine environments. As one commenter said, the existing wild crop standards "are very limited" and "do not provide sufficient metrics for certifiers". Given the complexity of this topic, this proposal is intended as a first step, with subsequent explorations of marine macroalgae uses in Handling and Livestock. Annotations for Handling and Livestock uses will be the next area the Materials Subcommittee investigates.

In conclusion, one harvester of certified organic kelp meal noted "agriculture by its very nature causes environmental harm, even organic agriculture disrupts the natural succession of the ecosystem". Organic agriculture is founded on practices intended to minimize its environmental impact and harm. The commitment organic farmers demonstrate to soil and water conservation, fostering biodiversity, and limiting negative impacts of synthetic chemicals through a host of practices relates to a desire by many to source inputs reflecting similar values.

Discussion:

Review of the Literature

A review of the literature on the environmental impact of commercial seaweed harvesting varies in its findings. The 2016 TR raised concerns about the potential for negative environmental impacts on marine ecosystems from macroalgal harvesting. Some examples noted in the 2016 TR were specific to species used in organic crop fertility inputs and aquatic plant extracts. For example, in mechanical harvesting in Iceland, as with other areas where *Ascophyllum nodosum* and *Laminaria digitata* are harvested commercially, ecological concerns about changes in species diversity resulting from harvesting have been noted (TR 2016 lines 892-6). The cited paper states "industrial harvesting of the seaweed *Ascophyllum nodosum* in the Bay of Breioafjorour inevitably leads to the death of huge numbers of invertebrates, including species that are important food for birds" (Ingolfsson 2010). In

Nova Scotia, commercial yields of rockweed are maintained. A comprehensive assessment of impacts performed by industry or third-party research proving harvest rates are not detrimental to the rockweed marine community is lacking. Estimated recovery times based on percentages of rockweed removed vary between publications (TR 2016 lines 597-600). Additionally:

> There is one species of red algae and two species of brown algae growing along the coasts of the United States that have gained attention as ecologically threatened in recent years. They are respectively, Irish moss (*Chondrus crispus*), rockweed (*Ascophyllum nodosum*) and giant kelp (*Macrocystis pyrifera*). These plants are economically important and drive several seaweed industries including cosmetic products, nutraceuticals, fertilizers and hydrocolloids. Fertilizer applications are similar to farmyard manure, but may also include extracts and foliar applications (Chojnacka, 2012).
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> Kelp and rockweed, are foundational species forming large expansive marine habitats supporting a diverse range of wildlife, including other algal species, marine animals and many species of protozoans and bacteria (Seeley and Schlesinger, 2012). Without a good accounting of all of the species present it is hard to predict the effects of harvesting rockweed and kelp on each ecological niche. Thus, it has been important to recognize that sustainable seaweed production perceived as reproducible harvest capacity, may not guarantee the sustained subsistence of each resident species. Although not part of any agricultural waste stream, extracts from wild-harvested kelp and rockweed are allowed for use in organic production as soil amendments (§205.601(j)(1)). [TR 2016 lines 522-535].

Even within the 2016 TR, differences of opinion about the environmental impacts of harvesting were noted within the scientific community. For example:

> One study addressing the major components of the resident fish community in the rocky intertidal zone after rockweed harvest found no evidence linking rockweed harvest to changes in the ichthyoplankton component or the juvenile and adult fish of that community (van Guelpen and Pohle, 2014). In a summarized review of selected work, a researcher at the University of Maine also concluded that the effect of 17% rockweed harvest on some species including seabirds was negligible (Beal, 2015). [TR lines 326-31]

The TR goes on to explain that:

> Notwithstanding, rockweed has an important role as habitat, as food and as a nutrient source supporting a community of organisms that inhabit its "forests." Any cutting of rockweed can produce an effect on the supported eco-communities. Furthermore, many aspects of this ecosystem have not been elucidated, encouraging more precaution as the brown algae "forestry" industry grows into the future (Seeley and Schlesinger, 2012). [TR lines 356-60]

Since 2016, the board has received numerous public comments by marine macroalgae experts and other stakeholders, and these have included myriad references to the academic literature. A reading of the comments and their citations reveals the many views on the environmental impacts of harvesting marine macroalgae. Nevertheless, it cannot be said that removing a wild native species from a wild native ecosystem, as in the case of commercial marine macroalgal harvests, has no impact on the environment. As explained above, the extent to which harvesting causes negative environmental impacts is contested within the literature[4]. There are certainly papers that will state views counter to those cited below, and interestingly, the same papers are quoted to support competing claims[5]. It is not the goal of this proposal to argue over whose science is right.

The literature review on the environmental impacts of harvesting is not intended to suggest that effects cannot be at least partially mitigated or that harvesting should not occur. Rather, the information was requested in public comments, and it is presented to demonstrate the complexity of the issue and to address claims made in some public comments that harvesting has little effect on the environment. While it is not possible to provide a comprehensive analysis of peer-reviewed research here and there are numerous other articles that could have been cited, the following review of the scientific literature provides the technical data to support this proposal.

"Canopy-forming seaweeds, including kelps, rockweeds and many red seaweeds are widely acknowledged as foundation species that form important three-dimensional structure in marine coastal environments which contribute important functions and services" (Lotze *et al*. 2019). These include primary and secondary production, production of detritus, nutrient cycling, carbon storage, nutrient retention, provision of food for biodiversity, biological links between marine ecosystems, habitat for year-round residents, foraging grounds, breeding and nursery areas, refugia from predators, coastal buffers from waves and storms, and filters for runoff (Ibid). "Despite the ecological importance of seaweed canopies and their long history of harvesting, relatively few studies have directly examined the effects of harvesting beyond the resource species itself on ecosystem structure, functions and services" (Ibid). The authors conclude that:

> harvesting canopy-forming seaweeds affects the morphology, canopy structure, standing stock and species composition of the foundation species which in turn affects their ecological roles in marine ecosystems (Table 2). The magnitude and range of ecosystem impacts depend on the species being harvested, the harvest methods employed, the intensity of biomass removal and its spatial and temporal extent (Supplementary Text S2 and Table S2.1). The broader ecosystem effects further depend on the recovery of seaweed fronds and regeneration of seaweed canopies after harvesting, and the ability of associated flora and fauna to recolonize and reorganize associated communities. (Ibid)

Schmidt et al.'s (2011) study of ecosystem services of eelgrass and rockweed found that:

> marine vegetation provides important habitat, nitrogen, and carbon storage services, yet the extent of these services depends on the foundation species and its architecture. Changes in canopy structure will therefore have profound effects on associated food webs and ecosystem services. Thus, as increasing human pressures on coastal ecosystems threaten the continued supply of essential functions and services, the protection of marine vegetated habitats should be a management priority.

Mac Monagail *et al.* (2017) offer a comprehensive analysis of the environmental impacts of marine macroalgal harvesting, including the effects of over-exploitation on biomass and coastal habitats. They state, "as is the case with the use of all natural resources, the wild harvest of seaweeds inevitably has ecological implications for the species targeted, and the associated

[4] For example, Phillippi *et al*.'s (2014) study indicates potential beneficial impacts of *Ascophyllum nodosum* harvesting on invasive crabs. The paper acknowledges that "human utilization of any natural resource involves ecological implications not only for the species harvested, but for its associated community as well" (Ibid).

[5] See for example Sharp and Pringle 1990, Sharp *et al*. 2006, Ugarte 2010, and Ugarte and Sharp 2001, among others.

community of flora and fauna, leading to varying degrees of change" (Ibid). Additionally, "Poorly managing resources, such as opportunistic harvesting, excessive removal of holdfast material (reducing regeneration), trampling and enhanced grazing by herbivores all place additional stresses on the resource, while near denudation of a seaweed bed is perhaps the most extreme case of direct impact on the community (Ibid)". The authors point out that sustainable harvesting practices are possible and collaborations between scientists and harvesters have led to the development of best practices in some places.

The impacts of hand versus mechanical harvesting are contested, but mechanization increases the amount of biomass removal in the same amount of time. In Ireland, review of potential mechanization cautioned that it is "essential to develop a suitable management scheme to ensure sustainable exploitation of natural resources and continuous integrity of marine habitats" (Werner and Kraan 2004). In a separate study in Ireland, even traditional hand harvesting resulted in a difference in cover of associated algal species following the removal of the target species (Kelly *et al.* 2001). Additionally, there were seasonal differences in "the abundance of periwinkle *Littorina obtusata* in hand harvesting (Ibid). Krumhansl *et a*l. (2017) found that small-scale, "artisanal" harvesting of *Macrocystis pyrifera* in the Pacific Northwest had a minimal impact on kelp recovery rates. Lotze *et al.* (2019) note:

> Any harvesting method will affect the extent and three-dimensional structure of a seaweed canopy, but the magnitude and range of consequences will depend on the gear type, the harvest intensity and scale, and the cutting methods applied. While mechanical clear-cutting or trawling will remove most of the canopy with years to decades needed for recovery, even lower level hand-harvesting changes canopy structure through a truncation of larger, older and more voluminous fronds… Cutting height plays a crucial role in frond regrowth, such as for perennial rockweed, and repeated cutting can change the branching, size, and density of seaweed fronds. Such changes in the amount and structure of the seaweed canopy will affect the quantity and quality of habitat provision and community organization".

Calculations of the ecological effects of kelp trawling in Norway

> show that kelp trawling reduces primary and secondary production substantially within the kelp trawled tracks. Primary production is reduced with 45 % and secondary production with 70 to 98 %... Observations indicate that diversity of flora and fauna will be reduced within the trawled area. The diversity will probably not recover until the mean age of the plants reach the mean age of the large kelp plants in untrawled kelp forest. Mean age increases with increasing latitude and is about 7 years in mid-Norway, where the kelp forest has optimal growth conditions and is well developed. With a trawling interval of 5 years, the kelp forest within mid-Norway will not be recovered with respect to species diversity until next trawling. (Rinde *et al*. 2006)

In a study of biomass and productivity of intertidal rockweed, Vadas *et al*. (2004) found significant variation in the length of apical tip growth, estimates of standing crop weight, and annual productivity estimates. Another study measuring the effects of fucoid bioengineer species on the understory along intertidal elevation gradients in Atlantic Canada found "a combined experimental and mensurative approach shows that the same bioengineer species affect overall species richness, diversity, and composition differently along a stress gradient" (Watt and Scrosati 2013). Specifically, they discovered that "bioengineer canopies have different effects on understory communities depending on intertidal elevation", and this is significant to conservation efforts since "the loss of bioengineers is a concern because these organisms often have wide-ranging and cascading effects" (Ibid). Therefore, "biologists need to consider not only whether bioengineers are present, but also the abundance required to elicit positive changes in communities" (Ibid).

One review of the ecological impact of harvesting in the northwest Atlantic concluded that "long-term harvesting has altered the population structure and population ecology of *C. crispus* and *A. nodosum* in some areas" but went on to state that "both target species and associated communities are resistant to perturbation" (Sharp and Pringle 1990). Foster and Barilotti (1990) emphasize "the need for considering the potential effects of seaweed harvesting at both the population and community level, and the utility of approaching these effects in a comprehensive manner". They explain that considering the harvest type, procedures, and ecological effects on the target population, community, and ecosystem are essential for maintaining harvestable marine macroalgal resources. In an experimental study of the ecological effects of harvesting kelp in Chile (in this case for alginates), the researchers concluded there were significant impacts on both the harvested and related species:

> Experimental studies of *Lessonia nigrescens* and *L. trabeculata* have revealed several ecological effects of harvesting that ought to be considered when managing wild stocks of these species. In both kelps, the removal of the upper canopy eventually leads to death of the plants. The invertebrate fauna does not abandon the holdfast of pruned *L. nigrescens*. Therefore, both partial and complete plant removal has similar mortality consequences for the kelp and for the invertebrate fauna associated with the kelp.
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> The most important population effects of removal are the increments in inter-plant distances and the resulting increasing access of grazers to the kelp holdfast and to inter-holdfast surfaces. Increased grazing reduces recruitment of both *Lessonia* species and modifies the morphology of *L. trabeculata*, rendering individuals of the latter species more susceptible to being removed by water movement. (Vasquez and Santelices 1990)

In a review of global kelp forests, Wernberg *et al*. (2019) state that "kelp species show global declines and, like so many other marine ecosystems, they are under pressure from direct and indirect anthropogenic activities". These include climate change (warming waters, acidification, and increased storm activity), fishing (when urchin predators decline due to fishing, urchins increase grazing on kelp), and direct harvesting of kelp. However, when species-specific biology is understood and respected, sustainable harvests are possible (Ibid). In another global review of kelp forest change, Krumhansl *et al*. (2016) note that "kelp harvesting accounted for recent kelp declines in Central and Northern Chile despite a regional cooling trend".

Sharp *et al*. (2006) explain that "harvesting can affect the structure of these marine plant habitats by changing branching structure, canopy height, distribution of biomass and overall density of plants and fronds". Vasquez (1995) states that "if the disturbance (e.g. harvest) is strong enough, changes occur in the abundance of harvested and/or associated species, and in availability of some resources (e.g. space and light)".

Boaden and String's (1980) study abstract in Northern Ireland provides a quantitative overview of ecosystem effects of harvesting *Ascophyllum nodosum*, though it must be noted that the study cut rockweed "within 10-15 cm of the base, rather shorter than normal harvesting practice":

> In 1976 an attempt to establish harvesting in Strangford Lough, Northern Ireland, was opposed on mainly theoretical conservation grounds. The attempt began and stopped within a single small bay leaving a sharp boundary between cut and uncut areas. A subjective survey apparently confirmed the predicted loss of cryptic fauna, decline through predation and the resorting of interboulder sediment. In April 1979 the cut and uncut areas were examined in detail to determine whether any of these effects had persisted and were demonstrable scientifically. Beach and boulder transects and various other studies showed some increases in the cut area.

There was significantly more *Fucus*, *Enteromorpha* and *Ulva*; *Cirratulus* (inhabiting *Rhodochorton*-bound sediment on boulder surfaces) had a greater biomass. Some changes in *Littorina* colour morphs were apparent. Sediment in the cut area was coarser and had significantly more crustacean meiofauna. *Ascophyllum* internodal length and lateral branching were increased but it still provided 20 % less shore cover than in the uncut area. There were significant decreases in the cover of *Cladophora* on the sides of boulders and of *Halichondria*, *Hymeniacodon* and *Balanus* on undersurfaces. Indeed on the habitable underside of boulders total animal cover had been reduced by nearly two-thirds and the average number of species per boulder by one-third. It is concluded that *Ascophyllum* harvesting has a significant and persistent effect on shore ecology. Littoral algae are a valuable commercial asset, but it is important that some fairly large intertidal areas should be left unharvested for general conservation purposes.

Defining overharvesting is potentially subjective, yet the consequences are not. "Over-harvesting can lead to a reduced density of seaweed thalli, skewing the population mix and increasing impurities (i.e. other, unwanted seaweed species) in the harvested seaweed loads" (Mac Monagail *et al*. 2017). "In Atlantic Canada, a shift from Irish moss to coralline algae has been observed multiple times over past decades due to overharvesting and did not easily or rapidly reverse" (Lotze *et al*. 2019). Some stakeholders have noted a "tragedy of the commons" associated with harvest areas. In Chile, research on the effects of fishing pressure found that Territorial User Rights for Fisheries "areas could be important ancillary conservation instruments in kelp forest ecosystems, if key processes of the subtidal community assemblages (e.g., interactions between grazers and reef fish) are maintained" (Pérez-Matus 2017).

An example of differing views on the harvesting *Ascophyllum nodosum* causing a deficit of detritus and the response reiterating the finding can be found in Garbary *et al*. (2017). The authors affirm that harvesting creates a "'missing' biomass … primarily in the form of detritus never produced because of the nature and timing of the harvest" and state their original paper underestimated the deficit (Ibid). Ugarte and Sharp (2012) assert that the consistent yields of *Ascophyllum nodosum* is "is proof of good management practices and an ecologically sustainable harvest in the Canadian Maritimes". However, Halat *et al*. (2015)state that while previous research demonstrates the regeneration of *Ascophyllum nodosum*, it "does not address wider ecological issues associated with overall environmental impact". Detrital deficits in *Ascophyllum nodosum* could be of concern due to "the role of the 'missing' detritus that should be serving coastal fertility in the form of dissolved and particulate nutrients for both planktonic and benthic organisms from primary producers through to detritivores" (Ibid). "This detritus is typically released through epidermal shedding, and if not consumed by herbivores or microbes before reaching the upper intertidal zone, it contributes to coastal, terrestrial
fertility" (Mac Monagail *et al*. 2017). For kelp, Krumhansl and Scheibling (2012) found that:

Detritus settles within kelp beds or forests and is exported to neighboring or distant habitats, including sandy beaches, rocky intertidal shores, rocky and sedimentary subtidal areas, and the deep sea. Exported kelp detritus can provide a significant resource subsidy and enhance secondary production in these communities ranging from tens of meters to hundreds of kilometers from the source of production. Loss of kelp biomass is occurring worldwide through the combined effects of climate change, pollution, fishing, and harvesting of kelp, which can depress rates of detrital production and subsidy to adjacent communities, with large-scale consequences for productivity.

A study measuring the biomass removal of *Ascophyllum nodosum* found that natural storm occurrences removed a significantly higher percentage of holdfast material than commercial harvestings (Ugarte 2010); however, this point (one made frequently in public comments) must bear in mind that storms are a natural part of the ecosystem whereas harvesting and removal of the species from the ecosystem is not. As the same paper notes, "environmental concerns will continue influencing marine resource management in Canada, especially when the harvested resource is also a habitat" (Ibid). Any amount of harvesting will have some ecological impacts, and in Nova Scotia "because Rockweed harvesting disturbs habitat through alteration of the canopy structure and has high levels of bycatch, unharvested Rockweed beds, which are likely more common on the Eastern Shore, have a substantially higher habitat value than those that are harvested" (Jeffery *et al*. 2020).

In a three-year study in Norway, the multitrophic effects of kelp harvesting were investigated by Lorensten *et al*. (2010):

> Coastal kelp forest ecosystems provide important habitats for a diverse assemblage of invertebrates, fish and marine top-predators such as seabirds and sea mammals. Although kelp is harvested industrially on a worldwide scale little is known about the multi-trophic consequences of this habitat removal. We investigated how kelp fisheries, which remove feeding and nursery grounds of coastal fish, influence local food webs and the availability of food to a marine top predator, the great cormorant (*Phalacrocorax carbo*). We conducted experimental harvesting of the canopy-forming kelp (*Laminaria hyperborea*) during a 3 year period (2001–2003) in an area at the coast of Central Norway while synoptically monitoring fish occurrence and cormorant foraging parameters. Our results demonstrate that cormorants preferentially foraged within kelp-forested areas and performed significantly more dives when feeding in harvested versus un-harvested areas suggesting lower foraging yield in the former case. In kelp areas that were newly harvested the number of small (<15 cm) gadid fish was 92% lower than in un-harvested areas. This effect was persistent for at least 1 year following harvest. To our knowledge, this is the first time that the ecological consequences of kelp harvesting have been tested at a multi-trophic level. The results presented strongly suggest that kelp harvesting affects fish abundance and diminishes coastal seabird foraging efficiency. Kelp fisheries are currently managed in order to maximize the net harvest of kelp biomass, and the underlying effects on the ecosystems are partly ignored. This study calls for re-assessment of such management practices.

In a twenty-year study of *Ascophyllum nodosum* in Iceland, Ingólfsson and Hawkins (2008) concluded that full canopy recovery after harvest took seven to eight years, but community recovery could take as much as twenty years. When *Ascophyllum nodosum* was removed but understory algae species were left undisturbed, some of those species died and did not return to the study sites (Ibid). In the southwest English Channel, Migne *et al*. (2014) found that while "the number of species [and] their distribution among trophic groups" was unaffected by canopy removal of *Fucus serratus* "and the algal community was only slightly affected", the "abundance and biomass of mobile invertebrates … were greatly reduced in the absence of canopy".

The importance of harvesting method is underscored in Waage-Nielsen *et al*. (2003) whose study showed that leaving kelp holdfasts was significant to associated kelp fauna. "The remaining holdfasts were the best refugia or alternative habitat in this study, as they contained a fauna very similar in composition to the fauna associated with the natural kelp plants" (Ibid). Alternative harvesting methods for *Ecklonia maxima* in South Africa, in which only the fronds were cut rather than the whole plant, "shows considerable promise in that the required commercial yield can be achieved from much smaller areas than if whole plants are harvested" as plants remain living and recover more quickly (Levitt *et al*. 2002). Nevertheless, "the possible effects of disturbance on the benthos, together with the short lifespan of suspended kelp zoospores …, may negatively affect *Ecklonia* recruitment, particularly if it is strongly episodic" (Ibid). In their study of the effects of commercial harvesting of *Fucus serratus*, *Palmaria palmata*, and *Porphyra* on ecosystem biodiversity and functioning, Stagnol *et al*. (2016) found that the hand harvesting methods employed had the greatest impact "on the diversity of the animal community and the metabolism of the studied area", largely due to the opportunistic settlement of *Ulva* spp. (2013). Steen *at al*. examined kelp regrowth after harvesting in Norway and found that the target species "had regained its dominance at the harvested sites, however, plant age, sizes and epiphytes were still below pre-harvesting levels". While *Laminaria hyperborean* biomass recovered after four years, this was due to high density of the recovering kelp vegetation; "the density of understory kelp recruits 4 years after harvesting was significantly lower than it had been prior to harvesting, and this may lead to a slower recovery if future harvests occur before the stocks of understory kelp recruits are restored" (Ibid). In their research of the impact of harvesting on canopy-forming macroalgae, Stagnol *et al*. (2016)

> found that patterns of recovery following the harvesting disturbance were variable and matrix specific, suggesting that local factors and surrounding habitat characteristics mediated the influence of harvesting. The greatest and longest effects of harvesting were observed for the targeted species that created a dominant and monospecific canopy on their site prior to the disturbance. Another relevant finding was the important natural spatiotemporal variability of macrobenthic assemblages associated with canopy-forming species, which raises concern about the ability to discriminate the natural variability from the disturbance impact.

Although certain countries have developed marine macroalgae management plans and regulations, others have not (Rebours *et al.* 2014). As harvesting:

> increases, there is also an urgent need to develop and implement ecosystem-based management models and integrated coastal zone planning. Policy makers must develop regulations and directives that enable a sustainable exploitation of the natural resource, not only to preserve marine and coastal ecosystems but also to ensure social stability and economic income of local communities (Ibid).

Lotze *et al.* (2019) "outline potential ecosystem-based management approaches that would help sustain productive and diverse seaweed-based ecosystems" for harvesting. They specify areas reflected below in this proposal, including "maintaining high canopy biomass, recovery potential, habitat structure and connectivity, limiting bycatch and discards, while incorporating seasonal closures and harvest-exclusion zones into spatial management plans" (Ibid). Stagnol *et al*. (2016) note their "results support the need to implement ecosystem-based management, assessing both the habitat conditions and ecological roles of targeted commercial species, in order to insure the sustainability of the resource". In the case of *Ascophyllum nodosum*, Seeley and Schlesinger (2012) state "besides setting the removal rate at the right level, other critical parameters that need to be considered in defining an ecologically sustainable harvest include recovery of preharvest rockweed morphology, rockweed bed structure, rockweed community structure and function, and ecosystem function". Similarly, in another study of *Ascophyllum nodosum*, Kay *et al*. (2015) found that "plant and canopy structure, including length, circumference and density, were much better predictors of associated community structure than rockweed biomass, which is often used for single-species monitoring".

The precautionary approach is not new to marine macroalgae harvesting and was used to development a management strategy for in Atlantic Canada following public concern over negative impacts of exploitation of marine resources and in recognition of its habitat function for invertebrate and vertebrates (Ugarte and Sharp 2001). Similarly, "the European Union has defined an organic label for macroalgae, which implies that the commercial harvest of algae shall not cause a significant impact on ecosystems" (Stagnol *et al*. 2013). In the absence of adequate baseline measures of existing macroalgal stands, "robust and precautionary management measures should be adopted" (Lotze *et al*. 2019).

Regulatory Oversight

"The current wild seaweed harvesting methods, regulations and management regimes vary widely across species and countries" (Lotze *et al*. 2019). Government regulatory agencies acknowledge the environmental impact of seaweed harvesting through various restrictions. For example, in Nova Scotia, the Rock Weed Harvesting Regulations of the Fisheries and Coastal Resources Act describe permitted harvest areas, allowable harvesting methods and quotas, leases, and record-keeping. Specifically, the "Harvest Manner" specifies harvest cannot interfere with re-growth, cannot harvest "in such a way that representative harvest samples contain more than 15% holdfast by weight", and must leave an upright shoot with "an absolute minimum length of 127 mm (5 in.) above the holdfast in non-leased areas" or as indicated in the lease management plan (Rock Weed Harvesting Regulations 1996)[6]. In Maine, a Fishery Management Plan for Rockweed makes recommendations for minimum cutting height, designated no-harvest areas, and harvester training (Maine Department of Marine Resources 2014); however, the plan has not been enacted to date. Washington Department of Natural Resources is responsible for marine macroalgae harvests, where harvest for sale or barter is not allowed on public or private land; in other words, the commercial harvesting of macroalgae is prohibited. Rules for hand harvesting, daily per person weight limits, and cutting heights are listed. Harvest of kelp and other marine macroalgae are regulated by the California Department of Fish and Wildlife and require a license. Regulations designate 87 kelp beds, some of which are open to all harvesters, some are available for lease, and some are closed. Eelgrass and surfgrass are prohibited from harvest. Harvesting is prohibited in state marine reserves and state marine parks. Regulations stipulate that harvesters "may not cut attached kelp at a depth greater than four feet below the surface of the water at the time of cutting", and that the kelp harvest plan must identify how harvesters will avoid "1. repetitive harvest from individual giant kelp plants; 2. harvest of bull kelp from those portions of kelp beds that contain both giant kelp and bull kelp; and 3. harvest of giant kelp near sea otter rafting sites used by female sea otters with dependent pups" (CDFW 2014).

In Scotland, "licensing of wild harvesting activities … provides a means to manage negative environmental impacts" (Scottish Government 2016). The absence of accurate assessments of marine macroalgae biomass can impede efforts to determine harvest volumes that would have limited environmental impact. "To our knowledge, there are no recent estimates of the wild seaweed standing stock of the UK nor of the potential stock that could be sustainably harvested" (Capuzzo and McKie 2016). Similarly, "very little research has been carried out in Northern Ireland on the direct and indirect effects of harvesting on biodiversity and coastal processes" (Environment and Heritage Service 2007). There is a "lack of specific information on the carrying capacity of marine ecosystems to support seaweed harvesting and mariculture" (Ibid).

[6] Some of these provisions, such as minimum cutting height and holdfast content for *Ascophyllum nodosum*, have been noted as potentially inadequate to protect not only regeneration of the target species, but also to mitigate ecosystem-wide effects of harvesting. "An overharvest of Ascophyllum could lead to an undesirable level of habitat loss at a landscape scale. This is an important perspective which has not been stressed in earlier assessments of the Ascophyllum harvest in Nova Scotia." (Vandermeulen 2013)

In Norway, regulations state that "importance shall be attached to the following in the management of wild living marine resources and genetic material derived from them: a) a precautionary approach, in accordance with international agreements and guidelines, b) an ecosystem approach that takes into account habitats and biodiversity, and c) effective control of harvesting and other forms of utilisation of resources" among other factors (Marine Resources Act 2008). The Act states in Section 16 The Conduct of Harvesting Operations:

> All harvesting and other utilisation of wild living marine resources shall be carried out as in such a way as to minimize impact.
>
> The Ministry may adopt regulations on the conduct of harvesting operations, including provisions on the following:
>
> a) the periods when harvesting is permitted and times for departure from port,
>
> b) the number of vessels from different vessel groups that may harvest at the same time in an area,
>
> c) prohibition of harvesting in certain areas, of certain species or using certain types of gear,
>
> d) the design, marking, use and tending of gear and other devices used in connection with harvesting,
>
> e) the maximum or minimum permitted sizes of individual organisms, and requirements for part or all of the harvest to consist only of males or females,
>
> f) permitted bycatches,
>
> g) the design and use of harvesting gear to reduce damage to species other than the target species. ((Directorate of Fisheries 2008)

It should be repeated that some countries have limited or no regulations on macroalgal harvests, and the extent to which countries with regulations have the capacity to fully enforce them is not known. The United States has no specific federal regulations on macroalgal harvests.

A number of third-party standards on sustainable seaweed harvesting offer non-regulatory options for verification of environmental stewardship goals, and these were outlined in the board's previous discussion document on this topic. The Aquaculture Stewardship Council-Marine Stewardship Council (ASC-MSC) sustainable seaweed standards indicate that there are environmental impacts to harvesting seaweed, hence the need for/benefit to certification. Their guiding principles state that "seaweed harvesting … must be conducted in a manner that does not lead to depletion of the exploited wild populations". Harvesting must additionally "allow for the maintenance of the structure, productivity, function and diversity of the ecosystem (including habitat and associated dependent and ecologically related species) on which the activity depends." (ASC-MSC 2020)

It is important to note that the regulations typically focus on regrowth of the harvested species, with such conditions as cutting height, holdfast restrictions, or repeat harvest guidelines. While those parameters are important, "generally, the management focus is on the regeneration of the seaweed resource itself, with no or limited consideration of other species that are associated with the target species and may therefore be affected by bycatch or habitat loss and alterations" (Lotze *et al*. 2019).

<u>NOSB Fall 2019 Marine Materials Panel</u>

In order to gain a deeper understanding of the topic from a range of stakeholders, the board convened an expert panel in fall 2019 panel to evaluate the environmental impacts of marine macro algae harvesting for crop fertility inputs and to explore possible means of mitigating harm. The panel was composed of 2 scientists specializing in marine ecology and seaweed, 1 certifier, and 1 harvester. The questions posed to were synthesized from public comment and NOSB members. Panelists were asked to identify and focus on those questions that best related to their experience and expertise.

Questions for the Scientists and a Summary of Their Responses in Italics:

1. Stakeholders have pointed out the need for a definition for the term "sustain". Current NOP standards for protecting environmental resources rest largely on the terminology of "maintain or improve", while the wild crop standard uses the word "sustain". The NOP regulations do not define this term. §205.200 requires that crop producers "maintain or improve the natural resources of the operation". §205.207(b) requires that wild crops be "harvested in a manner that ensures that such harvesting or gathering will not be destructive to the environment and will sustain the growth and production of the wild crop". How can the NOP define, measure, and verify the phrases "not destructive to the environment" and "sustain the growth and production" as related to wild harvested marine macroalgae?
    a. *Biomass is indicative of abundance of dependent organisms and measurable; architecture is more challenging to assess, but could be done intermittently.*
2. Could practice standards or guidelines be created that are sufficiently broad to cover the wide geographic distribution and differences in marine ecosystems while being simultaneously specific enough to provide adequate protection of marine algae and the ecosystem functions they afford?
    a. *Conservative guild level guidelines, but may require species specificity.*
3. What are the environmental implications of taking no action?
    a. *Given the rate of ocean change, the paucity of data on many of these systems, and tendency for overexploitation of marine resources, a cautionary approach is warranted. Additionally, aquaculture is an alternative to meet demand.*
4. Define an efficient, science-based method for measuring existing biomass to establish a baseline. How would this be measured post-harvest? Is there existing data from established harvest regions?
    a. *We reviewed several developing remote sensing and genetic techniques, in addition to standard visual assessments. Validation and training required.*
5. For all algae, what are the best methods for harvesting that minimize the impact on the recovery of the population of the harvested species and maintain ecosystem function and services? What would be measured and what benchmarks would be set? Who should determine the methods/benchmarks?
    a. *Benchmarking of harvesting approaches (e.g., holdfast minimums, no trawling).*
6. Are there some species that are so important to ecosystem structure and function that harvest should not be permitted at all?
    a. *Coralline algae should be considered as off-limits to harvesting because of their life history characteristics and ecological importance.*
7. Should there be protected areas that are off limits to harvesting? Should seasonal restrictions be considered?
    a. *Yes and Yes!*
8. What is an acceptable level of bycatch? Should this be assessed on a species by species basis? Are there any bycatch species that could prevent harvesting in an area altogether?
    a. *Harvest using least destructive and most selective gear; implement bycatch monitoring.*

Questions for the Certifier and Harvester:

1. What methods are currently being used by certifiers and harvesters to verify environmental goals and avoidance of harm when certifying marine algae to the wild crop standard for livestock feed, human consumption, or as a crop input?
2. Are certifiers adequately trained to certify marine algae? What could be done to address any deficiencies in knowledge and training?
3. What concerns exist regarding the NOP's regulatory authority to require organic certification of a crop production input ingredient?
4. Are government regulatory structures in place to ensure habitat protection from over-harvesting of marine algae? Should marine algae harvesting be permitted (under the organic regulations) where those regulations are weak or non-existent?
5. If biomass assessments are made pre- and post-harvest, who should perform them?
6. Who would monitor compliance and enforce management standards?
7. Should the NOSB propose requiring organic certification of marine macro algae crop input ingredients, create an annotation, or explore other methods to ensure that environmental criteria are met?

The expert panel provided the board with much-needed information on harvesting methods, certification concerns and areas for standards, the biology and ecology of marine macroalgae, and recommendations on future work. The harvester testified about his company's many years of research on harvesting impacts and management plans enacted to minimize them. Annual surveys are conducted to establish proper harvest quotas. The certifiers addressed current certification of "kelp" as an agricultural product in organic livestock feed and emphasized that additional training for certifiers is needed, as was proposed in NOP 5027-1. They certify six operations to the wild crop standard for "kelp" harvesting.

The scientists testified that marine macroalgae are ecosystem engineers providing habitat to other species, that harvesting reduces biomass and structure, and the extent of impact depends on harvesting methods. In some cases, seaweeds can recover. When clear-cut, it can take decades for recovery. They suggested a balanced view of desired ecosystem services from marine macroalgae. They affirmed that it was possible to create generalizable harvest parameters that could include baseline biomass assessments, minimum cutting heights and holdfast removal, and prohibitions on trawling.

Proposal:
Through its previous discussion documents, the board variously explored either requiring organic certification of macroalgae ingredients as a means of monitoring the environmental impact of harvests or an annotation in the National List that would achieve a similar result. There is resistance among some stakeholders to requiring organic certification due to concerns about a slippery slope for other natural inputs. On the other hand, there are species that are currently being certified organic for human consumption or livestock feed that are also used for crop fertility inputs. Additionally, there has been concern that requiring organic certification without specifying additional harvest parameters could lead to excessive variation in interpretation of the wild crop standard between certifiers.

Some were apprehensive that verification could increase the cost of these inputs for farmers. Public testimony by one certifier noted that of the 19 crop inputs they approve containing aquatic plant extracts, 7 already contain certified organic plant extracts. A quick search for certified organic kelp meal revealed a number of products containing certified organic *Ascophyllum nodosum*. When compared with kelp meal products containing the same species that was not certified organic, there were instances in which the product containing certified organic *Ascophyllum nodosum* was cheaper than the product containing *Ascophyllum nodosum* that was not certified organic.

After significant consideration, it was decided that an annotation with specific wording about harvest procedures was a desirable and achievable goal. In consultation with the NOP, it was determined that language requiring verification within the annotation itself was not feasible; however, that does not diminish the requirement to follow the annotation.

Although not a condition of the annotation, some harvesters and/or processor may seek verification. This could be done in a number of ways, including through a "material evaluation program" similar to the material evaluation requirement for High-Nitrogen Liquid Fertilizers (HNLF) explained in NOP Guidance 5012. A sample fee schedule for a material evaluation program can be viewed at the Organic Materials Review Institute and varies according annual gross sales for the company, the type of product being reviewed, and additional situations. Verification could also potentially be achieved through organic certification, with the certifier inspecting to the annotation harvest parameters as well as the wild crop standard.

This annotation applies only to the raw marine macroalgal ingredient, not the resulting product. Companies harvesting the marine macroalgae would be responsible for harvesting according to the annotation parameters. Moreover, if the harvester chose to certify their macroalgae harvest, the ingredient list could state that the marine macroalgae ingredient was certified organic, i.e. "USDA Organic *Ascophyllum nodosum*". If a producer opted to undergo a material evaluation program, the macroalgae would be product-verified and listed by that material review organization (producers can be individual harvesters or companies hiring independent contract harvesters).

While there would be some increased cost for producers who decided to certify their macroalgae or have it reviewed through a material evaluation program, this is not dissimilar to the cost farmers and handlers bear when electing organic certification for their products. Moreover, a number of harvesters are already certifying all or part of their macroalgal harvests. There may be uncertified harvesters already harvesting to the annotation parameters for whom acquiring verification would not necessitate significant changes to their practices.

This is a complicated subject and one the board has worked on for over five years. Differing views on the need for action exist. Finding the correct means of addressing harvesting has involved important exchanges between the board and stakeholders. The annotation must be broad enough to cover the range of species, geographies, and harvest methods while simultaneously being specific enough to be useful and feasible.

The Materials Subcommittee is proposing an annotation to the organic regulations stipulating harvesting parameters for marine macroalgae used in crop fertilizers, providing a science-based process and parameters to ensure that harvesting limits harm to the environment. The annotation wording came about through review of previous public comments, in looking at the Marine Materials Fall 2019 panel's scientists' recommendations, and in conversations with Dr. Robin Hadlock Seeley (Shoals Marine Laboratory, Faculty, University of New Hampshire and Cornell University). The draft annotation was then sent to the two scientist seats on the panel –Dr. Allison Schmidt (Dalhousie University, Professor, Department of Biology) and Dr. Nichole Price (Bigelow Laboratory for Ocean Sciences, Senior Research Scientist)—and they collaborated to make additional edits.

The draft language was shared with the certifier on the panel, Chris Grigsby (MOFGA Certification Services, Director) and the harvester, Dr. Raul Ugarte (Acadian Seaplants, Senior Manager Resource Science). Comments said the annotation should include not only biomass and architecture, but also the other species in the community. Additionally, it was suggested that a more feasible and ecologically sound metric than biomass and architecture returning to pre-harvest levels might instead be harvest rates below the annual rates of regeneration.

The annotation language was next reviewed, and edits were suggested, by Dr. Michael Graham at Moss Landing Marine Laboratories and Co-/Managing-Editor, Journal of Phycology. The draft annotation language was subsequently sent to 18 different marine scientists across the US, Canada, and Chile to solicit their feedback on feasibility, adequacy, and suggested edits. They came via public and stakeholder comments and recommendations and through referrals from scientists contacted about last fall's expert panel. Those that replied were:

- Dr. Susan Brawley, University of Maine, Professor School of Marine Sciences
- Dr. Dan Reed, University of California Santa Barbara, Marine Science Institute
- Dr. Robert DeWreede, University of British Colombia, Professor Emeritus Botany
- Dr. Thomas Mumford, Marine Agronomics LLC, Retired from the Washington Department of Natural Resources
- Dr. Heike Lotze, Dalhousie University, Professor Department of Biology
- Dr. David Garbary, St. Francis Xavier University, Professor of Biology
- A colleague of Dr. Pam Krone, Monterey Bay National Marine Sanctuary
- Dr. Jennifer Smith, University of California at San Diego Scripps Institution of Oceanography, Professor of Marine Biology
- Dr. Brian Beal, University of Maine, Professor of Marine Ecology & Director of the Marine Science Field Station
- Dr. Alejandro Heriberto Buschmann Rubio, Universidad de los Lagos, Professor
- Glyn Sharp, Retired from Department of Fisheries and Oceans-Nova Scotia

Broadly speaking, there was general agreement about the annotation and suggestions for revisions (with the exception of one scientist who thought it was satisfactory and feasible as written and one who expressed concern that it was too broad to be effectively applied to specific regions or species). Edits were made to the proposed language based careful analysis of the feedback received from the various scientists, including Drs. Schmidt, Price, and Ugarte from the Fall 2019 Expert Panel.

The "prohibited harvest areas" section was amended to specify established public and private conservation areas and to include sanctuaries and preserves. "Trawling" was refined based on near universal feedback to "bottom trawling". Given a range of views on language referring to "reproductive individuals", the wording was changed to reflect the diversity of species and their reproductive characteristics by rohibiting practices that prevent reproduction of the population. Additional language was added based on suggested wording from Dr. Ugarte regarding sufficient propagules to maintain the population. Phrasing about maintaining ecosystem functions was also added. Original wording stating that bycatch should be "minimized" was recognized as subjective, and so the wording was changed to "prevented" and "eliminated" in the case of special status species. One scientist noted that the absence of bycatch can demonstrate an unhealthy marine community. Monitoring practices would need to be clarified in guidance.

The language that drew the greatest amount of feedback was that regarding biomass and architecture returning to pre-harvest levels prior to repeat harvesting. Questions arose about how to measure this. Monitoring and data collection to measure biomass and architecture can take place using a variety of methods, including remote sensing, drones, GIS maps, genetic techniques, transect sampling, and visual assessments. Guidance would be needed to clarify how and when sampling should occur. It was recommended that "height" should be an average with some variation. One scientist noted that commercial harvesting affects the architecture of some species, making it challenging to require a complete return to pre-harvest levels. It was suggested that guidance on how different types of species are harvested would be needed. Establishing fully accurate pre-harvest levels was deemed difficult. One commenter said that hand raking of some species is preferred over mechanical harvest as it reduces in incidence of cutting to minimum allowed heights, which can negatively impact the biological community. An initial limited test harvest was recommended, along with subsequent designated strip harvesting. It is not the intent of the language to stop harvesting to establish a baseline measurement. All of these are points that should be evaluated in guidance.

The second version of the annotation with incorporated comments was sent back to all those who originally provided feedback. This time there was more agreement from the scientists that the changes had improved the annotation. Roughly half felt it was adequate as edited. A few had suggestions for additional edits. Thus, a third version of the language was drafted based on feedback and in consultation with four of the scientists, paying close attention to improvements that could gain the broadest degree of consensus within the stakeholder community. Importantly, the scientists represent a range of specialties in marine macroalgae. It was noted that storms and natural succession can impact biomass and architecture. Ice scouring of rock ledges and storm events affect biomass and architecture in the case of *Ascophyllum nodosum*. The earlier annotation language specified a return to pre-harvest levels. Preharvest measures of biomass and architecture in ice-scoured or winter storm-impacted areas may not adequately form the basis of sufficient recovery. Consequently, the wording was further developed to clarify that repeat harvest cannot reoccur until the biomass and architecture approach that of undisturbed natural stands of the target species in that area. This recognizes variability in site specific conditions.

All of the scientists were sent the final annotation wording. The vast majority agreed with the final wording as it was written, as well as the process of developing the language. Three provided additional comments, and most of those were incorporated into the final language. The two outstanding issues raised that will need to be explored in guidance are how to measure architecture (though length and circumference can be measured in a quadrant for intertidal species, this is more challenging for subtidal species; whether estimated measurements are adequate and how to define this should also be considered), and the importance of the relationship between species size and age. The final annotation wording reflects of a diverse spectrum of scientific feedback, collaboration, and support. The subcommittee thanks all those who participated in its crafting, particularly Dr. Allison Schmidt and Dr. Nichole Price for their tremendous time, effort, and expertise in helping guide this language development.

Adoption of this annotation should be accompanied by a NOP-appointed scientific task force to elaborate additional guidance and instruction to certifiers, with particular focus on providing species-specific parameters[7]. The task force could identify the top three to five species used and provide

[7] Modifying existing third-party standards that address environmental impact of seaweed harvesting or using them as a reference point could be explored by the task force.

recommendations for their unique biological and geographical characteristics. A periodically updated living document, reviewed at sunset intervals, would serve to address changes to the annotation as needed and to promote consistency in interpretation and application. Adoption of this annotation should be followed by a lengthy phase-in period of five years to allow for industry adaptation. Material review organizations and certifiers would need to use staff qualified to evaluate the harvest against the annotation parameters, for harvesters seeking certification or product verification. Task force-driven guidance should detail needed areas for training.

These parameters reflect values and science around marine macroalgae harvest the board supports. 1) Protected conservation areas should not be used for harvest of organic fertility inputs. 2) Bottom trawling is prohibited because of its potential for damage to the surrounding ecosystem, thus preventing the harvest of most coralline algae (as recommended by the scientists on the Fall 2019 Expert Panel) because of its slow growth rate[8]. 3) Harvesting should not interfere with reproduction for the continued growth and ecosystem functions of the species. 4) Although harvesting affects the architecture of some species, biomass or percent cover and architecture (density and height) must be allowed to approach the biomass and architecture of undisturbed natural stands of the targeted species in that area before a subsequent harvest so that ecosystem function interruption is minimized, to the extent possible. 5) Prevention and monitoring of bycatch are important to avoiding unnecessary mortalities associated with the harvest.

It is not intended that every harvest be monitored as that would be impossible to oversee, just as organic inspectors are not present for every action taken during a farm's growing season. As with the entire organic label, trust is involved. Finally, harvesters must comply with all local, state, federal, and tribal regulations, permits, and jurisdictions.

§205.601 Synthetic substances allowed for use in organic crop production

1) This proposal suggests an annotation to §205.601 (j)(1) requiring (proposed annotation changes are in red):

In accordance with restrictions specified in this section, the following synthetic substances may be used in organic crop production: Provided that, use of such substances does not contribute to contamination of crops, soil, or water...

(j) As plant or soil amendments.

(1) Aquatic plant extracts (other than hydrolyzed) –Extraction process is limited to the use of potassium hydroxide or sodium hydroxide; solvent amount use is limited to that amount necessary for extraction. Harvest Parameters - "Prohibited harvest areas: established conservation areas under federal, state, or local ownership, public or private, including parks, preserves, sanctuaries, refuges, or areas identified as important or high value habitats at the state or federal level. Prohibited harvest methods: bottom trawling and harvest practices that prevent reproduction and diminish the regeneration of natural populations. Harvest practices should ensure that sufficient propagules[9], holdfasts, and reproductive

[8] In the Mediterranean, Barbera *et al*. (2003) note "that maerl beds are non-renewable resources and cannot sustain direct exploitation", a species and region cited in the 2016 TR as used in organic fertilizers. Lotze *et al*. (2019) state "Trawling and dredging generally entrain a wide range of non-target species and have the most damaging effects on seafloor habitats, including the seaweed canopy".

[9] Definition of a propagule: a vegetative structure that can become detached from a plant and give rise to a new plant, e.g. a bud, sucker, or spore.

structures are available to maintain the abundance and size structure of the population and its ecosystem functions. Harvest timing: repeat harvest is prohibited until biomass and architecture (density and height) of the targeted species approaches the biomass and architecture of undisturbed natural stands of the targeted species in that area. Bycatch: must be monitored and prevented, or eliminated in the case of special status species protected by U.S. Fish and Wildlife Service or National Marine Fisheries Service."

2) An additional listing is proposed at §205.602 prohibiting marine macroalgae unless produced in accordance with the following annotation (identical to that proposed for §205.601 (j)(1)) in order to address marine macroalgae used in non-synthetic products and therefore not covered by the annotation under Aquatic Plant Extracts. This prohibition, unless harvested in accordance with the annotation, would help safeguard that marine macroalgae harvested for and used in organic crop production do not harm the environment (proposed changes are in red):

§205.602 Nonsynthetic substances prohibited for use in organic crop production.

The following nonsynthetic substances may not be used in organic crop production:

<u>(j) Marine macroalgae (seaweed)--unless harvested in accordance to the following parameters:</u>
Non-commercial harvests for whole and unprocessed seaweed are exempt from these parameters. Harvest Parameters - “Prohibited harvest areas: established conservation areas under federal, state, or local ownership, public or private, including parks, preserves, sanctuaries, refuges, or areas identified as important or high value habitats at the state or federal level. Prohibited harvest methods: bottom trawling and harvest practices that prevent reproduction and diminish the regeneration of natural populations. Harvest practices should ensure that sufficient propagules[10], holdfasts, and reproductive structures are available to maintain the abundance and size structure of the population and its ecosystem functions. Harvest timing: repeat harvest is prohibited until biomass and architecture (density and height) of the targeted species approaches the biomass and architecture of undisturbed natural stands of the targeted species in that area. Bycatch: must be monitored and prevented, or eliminated in the case of special status species protected by U.S. Fish and Wildlife Service or National Marine Fisheries Service."

Public comment indicated some farmers in coastal regions harvest small amounts of marine macroalgae for on-farm, non-commercial use. Such harvests are exempt from this annotation.

Conclusion:

On issues where universal agreement does not exist, it is the board’s aim to pursue a middle ground approach where achievable. Given the strong calls for action on the one hand and statements that action is unnecessary on the other, this proposal reflects the best effort at compromise. Prohibition of the use of marine macroalgae in crop fertility inputs is not viable, nor is inaction on safeguarding marine ecosystems from the impacts of harvesting. This annotation does not prohibit marine macroalgae but provides scientifically sourced harvest parameters to protect the target species and its associated community.

Much of organic agriculture is based on the precautionary principle. Similarly, this proposal prevents possible negative environmental impacts from commercial harvesting of marine macroalgae. The potential for a negative impact is sufficient to warrant a cautionary approach and was recommended by

[10] Definition of a propagule: a vegetative structure that can become detached from a plant and give rise to a new plant, e.g. a bud, sucker, or spore.

the scientists on the Fall 2019 Expert Panel. This proposal furthers the commitment to continuous improvement in organic farming by valuing marine macroalgae not simply as resources but also as integral species within complex ecosystems.

In the presence of conflicting views and given evidence describing the environmental impacts of harvesting, this proposal seeks to ensure that the raw input ingredient, marine macroalgae used in crop fertility inputs, is not harmful to the environment by establishing harvest parameters created in collaboration with marine science experts in the field. The review of the literature demonstrates the possibility for multi-level environmental effects of harvesting marine macroalgae. Even where regulations exist, and they are not legislated in every country, they do not typically address effects on the community and ecosystem functions and instead focus on regrowth and recovery of the targeted species. The organic regulations, as noted in the earlier section on relevant areas of the rule, is concerned not only with single species impacts but also with ecological balance and biodiversity conservation. This proposal helps assure that marine macroalgae used in organic production is consistent with a system of sustainable agriculture.

Subcommittee Vote:

Motion to adopt the proposal on Marine Macroalgae in Crop Fertility Inputs
Motion by: Emily Oakley
Seconded by: Dave Mortensen
Yes: 5 No: 0 Abstain: 0 Recuse: 0 Absent: 1

Approved by Dave Mortensen, Subcommittee Chair to transmit to NOSB, August 11, 2020

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