NATURAL RESOURCES

Native Aquatic Vegetation Survey Protocol: Siting Seaweed Farms

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WASHINGTON STATE DEPT OF NATURAL RESOURCES

Cover Photo: DNR scientist with blade of sugar kelp (*Saccharina latissima*). Photo taken at Maury Island Aquatic Reserve.

Contents

1. Purpose

This document is a guide for individuals who would like to work with the Washington State Department of Natural Resources (DNR) to establish seaweed farm leases. The DNR requires native aquatic vegetation (NAV) survey for any new seaweed farm.

A NAV survey is consistent with DNR stewardship measures and important to ensure that a kelp farm is not shading out naturally occurring macroalgae or eelgrass. With sufficient shading, these sunlight dependent species cannot survive. If NAV is found to be present in a proposed lease footprint, DNR will require the footprint to be shifted to a location where NAV is less abundant.

If information related to the composition of NAV in a proposed leasehold is already available, this may be utilized, on a case-by-case basis. Preliminary information about the presence of seagrass and floating kelp may already be available from DNR's Puget Sound Eelgrass Monitoring Data and Floating Kelp Forest Indicator, however these tools alone cannot fulfill the requirement of a survey and/or be used to substantiate evidence of the absence of NAV. These viewers are accessible at https://www.dnr.wa.gov/programs-and-services/aquatics/aquatic-science/puget-sound-eelgrass-monitoring-data-viewer and Floating Kelp Forest Indicator for WA State (arcgis.com).

This survey shall occur following DNR's receipt of a complete Joint Aquatic Resources Permit Application JARPA for the project. Specifically, this is upon initial review of site; during early and often; prior to permitting and directed at the time of Attachment E of the JARPA being signed. Surveys must be completed between July 1 – October 1, the time when NAV would most likely be visible.

The protocols for this survey are described in detail here. Submerged vegetation surveys of this kind will inform lease applicants and DNR resource managers if it is permissible to site seaweed farms in a certain location. If the entire footprint of a farm is sited in greater than -20 m or -66 ft (MLLW) of water, they will not be required to carry out a NAV survey since light penetration Ia not a concern at this depth (See Section 2.3 for more detail). By following this standard protocol, the farm siting process will be standardized for all applicants.

2. Introduction

DNR's mission is to manage, sustain, and protect the health and productivity of Washington's lands and waters to meet the needs of present and future generations. To accomplish this mission, DNR is dedicated to encouraging direct public access and use, fostering water dependent uses, ensuring environmental protection, and utilizing renewable resources. In addition to these core values, DNR strives to protect habitats that support listed aquatic species

on state-owned aquatic lands, with the intent to contribute to species persistence and recovery on broad geographic scales and to improve the overall health and function of aquatic ecosystems.

NAV provide important habitats for listed species. NAV refers primarily but not exclusively to seagrasses (*Zostera spp.)* and macro algae (*Rhodophyta, Chlorophyta,* and *Phaeophyta*), and provides three-dimensional structure to shallow-water benthic habitats, slows erosion and wave energy[1], and converts carbon dioxide (CO_2) into oxygen and plant biomass[2]. NAV is a major source of food for birds, fish, invertebrates, and mammals either as a result of direct consumption or through predation on species such as zooplankton, as well as larval and juvenile fish that shelter there[3,4]. Submerged aquatic vegetation provides a functionally important component of many soft bottom communities and supports a higher abundance of benthic and epibenthic species[5]. Certain species may also use vegetation for egg attachment, as a nursery or rearing area, or for refuge from predation[6,7].

Seaweed farming for kelp or other macroalgae is gaining interest worldwide for both food and non-food applications. In Washington State, the activity is relatively new and growing, with DNR and private farmers establishing lease agreements on state-owned aquatic land (SOAL). Some seaweed farming may provide secondary benefits such as nutrient absorption, additions of primary productivity to the food chain, and structured habitats for some species[8].

Despite these benefits, a seaweed farm will not support benthic and epibenthic species to the same extent as naturally occurring vegetation, largely due to its off-bottom structure. Additionally, there are potential environmental risks that may come with seaweed farming. These may include changes to benthic light availability, wave attenuation, crop-to-wild gene flow, habitat provisioning for diseases, and others[8,9].

2.1 SHADING FROM SEAWEED FARMING

Shading from over-story vegetation negatively influences sunlight-dependent organisms by inhibiting the settlement of juveniles[10–12]. It can also change the overall distribution of natural non photosynthesizing benthic and mobile organisms by shading out native aquatic vegetation which species depens on for food, shelter, or refuge[5,13]. Different species of marine vegetation have been found to be tolerant and survive in varied amounts of light[14,15]. Washington's native species of eelgrass (*Zostera marina*) needs a minimum of 3 - 6 mol photons/m²/day in the spring and summer to survive[14,16]. The same is true for leathery macrophytes and foliose algae which need less light to survive (1 mol photons/m²/day) and 0.13 mol photons/m²/day respectively[14,15]. The body of research that includes daily requirements for understory seaweed is sparse but points to a daily minimum value of 2 mol/day[17].

Overwater structures, such as floating rafts or docks, can attenuate the quantity of sunlight that reaches the bottom below the required level for NAV[18], including floating seaweed aquaculture facilities. At peak growth, seaweed farms can reduce benthic light levels. For example, sugar kelp (*Saccharina latissima*) farms in Europe have been recorded to reduce ambient light to 40% of the original level at a depth of only five meters (16 ft.)[9]. This corresponds to a photosynthetic

active radiation (PAR) of approximately 3.5 mol photons/m²/day prior to harvest at a depth of five meters below a farm[9]. Shading studies focused on overwater docks have found that the higher the structure from the bottom, the more diffuse a shadow it casts on the bottom resulting in greater light available under the dock[18]. For this reason, seaweed farms located in deeper water will have less of a shading impact on the NAV and benthic habitat below them.

Since the peak of farm biomass is during a relatively short period in the growing season, shading from a seaweed farm may have a limited functional and ecological effect on benthic photosynthetic communities[9]. Nevertheless, the collection of research that investigates shading impacts specifically from kelp aquaculture is sparse, and it is recommended that seaweed farms avoid well-vegetated habitats[8,18,19].

For this reason, the DNR has created NAV survey protocols to avoid areas abundant with NAV until more information on the relationship between seaweed aquaculture and NAV is available.

2.2 DNR Native Aquatic Vegetation Strategy

Revised Code of Washington (RCW) 79.105.030 directs management guidelines for the Department of Natural Resources. Ensuring environmental protection is one such management guideline. Accordingly, DNR seeks to ensure that all new activities and structures on SOAL avoid impacts to existing, attached, or rooted NAV by including a perimeter buffer of 8 meters (25 ft.) between the lease activity/ structure and NAV. For seaweed farming, this buffer encompasses the entire farm and extends through the entire water column from the surface to the bottom (Figure 1).

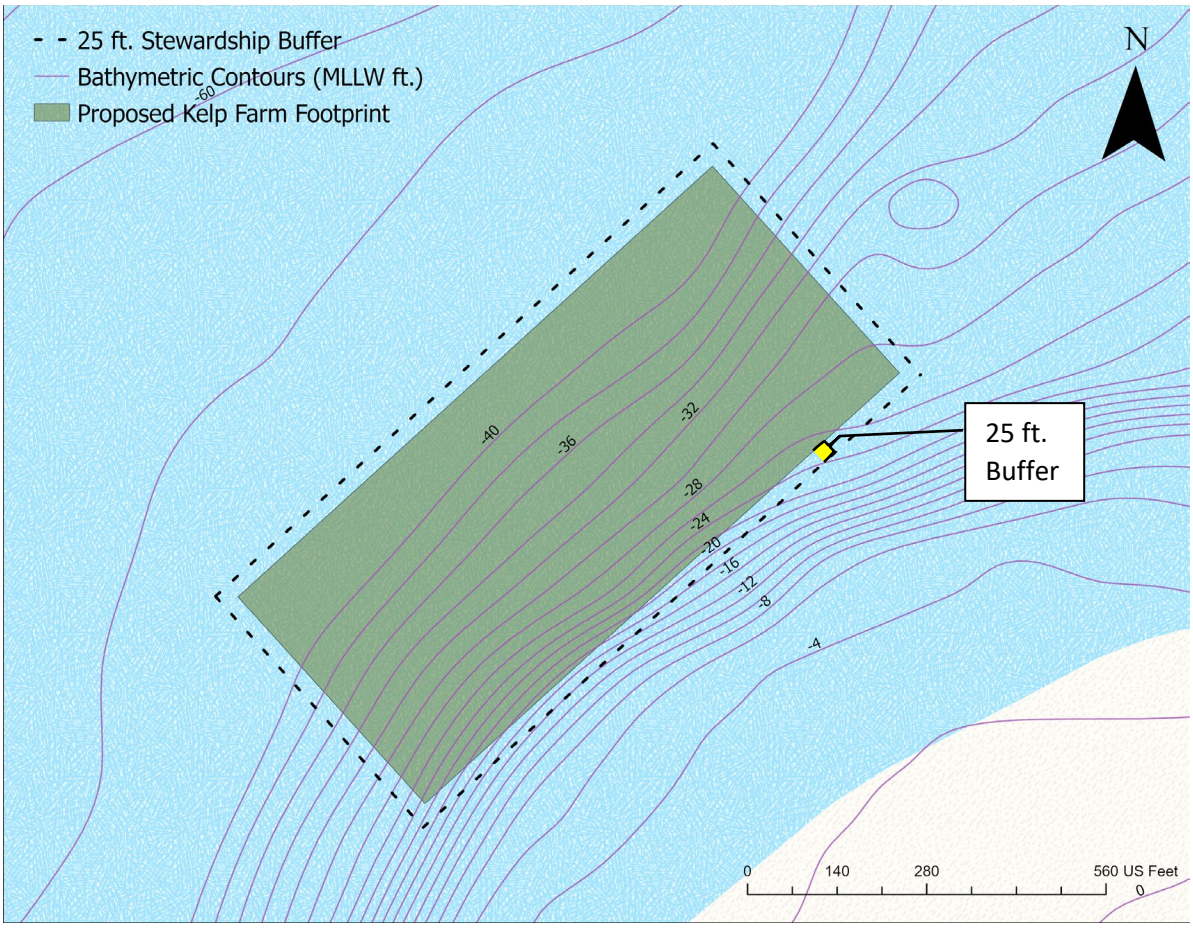

Figure 1. Image representing a 25-foot vegetation buffer around a farm.

The survey protocol described in this document is designed to provide project proponents and leaseholders with a guide to structure this NAV survey. This information will be used by DNR Habitat Stewardship Specialists to determine whether a proposed farm site poses a risk to submerged NAV which may include native seagrasses, brown algae (kelp included), or red algae.

2.3 Depth Ranges

The main factors determining the depth of NAV are species-specific light tolerances and water clarity. For example, eelgrass typically grows between 0 and -4 m (0 and -13 ft) Mean Lower Low Water (MLLW) in Washington's marine waters. However, brown and red algae grow much deeper. In places with high water clarity and light penetration (e.g., Strait of Juan de Fuca), some species of brown algae can be found growing down to a maximum depth of 30m (100 ft.)[20]. The footprint of a floating structure has less of an impact at greater depths, therefore, farms (and the area of their vegetation buffer) that are sited deeper than -20 m MLLW (-66 ft.) are unlikely to have significant impacts on species that are accustomed to low light levels[9,14,15]. Considering this, farms sited deeper than -20 m (-66 ft) MLLW will not be required to complete a survey as part of the siting process.

3. Survey Overview

The following surveys design serve to standardize the NAV surveys required by DNR for commercial seaweed farm leases such as kelp. It provides standard protocols for submerged NAV surveys, which will be used to inform lease applicants and DNR lease managers where it is permissible to site seaweed farms.

There are two phases of the survey. Phase 1 is an optional coarse-resolution survey of possible lease footprint locations around the vicinity of the proposed lease. It will detect whether vegetation is likely to be present in the parcel and help to guide placement of the smaller lease footprint.

Phase 2 is required and is a higher resolution survey of the preferred lease location based on the information gained from Phase 1.

In the event NAV that is found within 8 meters (25ft) in the horizontal plane of a proposed lease footprint during a Phase 1 or Phase 2 survey, DNR will determine whether the type and quantity of NAV found warrants relocating the lease footprint.

3.1 Phase 1

A Phase 1 survey is optional and is intended to be relatively rapid and low-resource intensive. This initial survey should help save time and effort in the second (Phase 2) survey. It is carried out prior to Phase 2, but both surveys can be completed on the same day. In a cursory survey of an area approximately nine times the proposed lease footprint this survey should identify the presence/absence of NAV to determine whether it is possible to site a farm at the proposed location (Figure 2). This area should surround the intended lease location in the longshore direction both ways and to the deep side of the proposed location in the cross-shore (Figure 1).

To carry out Phase 1, survey transects are placed in the middle of each proposed alternative lease footprint (Figure 2). Each survey transect should be surveyed with the methods outlined in Section 4. Alternatively, the applicant may choose to "spot check" the preferred zones by dropping a camera, ROV, or diver at 4 – 10 well distributed locations within the proposed footprint.

If saltwater habitats of concern (seagrasses and kelp) or (red algae within herring spawning zone) is found in Phase 1, the proposed farm footprint should be moved to a different location that will provide at least twenty-five feet between it and the nearest observation of these species. Buffers are required to protect (i.e. avoid and minimize) NAV from shading and farm operational impacts.[21] and are consistent with WDFW's Eelgrass/Macroalgae Habitat Interim Survey Guidelines[22].

DNR does not need a copy of survey results for a Phase 1 survey.

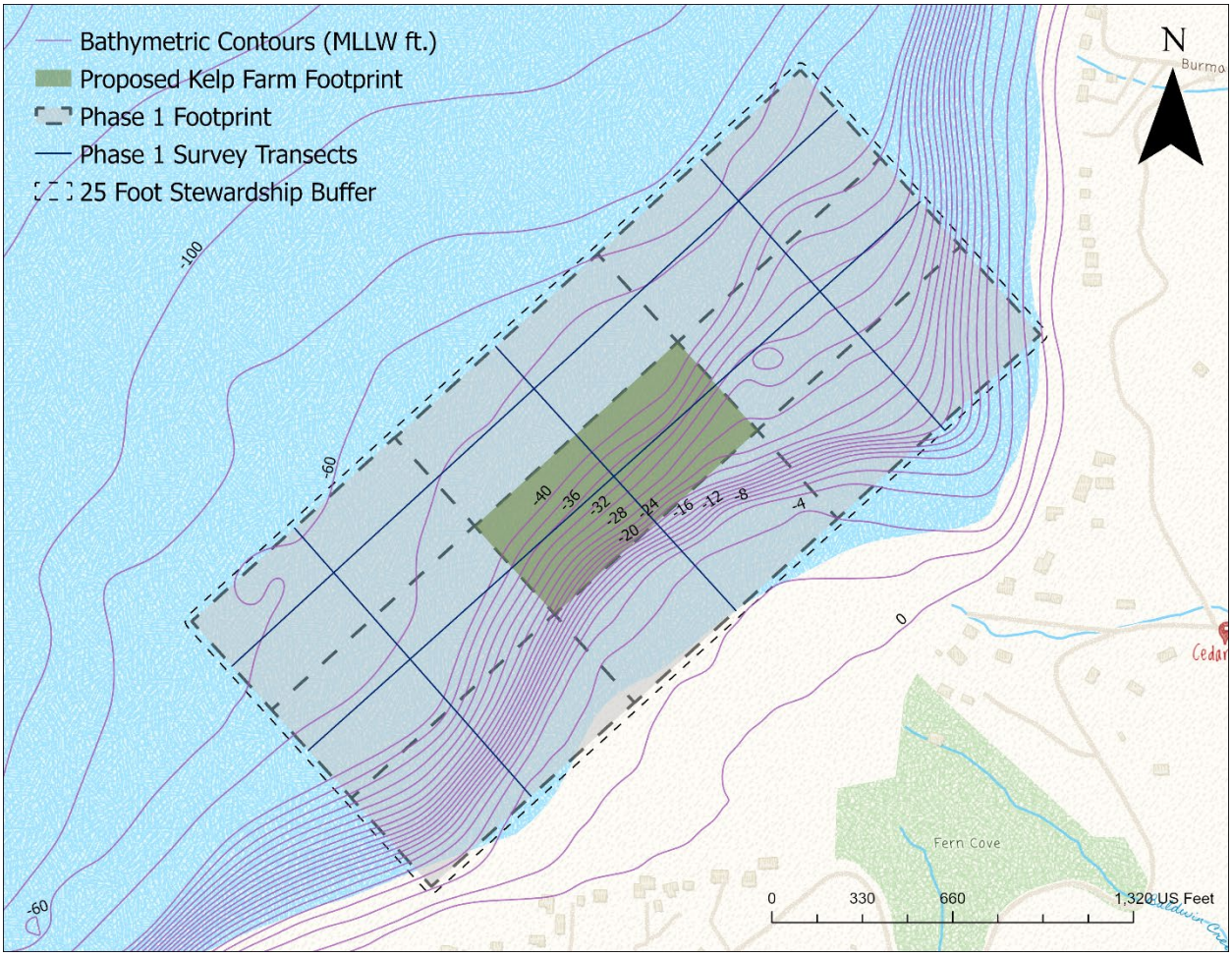

Figure 2. Phase 1 preliminary survey transect design example

3.2 Phase 2

Unlike the optional Phase 1 survey, Phase 2 is required (except as described in Section 2.3, if the entire farm is deeper than -20 m (-66 ft) MLLW then a Phase 2 survey is not required). The Phase 2 survey may be completed after the optional Phase 1 survey has confirmed the presence of sparse or nonexistent saltwater habitats of concern. The product of this survey will be a detailed map from a high-resolution survey of the area beneath the lease footprint. In addition to surveying a footprint where gear will be installed, DNR requires that a 25 ft buffer measured from the lease edge out is included in the survey area (Figure 2). Final Phase 2 maps should show all survey transects and illustrate the baseline conditions of NAV in the proposed farm footprint.

The Phase 2 survey includes more transects to provide a higher resolution assessment of NAV cover within the selected lease footprint. Depending on the depth range of the proposed farm

footprint, a tenant may only need to perform this survey on a portion of the proposed lease (see section 2.3).

For Phase 2, video transects can run either parallel or perpendicular to the shore and should extend 8 m (25 ft.) past both ends of the proposed footprint (Figure 2). Transects should be spaced every 30 m (100 ft.) both parallel and perpendicular to shore in the pictured "crosshatch" pattern (Figure 3). Transect spacing should remain at 30 m (100 ft.) until depths under the farm are greater than - 20 meters MLLW (-66 ft.), and after which no survey lines are needed. Video review will classify vegetation presence and absence every 5 meters. See section 4 for information on how to analyze video collected in Phase 2.

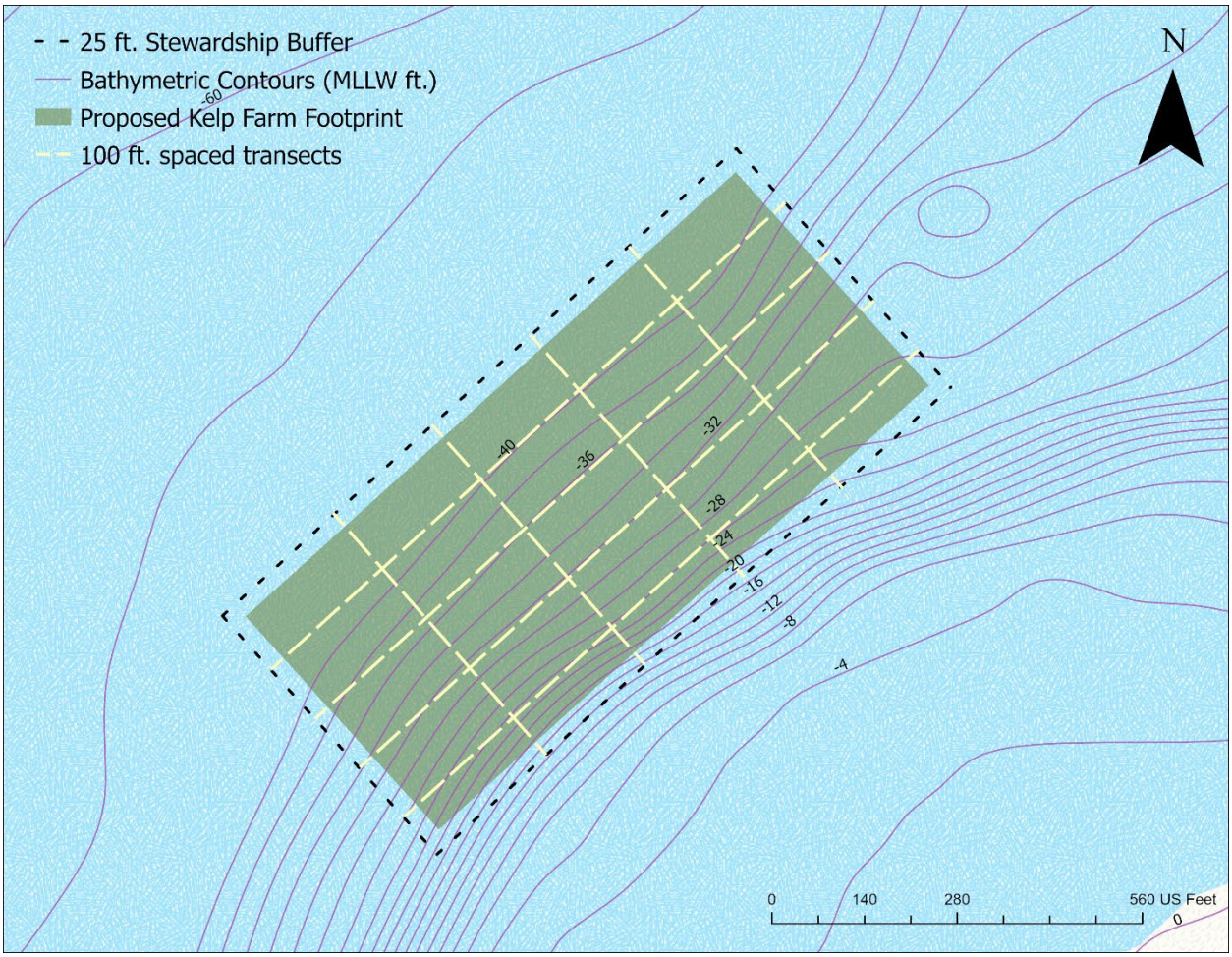

Figure 3. Schematic of example Phase 2 survey design.

3.3 Survey Timing

All surveys, including Phases 1 and 2, must occur between July 1 and October 1. This timing targets the peak growing season for many species of NAV in Washington's marine waters.

3.4 Survey Type

3.4.1 Option 1: Towed Video/ ROV Survey

Note: it is imperative that the surveyor does not drive motorized boat through floating kelp during any part of the protocols. If kelp is encountered on the surface, it must be avoided.

Video Survey

Tow a tethered camera by boat along a series of transects, georeferenced with a boat-based Global Positioning System (GPS) connected to the camera, providing real-time data to both the camera as well as mapping software. The survey must be recorded with the date, GPS time (UTC), and coordinates (decimal degrees) all visible in the video frame. Surveys must occur with the camera at a distance of 1 meter off the bottom at all times. This distance is adequate to allow for accurate species identification as well as provide a standard viewing width (approximately 2 meters). A vessel speed of 1 meter per second over-ground should be maintained for a constant rate of coverage. This method is not suitable for sites where canopy forming kelp is present.

ROV Survey

Drive a submersible remotely operated vehicle (ROV) along a series of transects georeferenced with a boat-based GPS and transmitter on the ROV. The ROV should be driven approximately 1 meter above the bottom to collect the same data as described above in the towed video survey.

3.4.2 Option 2: Dive Survey

For lease areas less than 0.40 hectares (1 acre), a dive survey may suffice under the following conditions:

- Surveys are video-recorded.
- Surveys can be geo-referenced based on the start position and a traversed bearing. Based on the orientation of the farm footprint, contour lines may be followed for a diver to maintain the same transect.
- The same 1-m accuracy percent cover data that can be transcribed onto a map will be necessary for this type of survey.

4. Video Analysis

Video analysis shall be performed by someone qualified to identify functional groups as classified into the NAV classification described below. Prior to classification, DNR requires that

a curriculum vitae (CV) for the individual conducting the analysis shall be provided for review and approval.

NAV Classification

Examples of some but not all species that may be found and classified into groups are indicated below:

1. **Seagrass**
   - *Zostera spp.*
   - *Phyllospadix spp.*

2. **Green Algae**
   - *Ulva spp.*

3. **Understory Kelp (Laminariales)**
   - *Saccharina spp.*
   - *Alaria spp.*

4. **Floating Kelp**
   - *Nereocystis luetkeana* (Bull Kelp)
   - *Macrocystis pyrifera* (Giant Kelp)

5. ***Sargassum spp.***

6. **Other Brown/Red Algae**
   - Branching, bushy, leafy, or filamentous red algae
   - *Desmarestia spp.* (Acid Kelp)

For a guide to identify different types of marine algae, see the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) Benthic Algae Survey Training Guide.

The following steps ensure the standardization of video methods and data quality:

1. Export GPS data into a spreadsheet format to allow for analysis of one frame per second.
2. Pull out a video frame from every 5 meters and classify NAV into presence or absence (Table 1).
3. The following columns should be exported and filled in – a template spreadsheet is linked on the DNR website at: Leasing and Land Transactions | WA - DNR (Table 1 and Table 2).

- Date
- UTC Time (H:M:S)
- Latitude (decimal degrees)
- Longitude (decimal degrees)

- Presence (0 = absent 1 = present)
  - Seagrass (0 – 1)
  - Green Algae (0 – 1)
  - Understory Kelp (0 – 1)
  - Floating Kelp (0 – 1)
  - Sargassum (0 – 1)
  - Other red/brown algae (0 – 1)
- Vegetation Drift (0 = False, 1 = True)
- Sediment Type

Table 1. Video spreadsheet attributes

Column Header	Description
Date	Format: MM/DD/YYYY
UTC Time	Format: military time, HH:MM:SS
Latitude	Format: decimal degrees
Longitude	Format: decimal degrees
Seagrass	0-1 for presence or absence, NA for camera out of water or obstructed
Green Algae	0-1 for presence or absence, NA for camera out of water or obstructed
Understory Kelp	0-1 for presence or absence, NA for camera out of water or obstructed
Floating Kelp	0-1 for presence or absence, NA for camera out of water or obstructed
Sargassum	0-1 for presence or absence, NA for camera out of water or obstructed
Other Red/Brown Algae	0-1 for presence or absence, NA for camera out of water or obstructed
Vegetation Drift	0 or 1 = Identify if the majority of vegetation is False (attached to substrate), True (freely drifting). NA for no vegetation.
Sediment Type	Boulder, Cobble, Pebbles, Sand, Silt, Clay. (Defined in Table 2)

Table 2. Grain size classes and sizes based on the Wentworth Scale.

Size Terms	Grain Diameter
Boulder	4096 – 256 mm
Gravel	64 – 2.38 mm
Sand	2 - .004 mm
Silt	.0039 to .0313 mm
Clay	< .0039 mm

5. Geospatial Products and Reporting

5.1 Maps

Maps for NAV presence shall be produced using ArcGIS, QGIS, or a similar geospatial analysis software.

DNR requires a separate map for each vegetation class observed to be included in a report that displays percent-presence. An example for red algae is shown in Figure 3.

The following features must be included in each map:

1. An outline of the proposed farm and required buffer footprint
2. Video track lines driven within the presence of each vegetation class specified by color.
3. A Legend
4. A North Arrow
5. A Scale Bar

5.2 Submission of Data

DNR requires submission of the following data:

1. Report including map(s) as described in Section 5.1
2. The processed transect data in spreadsheet format
3. Survey video data

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