National Organic Standards Board
Livestock Subcommittee Discussion Document
Marine algae listings on National List
September 6, 2016

I INTRODUCTION

During its recent five year sunset review of almost 200 materials the NOSB noted that there are a number of materials listed that are either marine algae or extracts of marine algae. The National List includes overlap in species in the various material listings. Some of the materials listed lack a Technical Report (TR) which limited full review of all algal materials. Public comment during Sunset Review indicated serious concerns about the following:

- Conservation of wild marine algae species
- Overharvesting of some species in some geographic areas
- Need for clarification of which species are used, and from which geographic areas
- Need for clarification of which species can or are being cultivated
- Clarification of wild harvesting techniques
- Feasibility of harvesting by individual species selection as opposed to multi-species harvesting by littoral or marine zone
- Extraction methods
- Sequestration of metals or other contaminants in some wild algal species

Because of public comment the NOSB requested a limited scope TR to address these concerns. The TR was received on August 9, 2016.

The goal of this discussion document is to present a brief analysis of our present understanding of the 9 marine algae on the National List and request public comment. Depending on public comment the NOSB may develop a proposal to annotate some of the materials on the list, or clarify the naming convention used to list these marine materials because many of the naming conventions may be duplicative and redundant. Alternatively, the NOSB may recommend that the NOP provide further guidance on use of seaweeds in organic production.

II BACKGROUND

Seaweeds have been commonly used, in many ways, throughout human history. They comprise a seemingly unlimited renewable resource subject, however, to the usual depletion through unintended over harvesting and pollution. Open oceans, tidal and intertidal zones appear to be relatively open to public harvesting. The laws that control harvesting, establish conservation zones and seek to ensure sustainable seaweed harvest, while protecting marine ecosystems worldwide, are highly variable, and typically poorly articulated and not easy to enforce.

In the face of exponentially growing pressure on marine resources, decline in fisheries, decline in species, decline in habitats, and depletion of seaweed species in many geographic areas, the European Commission in May 2016 held a conference to focus on ***Organic Seaweed Rules, Blue Growth and the Bioeconomy***[1]. The conference provided examples of good management in areas of high ecological quality which were not contaminated, and where environmental assessment and estimation of biomass was undertaken at the outset, and a sustainable management plan is in place.

[11] http://coastwatch.org/europe/wp-content/uploads/2016/05/Organic-Seaweed-Coastwatch.pdf

However, most of the seaweed harvested for human use is not certified organic, but simply harvested from or cultivated in marine environments worldwide. Some marine environments are polluted by run off from terrestrial activities taking place over generations. Some seaweed species grow back very fast following harvest, while others take many years. Because of high demand, harvesting does not necessarily protect biomass and rarely involves ecosystem management. Little is really understood about the multi-tropic impact on seaweed harvesting or cultivation.

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.

There are nine separate listings for marine materials on the National List which are the subject of this document:

1. **Aquatic plant extracts** (TR 2006) - aquatic plant (algae) extracts are most commonly derived from kelp such as *Ascophyllum* species and *Ecklonia maxima* (Sea Bamboo) as well as other seaweeds harvested from the North Atlantic. *Ascophyllum nodosum,* (Rockweed) a species known to be overharvested in many geographic regions, is in the *Fucaceae*, a brown seaweed, Class *Phaeophyceae* – not able to be cultivated and known to be regionally overharvested.

2. **Alginic acid** (TR 2015) is primarily extracted from brown seaweeds, Class *Phaeophyceae.* Major commercial sources are from species that include *Ascophyllum* (North Atlantic), *Laminaria* and *Saccharina* (various northern hemisphere oceans) and *Macrocystis* (California and Mexico), with lesser sources from *Lessonia* (South America), *Durvilea* (Australia), *Ecklonia* (South Africa), *Sargassum*, and *Turbinaria*.

3. **Agar-Agar** (TR 2011) is typically derived from red seaweeds, Class: *Rhodophyceae*. The marine algae that produce agar-agar are widely distributed throughout the world and several different species are utilized for extraction. Most commercial agar-agar is extracted from *Gelidium* and *Gracilaria* species, but other commonly used species include *Pterocladia* and *Gelidiella*. The most important sources worldwide include the coasts of Japan, Spain, Portugal, Morocco, Senegal, Chile, Mexico, the southern United States, India, the Philippines, Madagascar, South Africa, Egypt, and New Zealand although many other countries also supply algae used to make agar-agar. Although most agar-agar is produced from algae that grow in the oceans, *Gracilaria* algae are also cultivated on a commercial scale by some countries.

4. **Carrageenan** (TR 2011) is a generic term for a family of linear polysaccharides derived from species of red seaweeds (*Rhodophyceae)*. They can be wild harvested or cultivated. Typical species used are *Chondrus crispus, Mastocarpus stellatus, Euchema cottonii and Eucheuma spinosum*, which grow in the warm waters of the Philippines, Indonesia, and Tanzania and produce kappa- and iota-carrageenan, respectively. The Asia-Pacific region has remained the largest source of carrageen-producing seaweed, supplying over 50% of the market from 1999 through 2009, and the Americas have similarly maintained 16-18% of the global market.

5. **Alginates** are derived from brown seaweeds (See TR 2015). Of the species in the class of brown seaweeds, 41 species are used for extracting alginates, including: *Ascophyllum nodosum* from Ireland, Norway, UK; *Cystoseira barbata* from Egypt; *Durvillaea potatorum* from Australia; *Fucus serratus, F. vesiculosus* from Ireland; *Laminaria digitata* from France, Ireland; *Laminaria*

hyperborea from Ireland, Norway, Spain, UK; *Laminaria japonica* from China*; Laminaria ochroleuca* from Spain; *Lessonia nigrescens* from Chile, Peru; *Lessonia trabeculata* from Chile; *Macrocystis integrifolia* from Peru; *Sargassum crassifolium, S. gramminifolium, S. henslowianum, S. mcclurei, S. siliquosum, S. vachelliannum* fromVietnam; *Sargassum ilicifolium, S. myriocystum, S. wightii, Turbinaria conoides, T. decurrens, T. ornata* from India; *Sargassum polycystum* from Indonesia, Thailand.

6. **Beta-carotene from algae** (TR, 2011) is typically derived from green algae, Class: *Chlorophyceae*. The common source of beta-carotene color is derived from the micro-algae *Dunaliella salina* and *Dunaliella bardawil*. These species are cultivated. *Dunaliella* species are commonly observed in salt lakes in all parts of the world from tropical to temperate to Polar Regions where they often impart an orange-red color to the water. In a review article conducted by Dufosse et al. (2005), they concluded that algal forms are the richest source of pigments and can be produced in a renewable manner, since they produce some unique pigments sustainably. The report also stated that the production of β-carotene from *Dunaliella* will surpass synthetic as well as other natural sources due to microalgae sustainability of production and their renewable nature. (TR 2011, 530-545).

The following 3 materials did not have detailed TRs until 2016:

7. **Kelp** is a broad generic term for brown seaweeds, Class *Phaeophyceae*, in the Order *Laminariales*, with at least 30 genera and many species, and in the Order *Fucaceae* such as *Ascophyllum nodosum.* However the term "kelp" as used in fertilizer means ANY macroalgae seaweed, brown (*Phaeophyceae*), red (*Rhodophyceae)* or green (*Chlorophyceae)* (Assoc. of American Plant Food Controls (AAPFC)). Kelp used in organic livestock production must be certified organic, but for use in processing for humans non-organic kelp is allowed. Pacific Kombu, and *Undaria innatifida* are also Kelp species. *Fucus* species are intertidal, but *Laminaria* species are deep water.

8. **Seaweed- Pacific Kombu** is a kelp, often *Laminaria japonica*. This species is cultivated in waters of Japan, Korea and China.

9. **Wakame-** *Undaria pinnatifida* is a kelp species native to cold temperate coastal waters in Japan, Korea and China, but it has also become an invasive weed species in numerous other locations. *Undaria* is widely cultivated in China and Japan.

III RELEVANT AREAS OF THE RULE, NOP GUIDANCE, AND NOP MEMOS

§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 do 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.

§205.605 Nonagricultural (nonorganic) substances allowed as ingredients in or on processed products labeled as "organic" or "made with organic (specified ingredients or food groups))."

(a) *Nonsynthetics allowed*:

Acids (Alginic; ...).
Agar-agar.
Carrageenan.

(b) *Synthetics allowed:*
Alginates.

§205.606 Nonorganically produced agricultural products allowed as ingredients in or on processed products labeled as "organic."

(d) Colors derived from agricultural products-must not be produced using synthetic carriers and solvent systems or any artificial preservative.

(2) Beta-carotene extract color derived from carrots or algae (pigment CAS 1393-61-1).

(l) Kelp – for use only as a thickener and dietary supplement.

(t) Seaweed, Pacific Kombu.

(x) Wakame Seaweed (*Undaria pinnatifida*).

§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.

NOP 5022, Guidance- Wild Crop Harvesting, effective July 22, 2011, provides details to clarify **§§**205-207.

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.

IV DISCUSSION:

The NOSB submitted brief information on each of the nine materials and posed seven questions to the NOP for the limited scope TR. This TR was received in August 2016 and the responses to these questions are briefly discussed below. The TR cited a number of references but the literature review was limited. Some additional relevant references are included in this discussion.

1. <u>Nomenclature:</u> *Many of the National List listings are generic terms or overlapping terms lacking specificity, such as "agar-agar", "carrageenan", "aquatic plant extracts" or "kelp". Should each listing include specific Latin names of approved algae? Should the word "plant" be replaced by the word "algae"?*

   The TR provides sources of marine polysaccharides (TR 2016, Table 3) but acknowledges the somewhat arbitrary nomenclature of red algae. Thus it may be possible for the NOSB to propose some clarity in the listings through use of Latin names. However, it must be noted that taxonomic revision amongst algal species has become commonplace. Morphologically plastic species in the same geographical location and identical species in different geographic locations are frequently given different scientific names (TR 2011 631-634 and 689-716).

   Habitat forming seaweeds include the *Laminariales* (*Laminaria* species and others) and *Fucales* (*Ascophyllum* and others). Currently many of these species are referred to by a single common name "kelp". This creates confusion because macroalgal species are harvested by different methods, their life histories and growth rates differ, and thus the impacts of cutting and harvesting on these species will differ. Clarification in naming conventions is thus of importance if conservation of habitat and species is taken into consideration.

2. <u>Overharvesting:</u> *The nine listings include thousands of species of algae from many different geographic locations, the marine intertidal zone, deeper ocean areas, and wild harvested beds. Which species, genera, classes are being overharvested? Which geographic regions indicate overharvesting impact? What is the trend in harvesting marine algae? What is the present status and trends in harvesting and overharvesting of Ascophyllum nodosum?*

   The TR provides examples of the following seaweeds being overharvested: Irish Moss (*Chondrus crispus*), Rockweed (*Ascophyllum nodosum*) and giant Kelp (*Macrcustis pyrifera*). It must also be noted that ocean warming and other environmental factors probably contribute to depletion of these species (see also: Halat et al, 2015[2]; Kay et al, 2016.[3]). Overharvesting impacts not only the specific plant species or genus, but all the associated plant and animal species that form the marine ecosystem in a given location. (see also Keats et al 1987[4] and Kelly, 2005[5]

   There is limited evidence to suggest that the harvesting of agarophytes (algae used to make agar-agar) may be harmful to biodiversity. The current world demand for agar-agar is reportedly increasing, which has placed pressure on the overharvested natural sources. Overharvesting of many wild *Gracilaria* strands has resulted in the destruction of some of the larger genetic reserves

[2]Laryssa Halat, Moira E Galway, Sara Gitto and David Garbary, Epidermal shedding in *Ascophyllum nodosum* (*Phaeophycea*): seasonality, productivity and relationship to harvesting. *Phycology*, Vol.54(6), 599-608, 2015.
[3] Lauren M. Kay, Allison L. Schmidt, Kristen L. Wilson, Heike K.Lotze, Interactive effects of increasing temperature and nutrient loading on the habitat-forming rockweed Ascophyllum nodosum. Aquatic Botany 133, 70-78, 2010.
[4] Keats, D.W., Steele, DH and South, G.R. The role of fleshy macroalgae in the ecology of juvenile cod (Gadus morhua) in inshore waters off eastern Newfoundland. Journal of Zoology, 65:49-53, 1987.
[5] Kelly, E (ed) The role of Kelp in marine environment. Irish Wildlife Manuals, No. 17, National Parks and Wildlife Service, Dept. Environment, Heritage and Local Govt., Dublin, Ireland.

for the species. Harvesting of wild agarophytes may also reduce biodiversity on nearby beaches (TR 2011). In 2015 there was a global downturn in availability of agar-agar.

Carrageenan production levels have decreased in Europe and increased substantially in China. Cold water species of red seaweed used to make carrageenan (from Chile, Mexico, Canada, and France) are generally harvested from wild populations. Overharvesting of *Gigartina* species at its northernmost limit in Chile resulted in a severe reduction in population size and a complete crash in the total number of seaweed landings in the early 2000s (TR 2011). Most carrageenan production comes from cultivated beds.

3. <u>Selective harvesting</u>*: There are about 6,500 species of red algae (Rhodophyta) such as Chondrus species, Palmiria, Delessaria; about 2,000 species of brown algae (Phaeophyta) such as Laminaria species, Ascophyllum species, Sacharina, Fucus, Sargassum muticum; and about 1,500 green algae (Chlorophyta) such as Dunaliella, of which many are not marine. How many species of each class are being wild harvested? Can one species be harvested without impacting other species in the same location?*

   The TR 2016 provides Table 5, outlining algal species harvested for economic purposes. The TR indicates that there is limited research on this topic. Additional literature search shows some work has been done on multi-tropic consequences of kelp harvest on the coast of Norway, indicating negative impacts of kelp harvesting on fish abundance and diminishment of coastal seabird foraging efficiency (Lorentsen et al, 2010[6]). Lorentsen points out that kelp fisheries are currently managed in order to maximize net harvest of kelp biomass, and the underlying effects on the ecosystem are partly ignored. Literature review did not turn up any scientific research comparing certified organic kelp harvesting with non-certified wild harvesting.

   There is peer reviewed research on habitat impact of seaweed on common eider ducks, such as Blinn et al, 2008,[7] and fish impact in Nova Scotia, such as Black, 1991[8], and impact of mechanical harvesting on Ascophyllum , such as Ang, 1993[9], and Ang, 1996,[10] and Arzel, 1998[11]. And there is considerable research on Ascophyllum harvesting impacts.

4. <u>Contamination</u>*: Seaweeds can sequester metal ions such as arsenic, lead, zinc and copper. What is the indication from the most recent scientific research on sequestration of metals by marine algae? Is there a difference in sequestration between species of algae? Are there additional processing steps taken to reduce and control for metal content from the raw seaweed material?*

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[6] Svein-Hakon Lorentsen, Kjersti Sjotun and David Gremillet, Multi-tropic consequences of kelp harvest, *Biological Conservation*, 143, 2054-2062, 2010.

[7] Blinn, B.M., A.W. Diamond and D.J. Hamilton. Factors affecting selection of brood-rearing habitat by common eiders (Somateria mollissima) in the Bay of Fundy, New Brunswick, Cnada. Waterbirds 31:520-529, 2008.

[8] Black, R & R.J. Miller, Use of intertidal zone by fish in Nova Scotia. Env. Bio. Fishes, 31:109-121, 1991.

[9] Ang, P.O., G.J. Sharp & R.E. Semple. Change in the populations structure of Ascophyllum nodosum due to mechanical harvesting. Hydrobiologia, 260/261:321-326, 1993.

[10] Ang, P.O, G.J. Sharp & R.E. Semple. Comparison of the structure of populations of Ascophyllum nodosu, (Fucales, Phaeophyta) with different harvest histories. Hydrobiologoa 326/237 179-184.

[11] Arzel, P. Les luminaires sure les cotes bretonnes. Evolotion de l'exploitation et de la flottille de peche, etata actuel et perspectives. Editions IFREMER BP 70-29280 Plouzane, France 139 pp.

Marine algae have a large capacity to sorb metals. In fact, algal species are often used as biosensors for contamination with arsenic and heavy metals. Their analysis in heavily contaminated areas, particularly agricultural soils, can be used to determine required bioremediation strategies (TR 2016 775-777). The EPA found that levels were well below safe levels in research conducted in the St. Lawrence. However, increased pollution will lead to higher levels of arsenic and heavy metal in algae for human consumption.

5. <u>*Organic certified wild crafting:*</u> *Which marine algal species are being harvested under the "wild crafting" organic standard, and in which geographic locations?*

   7 CFR §205.207 provides the wild crop harvesting standard. This section is further clarified in NOP 5022 (7/22/2011) as follows:

   4. 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… and

   5.4. Verification of lands or waterways:

   1. In the case of public lands or waterways, the responsible authority of those lands or waterways should verify that no prohibited materials have been applied to or have contaminated the land or waterways for at least three years prior to harvest by providing a signed and dated affidavit to the certified operation.

   2. In the case of private lands and waterways, the private owner shall provide a verification that no prohibited materials have been applied to or have contaminated the land or waterways for at least three years prior to harvest by providing a signed and dated affidavit to the certified operation.

   There are 5 operations certified by the NOP to produce marine algae. One in Brazil harvests red algae; one in China produces nori (red algae); one in Iceland mechanically harvests both kelp (*Laminaria digitata*) and rock weed (*Ascophyllum nodosum*), and ecological concerns about changes in species diversity have been noted (TR 896-897.) In Argentina, several commercial species are harvested both by wild crafting and cultivation.

6. <u>*Cultivation:*</u> *Which species are being cultivated, and in which geographic locations? What are the environmental issues associated with farming marine algae?*

   Increasing demand for seaweeds over the last 50 years has outstripped the ability to supply the market from natural wild stocks, and 90% of the market demand is met from cultivation (TR 2016, 189-190). However, not all marine algal species are easily or economically cultivated. For example, *Ascophyllum nodosum* (Rockweed) a species widely harvested, and over harvested, for aquatic plant extracts and alginic acid, is a brown seaweed, which is not economic to cultivate. The TR provides considerable detail on seaweed farming of many species worldwide.

7. <u>*CO2 sequestration*</u>*: What does recent research indicate about the ability of marine algae to positively impact the environment, including global climate change, by their ability to absorb excessive CO2*?

   The TR 2016 briefly presents research indicating that marine algae are critical in their role as carbon sinks with substantial benefits for global climates. Note also the findings of Treventhan-Tacket et al,

2015 which provides a comparative analysis of various seaweeds and their contribution to carbon sequestration[12]. See also Kay, 2010 cited above.

Summary:
All materials on the National List are reviewed as separate, individual materials, described by chemical or species name. However each marine material grows in a complex and not fully understood ecological context subject to internal and external stressors, never in homeostasis. In order to fully review a material against the required OFPA criteria each material must be assessed in the context of where it grows, and with an understanding of verifiable assurances of sustainability. Production of marine materials must be based on the maintenance of biodiversity of natural aquatic ecosystems, and the continuing health of the surrounding aquatic and terrestrial ecosystems. With these contexts in mind the NOSB asks the public for comment on the nine marine materials noted above.

V REQUEST FOR PUBLIC COMMENT

1. Should the naming conventions of the marine plant/algae listings on the National List be consolidated and/or clarified to avoid redundancies and duplication, using Latin binomials?
2. Should annotations be written to clarify specific uses, or harvesting guidelines for any of the marine algae listings, such as "no machine harvesting of *Ascophyllum*", and "Not harvested from a conservation area identified by State, Federal or International bodies"?
3. Is there a need for further NOP Guidance on marine plants/algae?

Motion to accept the discussion document on marine algae listings on National List
Motion by: Jean Richardson
Seconded by: Ashley Swaffar
Yes: 9 No: 0 Abstain: 0 Absent: 0 Recuse: 0

[12] Teventhan-Tacket S.M., Kelleway J.J., Macreadie P.I., Beardall J., Ralph P., Bellgrove A., Comaprison of marine macrophytes for their contribution to blue carbon sequestration. Ecology 96"3043-3057, 2015.