UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
55 Great Republic Drive
Gloucester, MA 01930-2276

March 29, 2021

Michelle Morin
Chief, Environmental Branch
Office of Renewable Energy Programs
Bureau of Ocean Energy Programs
45600 Woodland Road, VAM-OREP
Sterling, Virginia 20166

Re: Updated Recommendations for Mapping Fish Habitat

Dear Ms. Morin:

We appreciate your continued effort to work with us to facilitate a more efficient Essential Fish Habitat (EFH) consultation process for offshore wind development projects. We are attaching an updated version of our "Recommendations for Mapping Fish Habitat", which was previously submitted to you on May 27, 2020. Through our work with your staff and meetings with developers, we have identified additional ways to further clarify our recommendations and make them more user-friendly. This document is intended to supplement the information in your existing guidelines. The proposed methodologies will help to ensure that applicants collect baseline habitat data and information that is both adequate for our EFH consultation and consistent across all projects in our region.

As we discussed in our May 27, 2020, letter to you, we have found that the existing Bureau of Ocean Energy Management (BOEM) benthic survey guidelines for collecting acoustic and benthic data across a lease area have not been applied consistently and are inadequate to ensure the collection of sufficient site-specific baseline data for our consultations. While your guidelines state that consultation with our agency is recommended prior to conducting these surveys, applicants have not consistently done so and, as a result, our recommendations have not been incorporated consistently across all projects. We hope that these recommendations will help to alleviate that inconsistency.

The attached updated document provides additional information for each step in the mapping process, includes details on sampling frequency, and incorporates recommendations for mapping inshore habitats, such as submerged aquatic vegetation. In addition, as we have discussed with your staff, we understand that in many cases, benthic sampling is conducted concurrently with the collection of acoustic data. However, this method is not consistent with standards for habitat mapping. We strongly recommend that you work with the developers to ensure that they use the

acoustic data to focus and refine additional, targeted benthic sampling to characterize habitat delineations. Incorporating these recommendations will provide the level of accurate and precise baseline habitat data necessary for an efficient and effective consultation process.

In the absence of adequate site-specific habitat information, we may be required to provide overly conservative EFH recommendations. Considering the significant size and scale of offshore wind projects, such a conservative approach may result in unnecessary burdens on BOEM and the applicant and would not allow for the most effective or efficient consultation process. The attached recommendations for mapping fish habitat are intended to ensure we receive the information necessary to provide the most appropriate recommendations to avoid and minimize impacts to EFH, as required by the regulations.

As we have discussed, early coordination is also critical to ensure an effective consultation process. We encourage BOEM and developers to meet with us early in the process, prior to developing benthic survey plans, to facilitate an understanding of our resource concerns and information needs for the consultation process. These early coordination efforts may also reduce the extent of additional information requests and streamline the EFH consultation process.

We appreciate your efforts to distribute our "Recommendations for Mapping Fish Habitat" to developers and encourage early coordination with our agency. We value your continued coordination with us and look forward to continuing to work with you and your staff.

Sincerely,

Louis A. Chiarella
Assistant Regional Administrator
for Habitat Conservation

cc: Brian Hooker, BOEM
Thomas Nies, NEFMC
Christopher Moore, MAFMC
Lisa Havel, ASMFC

National Marine Fisheries Service Greater Atlantic Fisheries Office
Habitat Conservation and Ecosystem Services Division

Recommendations for Mapping Fish Habitat
March 2021

The following information provides recommended steps for mapping seafloor habitat to ensure the information collected for offshore wind development projects is sufficient for BOEM to meet requirements for the Essential Fish Habitat (EFH) consultation under the Magnuson Stevens Fishery Conservation and Management Act. This information is not intended to replace BOEM's existing guidance, but rather to clarify and supplement guidance provided through BOEM Benthic Survey Guidelines.

It is critical that BOEM and project developers meet with us to discuss habitat mapping plans before conducting survey work or finalizing survey plans. Prior to any habitat mapping meeting, proposed benthic sampling and survey plan documents should be provided for our review. Coordination with us should occur regularly throughout the development and execution of benthic survey plans. Specifically, we recommend comprehensive pre-survey coordination be completed that includes a review of approaches for acquisition of acoustic data and the proposed sampling design. Follow-up survey coordination with us should focus on seafloor sampling results incorporated with acoustic data, including acoustic data analysis and interpretation. See attached flow chart (Figure 1, page 11) for recommended coordination with us related to benthic surveys.

DOCUMENT PURPOSE

For the purposes of the EFH consultation, all benthic habitat types throughout the project area should be accurately mapped. Benthic substrates and features should be mapped using acoustic data (bathymetry and backscatter), sediment grain size analysis, and optical imagery. It is particularly important to delineate[1] and characterize[2] complex and sensitive habitats that are more vulnerable to project impacts. Complex habitats are widely variable and differ in terms of their vulnerability, response to adverse effects, and potential for recovery. It is important to understand the distribution and components of all habitat types within the project area in order to evaluate what measures can be taken to avoid, minimize, and offset such impacts. The purpose of this document is to outline our recommended approach to ensure benthic habitats are mapped consistently across offshore wind

[1] *Delineate* means to indicate the border or boundary of features or areas of interest, typically through the use of polygons. Transitional areas between substrate types are typically encountered. The delineation boundary between soft and hard substrate types should be conservative to ensure hard substrates are fully encompassed within the areas delineated as hard substrate.

[2] *Characterize* means to identify and describe the physical and biological components of benthic habitats, including benthic features.

development projects and that appropriate baseline habitat information is provided to inform the EFH consultation process. This document outlines our recommended approach for mapping fish habitat that takes into account the typical methods used for collecting acoustic data for wind projects. The approach includes using acoustic survey data as the basis for all delineations. Seafloor sampling, specifically sampling that targets acoustically delineated substrate and feature types, should be used to characterize the habitats present within the delineated areas. Habitat maps that clearly display the characterized delineations should then be generated to support the EFH consultation.

INFORMATION TO CONSIDER

The fish habitat mapping (i.e. delineation and characterization) methodology presented in this document is intended to ensure that the data collected during standard acoustic survey campaigns for offshore wind projects are used appropriately. These mapping recommendations follow a standard methodology for habitat mapping that includes collecting acoustic data and using that data to target areas for characterization through seafloor sampling. For additional references related to habitat mapping, we recommend you review The Long Island Sound Study (Zajac et al. 2020) and GOM study as a reference. While the general approach is consistent with these mapping efforts, our recommendations have been modified to account for the methods used to collect acoustic data for offshore wind projects and focus on site specific data collection in areas of anticipated project impacts.

In order to map fish habitat, acoustic data should be processed at the finest resolution possible given the limitations imposed by the collection methodology. Typically, the acoustic surveys used for offshore wind projects do not provide data that can be processed at a resolution that allows for reliable detection and differentiation of pebbles, cobbles, and/or small boulders[3]. The BOEM survey guidelines do not require the identification of objects smaller than 0.5-1.0 m (50-100 cm) in diameter. Multibeam and/or sidescan sonar imagery should not be used to characterize sediment types unless the resolution of the imagery is capable of detecting, at a minimum, the full range of cobbles (6.4-25.6 cm in diameter). Because of the limitations of acoustic data, it is critical to collect additional data derived from targeted seafloor sampling to adequately characterize fish habitats for the purposes of environmental evaluation and the EFH consultation. We have attached example mapping diagrams (pages 12-15) to provide a visual reference for integrating the steps described below for mapping fish habitat into final habitat maps.

[3] Pebbles = 2 mm to < 64 mm; cobbles = 64 mm to < 256 mm; and boulders = 256 mm to < 4,096 mm.

Zajac, R.N., Stefaniak, L.M., Babb, I., Conroy, C.W., Penna, S., Chadi, D. and Auster, P.J., 2020. An integrated seafloor habitat map to inform marine spatial planning and management: A case study from Long Island Sound (Northwest Atlantic). In Seafloor Geomorphology as Benthic Habitat (pp. 199-217). Elsevier.

HABITAT FEATURES AND DEFINITIONS

For the purposes of mapping fish habitat, **complex habitats** are defined as:

1) **Hard bottom substrates** (defined as Substrate Class Rock Substrate, and the four Substrate Groups: Gravels, Gravel Mixes, Gravelly, and Shell, in the attached Coastal and Marine Ecological Classification Standard (CMECS) modifier and includes both large grained and small grained hard habitats);
2) **Hard bottom substrates with epifauna or macroalgae cover**; and
3) **Vegetated habitats** (e.g. submerged aquatic vegetation and tidal wetlands).

The attached **CMECS Modifiers** (pages 16-20) outlines how substrate types should be classified when analyzing grab samples and/or images.

Benthic features defined as sand waves, megaripples and ripples[4] should also be delineated in the project area. These features do not need to be mapped at the same minimum mapping unit or resolution as complex habitat, but they should be identified and delineated at the landscape scale as described below. Identifying sand features that occur or migrate over gravel pavements (i.e., gravel exposed in sand wave troughs) versus those that do not is of importance to differentiate types of EFH.

Other ecologically **important biogenic habitats**, including soft bottom habitats with emergent fauna (e.g. octocorals and pennatulids, tube dwelling anemones and structure forming amphipods and polychaetes) that occur within acoustically delineated areas should be characterized and the information incorporated into the EFH assessment as described below. These features should be characterized using benthic sampling and/or optical imagery.

STEPS FOR MAPPING FISH HABITAT

For the purposes of mapping fish habitat to inform EFH consultations, acoustic survey data should be used as the basis for all substrate delineations and seafloor sampling should be used to characterize the habitats within those delineations. While different habitat mapping technologies may be used, we recommend the following sequential steps be taken to provide the necessary information to inform the EFH consultation:

1) **Acoustic multibeam data should be used to create initial delineations.** Multibeam bathymetry and backscatter data, processed at a resolution of 0.25 - 0.5 m, should be used to delineate:
    1) low acoustic return areas (typically mud or sand habitats);
    2) intermediate return areas (typically sand or mixed sand and hard bottom habitats; potential complex habitat);
    3) high acoustic return areas (typically hard bottom habitats; potential complex habitat);

[4] Sand ripples, megaripples, and waves should be defined consistent with BOEMs May 27, 2020, Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information. Sand wave: >60 m wavelength and >1.5 m height. Megaripple: 5 – 60 m wavelength and 0.5 – 1.5m height. Ripple: <5 m wavelength and <0.5 m height.

4) intermediate and high acoustic return areas with detectable vertical relief (typically large grained hard bottom substrates, e.g. rock outcrops or large boulders; potential complex habitat), as feasible; and
5) identify and delineate benthic features (i.e. areas with sand ripples and sand waves, as defined above) within and across all delineated areas, if feasible.

2) **Acoustic sidescan sonar data should be used to refine and supplement the multibeam delineations.** Specifically, the 0.1 - 0.25 m processed sidescan sonar (SSS) data may be used to:
   1) refine the initial multibeam based delineations (i.e. low, intermediate, and high polygon boundaries), as feasible;
   2) further delineate areas with distinct acoustic signatures within initial multibeam based delineations, as feasible;
   3) identify/confirm areas with vertical relief within intermediate and high acoustic return areas; and/or
   4) identify and delineate benthic features (i.e. areas with sand ripples, megaripples and sand waves, as defined above) across the survey area.

   The sidescan imagery should be used to determine if there is a distinct and notable difference in the acoustic return along the delineated boundary that would better represent the edge between two areas of different acoustic returns. The delineations derived from the backscatter should only be modified if the sidescan imagery presents a clear distinction that would result in an increase of accuracy of the location of the boundary between two multibeam based delineated areas.

   In addition to refining boundary edges, SSS may also be used, if feasible, to further delineate areas with distinct acoustic signatures *within* the multibeam based delineations. If one or more clear and distinct change(s) in the acoustic signature are identified within a multibeam based delineation (e.g., a high return area), sub-areas with distinct acoustic signatures may be delineated. Any multibeam based delineations that are further delineated based upon SSS data should be clearly identified in the final maps and noted within the legend.

   Sidescan sonar imagery should also be used to identify areas with clear vertical relief (e.g., areas with large boulders). Any areas of vertical relief identified using the multibeam acoustic data should be confirmed, and boundaries refined, as feasible.

   Areas with sand ripples, megaripples, or waves should also be identified and delineated using the processed sidescan sonar imagery. These features should be identified and delineated clearly, and independently, of the backscatter based delineations. These features may occur within complex or soft bottom habitats and should be identified by shaded or cross-hatched overlays within the acoustically derived delineations in the final habitat maps.

   Please note: SSS data processed at a 0.1 - 0.25 m resolution cannot be used to adequately detect cobbles and small boulders and should not be used to characterize substrate types. Seafloor sampling will be necessary to characterize delineated areas. See *Seafloor Sampling* below.

Following Steps #1, and #2, we recommend that BOEM and project developers meet with us to review acoustic data results and discuss plans for additional survey work (outlined below in Steps #3 and #4), including targeted seafloor sampling approaches and locations, well in advance of the development of survey plans.

3) **Acoustic delineations should be characterized by seafloor sampling.** Characterization of delineated areas should focus on areas where direct or indirect benthic impacts are anticipated to occur as a result of the project. Seafloor sampling techniques used to characterize and verify acoustic delineations should include benthic grabs, sediment profile imagery (SPI) and plan view (PV) imagery, video transects, and/or still imagery, as appropriate based on substrate type and spatial distribution of the feature. Seafloor sampling should be conducted at an appropriate resolution to resolve features and associated structure forming taxa. Specifically, the delineated areas should be adequately sampled to characterize the habitats as accurately as possible. The seafloor sampling should be used to characterize the delineated areas as either: soft bottom, complex, heterogeneous complex, or large grained complex habitats. For more information see *Seafloor Sampling* below.

4) **The delineated and characterized areas should be incorporated into habitat maps to support the EFH consultation.** For the EFH consultation, the characterized delineations should be incorporated into habitat maps that clearly illustrate, as applicable:

    1) soft bottom habitats;
    2) complex habitats;
    3) heterogeneous complex habitats;
    4) large grained complex habitats (e.g. large boulders); and
    5) benthic features (i.e. sand ripples, megaripples, and waves).

SEAFLOOR SAMPLING

Adequate seafloor sampling is necessary to characterize delineated areas. While a general understanding of the habitat types within the full lease area is necessary, areas expected to be impacted by project construction and operation should be prioritized for seafloor sampling.

Sampling Methods

Benthic sampling (e.g. benthic grabs[5], SPI/PV imagery, video transects, and/or still imagery) should be conducted in all delineated areas. Imagery and video data collection should include high resolution equipment (e.g. >/= 1080i/ video, >/= 10 MP still image, etc.) and be collected in a manner that allows for detailed seafloor analysis (e.g. adequate artificial lighting to illuminate entire seafloor image, vessel/ROV speed slow enough to clearly detect habitat characteristics, minimizing height of camera system off the seafloor to no greater than ~0.5m, etc.). Image frame grabs from captured video transects should not be relied upon for detailed analysis (e.g. epifaunal species identification and enumeration). Instead, still images should be used for all image analyses.

Sampling of delineated low acoustic return areas: Benthic grabs and/or SPI/PV image capture are recommended in potential project impact areas to characterize low acoustic return areas.

[5] We recommend using 0.04 sq m Young-modified Van Veen grab with the depth of the sediment grab being at least 7 cm deep or greater to be consistent with other state and federal survey activities.

Low acoustic return areas are generally composed of soft, fine-grained sediments (i.e. fine unconsolidated substrate types as defined in the attached CMECS modifier), that are well sampled using benthic grabs.

Sampling of delineated intermediate and high acoustic return areas: Intermediate and high acoustic return areas typically contain hard bottom sediments (e.g. pebble, cobble, boulder, etc.). Small grained hard bottom substrates (i.e. pebble/granules) may also be well sampled using benthic grabs and SPI/PV imagery. However, benthic grabs are not suitable for sampling cobble, boulder or larger rock substrates. Rather, video, SPI/PV imagery and/or still imagery should be collected to characterize areas containing cobble and boulder. We recommend the use of video transects - supplemented with still imagery at sufficient resolution to identify associated organisms - for characterizing these complex habitats. Complex habitats may be patchy and/or include scattered cobbles or boulders that may not be well characterized using SPI/PV or still imagery alone. Such habitats can also occur in the troughs of sand waves and related sand features.

Sampling of delineated intermediate and high return areas with vertical relief: Intermediate and high acoustic return areas with vertical relief typically contain larger grained hard bottom sediments (i.e. boulder, rock ledge, megaclasts). Video and/or still imagery should be conducted to characterize areas containing large grained complex substrates. SPI/PV imagery has limited ability to sample these three-dimensional habitats well. We recommend the use of video transects for sampling large grained complex habitats and still imagery for detailed characterization of these habitats.

Vegetated substrate sampling: At a minimum, video transects and/or still imagery should be conducted to survey areas of vegetated habitats. Submerged aquatic vegetation located within the project area should be fully delineated consistent with regional or state guidelines (for more information see *Fish Habitat Mapping in State Waters* below).

We strongly recommend incorporating video transects, including both down-facing and oblique forward facing cameras, to characterize all potentially complex habitats. Video transects are also useful for reconnaissance surveys to help inform the benthic survey, and for investigating and resolving transitional areas.

Sampling Rates/Density

To accurately characterize delineated areas and provide adequate information for the EFH consultation, benthic sampling should be conducted at a rate higher than what is described in BOEM's existing guidelines (1 sample every 1-2 km or 1-2 km^2) to allow for targeted sampling. We recognize that multiple types of data (e.g., acoustic, benthic grabs, and/or optical imagery) may be collected during a single survey campaign for offshore wind projects. For this reason, we recommend that any fixed-spacing (e.g., 1 sample every 1-2 km or 1-2 km^2) or randomized seafloor sampling (e.g. benthic grabs or optical imagery) that occurs during initial acoustic surveys should be used to supplement targeted seafloor sampling. Targeted seafloor sampling should be conducted in subsequent surveys once acoustic data has been processed and used to generate delineations as described above.

To provide adequate sampling within the acoustically derived delineated areas, multiple *stations* (i.e. sites/sampling locations) should be sampled with a minimum of 3 replicate *samples* per *station*. Areas of potential complex habitats (i.e. intermediate and high acoustic return delineations) should be

sampled using a greater number of replicate *samples* per *station* (e.g. 10-15) and/or the use of video transects (50 m or greater in length).

For targeted sampling, acoustic delineations should be sampled at a minimum density of 3 *stations* per 2,000 m^2 area, an area consistent with the minimum mapping unit (see MMU in *Mapping Specifications and Data Products* below). However, such a dense sampling rate is not likely to be necessary for larger areas, particularly within low acoustic return delineations. Delineated areas greater than 2,000 m^2 should be sampled at a rate that adequately accounts for both the extent of the delineated area and variations in acoustic signatures. We recommend pre-survey coordination with us, as noted above, be completed to evaluate adequate sampling rates for larger delineated areas prior to finalizing benthic survey plans. It should be noted that if delineated areas are not adequately sampled, it will be necessary to assume that low acoustic return areas are "soft bottom habitats," and medium and high return areas are "complex habitats."

In areas with samples that have high densities of soft bottom emergent fauna (e.g. corals, tube dwelling anemones and structure forming polychaetes), additional sampling, including video transects, should be done to clearly determine the extent of the high density area for these important and sensitive biological communities.

Please note that these recommendations for determining benthic sampling rates are intended to allow for basic characterization of acoustically delineated areas. While the baseline habitat information collected using these mapping procedures may help inform a benthic monitoring study design, additional sampling and characterization will likely be necessary for benthic monitoring to assess project impacts.

Sample Classification

Seafloor samples (including benthic samples and/or imagery) should be used to classify[6] substrate types using the modified CMECS substrate classifications (see CMECS modifier).

Biotic data should be obtained from grab samples and visual survey methods (e.g. SPI/PV, still imagery). Biotic data should focus on identifying and describing the composition/abundance of structure-forming taxa that provide habitat (e.g., shelter, food) for associated fish and invertebrates. CMECS biotic classifications should be used to the extent practicable, but are not required, provided that the presence of macroalgae, structure forming and long lived epifauna, such as sponges, anemones, polychaetes, bryozoans, corals, tunicates and habitat forming bivalves (i.e. clams, mussels, oysters) is documented.

The substrate and biotic classification of each grab sample and image should be noted and provided with the EFH Assessment. This should be provided both in table form and as points overlaid on substrate maps to provide reference to where samples were collected within the project area.

> **Characterization of seafloor sample stations and delineated areas:**
> In order to apply the CMECS sample classification data for habitat characterization purposes, the seafloor samples should be categorized as either soft bottom habitats or complex habitats. More detailed habitat information may also be incorporated (i.e. substrate and biota) into the EFH Assessment for the delineated soft and complex habitats (e.g. sand, sand with ripples, mud, biogenic, shell aggregates, pebble/granule with cobbles, etc.). The modified CMECS

[6] Classify means to assign or designate into categories based on the characteristics or attributes of the sample.

classifications (attached) that comprise soft bottom habitats and complex habitats are described below.

Soft bottom habitat: Fine Unconsolidated Substrate groups (i.e. Sand, Muddy Sand, Sandy, mud, and Mud) including the subgroups (i.e. Very Coarse/Coarse Sand, Medium Sand, and Fine/Very Fine Sand) should be characterized as "soft bottom habitat."

Complex habitat: Rock Substrate subclasses (i.e. Bedrock/Megaclast) and Coarse Unconsolidated Substrate groups (i.e. Gravels, Gravel Mixes, Gravelly, and Shell) including subgroups (i.e. Boulder, Cobble, Pebble/Granule, Gravel Pavement, Sandy Gravel, Muddy Sandy Gravel, Muddy Gravel, Gravelly Sand, Gravelly Muddy Sand, and Gravelly Mud) should be characterized as "complex habitats."

Characterizing stations: Should replicate *samples* collected at an individual *station* include *samples* characterized as complex, that *station* should be identified as "complex." For *stations* where all *samples* are characterized as "soft" or "complex," the *station* should be characterized accordingly.

Characterizing delineations: Should *stations* within a delineated area comprise a mix of both soft bottom and complex habitats, that delineation should be characterized as "heterogeneous complex" habitat. For delineated areas where all *stations* are characterized as either "soft" or "complex," the delineated area should be characterized accordingly.

MAPPING SPECIFICATIONS AND DATA PRODUCTS

For mapping purposes, it is only necessary to characterize the delineated areas as:

1) soft bottom habitats (i.e. mud and/or sand);
2) complex habitat (i.e. SAV, shell/shellfish, and/or hard bottom substrate);
3) heterogeneous complex habitat (i.e. mix of soft and complex stations within a delineated area);
4) large grained complex habitat (i.e. large boulders); and
5) benthic features (i.e. sand ripples, megaripples, and waves). Benthic features should be mapped as an overlay (e.g. hatched areas) within and/or across the habitat delineations.

Habitat maps that display the characterized delineations and benthic features should be provided at a landscape scale of 1:25,000. Maps that display complex habitats (i.e. complex, heterogeneous, large grained) should be provided at a larger scale (i.e. 1:1,000 or 1:5,000). Maps that display extensive areas of homogeneous can be provided at a smaller scale (i.e. 1:50,000 or 1:100,000).

Minimum Mapping Unit (MMU): The minimum mapping unit for delineating areas for mapping habitats that may be directly or indirectly impacted by the project should be 2,000 m^2. However, as complex habitats may be patchy in distribution, a smaller unit of 100 m^2 should first be used to delineate potentially complex areas (i.e. intermediate and high acoustic return areas, with and without vertical relief). If two or more areas of potentially complex habitat 100 m^2 in size or larger occur within a 2,000 m^2 area, the entire 2,000 m^2 area should be delineated consistent with the highest acoustic return signature (i.e. intermediate or high). This allows for mapping of patchy complex habitats, such as areas of generally featureless bottom that are punctuated by areas of complex habitat. Additionally, the delineation of benthic features (i.e. sand ripples, megaripples, and waves) may use a larger MMU of

8,000 m^2, and should be included in the final habitat maps as an overlay (e.g. hatched areas) of the habitat type delineations.

The location of each seafloor sampling station and/or transect should be identified on the habitat maps. Both the location and station identifier for each sample station should be included and labeled to allow for easy reference to the station data (i.e. station sample classification data) included in the EFH Assessment.

Incorporation of the CMECS habitat classifications into the final map legend to provide additional description of delineated soft and complex habitat types (e.g. sand, sand with ripples, mud, biogenic, shell aggregates, pebble/granule with cobbles, etc) should be included as feasible.

Mapping Data products:

- **Landscape/small scale maps** (i.e. zoomed out) of all habitat types in the project area, including areas of complex habitat (scale in the range 1:25,000 to 1:100,000). These maps should be provided as PDFs (hard copies may also be provided) and as ESRI compatible data layers/shape files.
- **Large scale maps** (i.e. zoomed in) that focus on complex habitat, in both inshore and offshore waters (scale in the range 1:1,000 to 1:5,000). These maps should be provided as PDFs (hard copies may also be provided). Complex habitats should be included in the landscape/small scale ESRI compatible data layers/shape files, so separate ESRI compatible files for complex habitats are not necessary.
- **Bathymetry, backscatter, and sidescan sonar mosaic maps** processed at 0.1 to 0.5 m, using continuous variables (i.e. displayed with conventional color ramps). These maps should be provided both as digital landscape scale maps (e.g. as pdfs) and as ESRI compatible data layers/shape files. The sidescan sonar mosaic should include trackline information embedded within the mosaic, or as a separate data layer. Individual maps displaying derived values such as slope, slope of the slope, or curvature may also be provided, but are not required.
- **ESRI compatible data layers/shape files** should be provided that include: 1) the lease area and proposed cable corridor boundaries; 2) proposed WTG and substations locations; and 3) all seafloor sample locations.
- **All seafloor sampling data**, including grain size analysis, images, and video, should be provided with a naming convention that directly correlates to the data presented in the EFH assessment. Copies of all state waters shellfish and SAV surveys should also be provided.
- **Raw, unprocessed sidescan sonar track line** image files (e.g. tif, jpeg, etc) should be made available upon request.

FISH HABITAT MAPPING IN STATE WATERS

Habitats within inshore state waters where direct and indirect impacts of the project may occur should also be delineated and characterized.

- Benthic features, soft and hard bottom substates, and large grained complex habitats should be delineated and characterized as described above, where feasible. In shallow-water systems where multibeam data are not easily collected, the use of side scan sonar, light detection and ranging (LiDAR), and/or imagery data may be relied upon.

- Due to regional differences in species composition and distributions, the appropriate regional/state guidelines or recommendations should be used to survey and delineate habitat forming shellfish habitats (i.e. clams, oysters, mussels) and submerged aquatic vegetation (SAV) within State waters. However, due to rapidly changing technology, combined with the sometimes general (lack of specificity) and static (state-approved documents) nature of some guidelines, any proposed survey plans should be submitted to us for review and comment prior to commencement of field work. States may have existing data and/or maps of these habitats, and, where available, those should be reviewed prior to any sampling to aid in understanding of survey areas and previous distributions and abundances of shellfish and SAV.

EFH ASSESSMENT NARRATIVE

For the EFH Assessment, the benthic habitat classification methodology should describe how the data were used at each step in the process and include factors used in determining habitat classifications such as depth, surface reflectivity, expert opinion, visual verification, etc. Information for the EFH Assessment should include the habitat maps as well as information on the number of acres of each habitat type that may be disturbed, including the total areas of temporary and permanent impacts. The EFH Assessment should focus additional analysis on potential effects to complex and sensitive habitats, including biological components, that may be more vulnerable to permanent project impacts, as well as species and life stages that may be more vulnerable to project construction and operation. The narrative accompanying this information should specifically define any measures that are being taken to avoid, minimize, or mitigate impacts to sensitive benthic habitats present. The analysis in the EFH Assessment should be comprehensive and include an analysis of impacts from construction, operation and decommissioning of the project. For more information about EFH, including the EFH regulations and consultation process, please visit our website.

Years / Field Seasons

Figure 1. Recommendations for Mapping Fish Habitat Flowchart

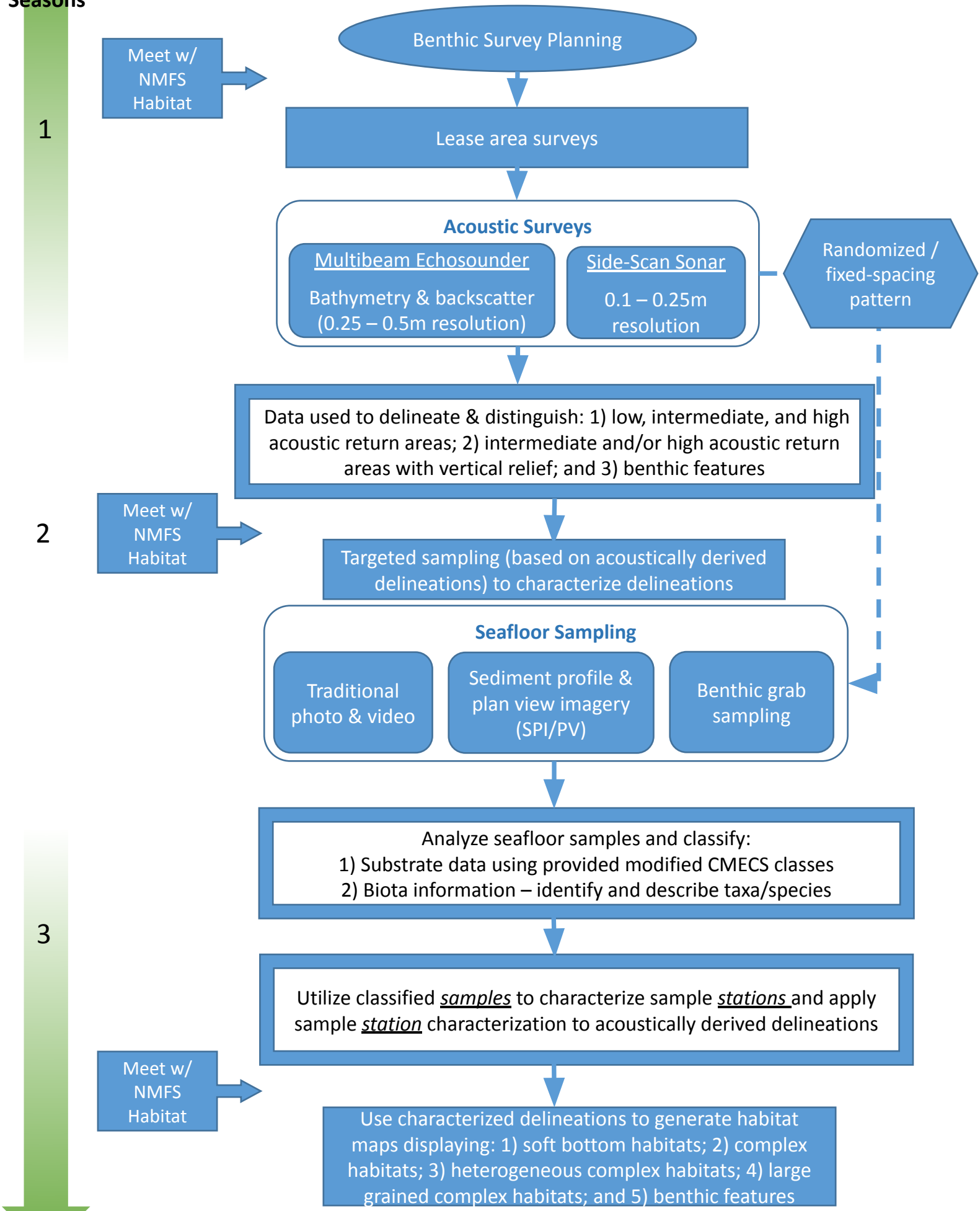
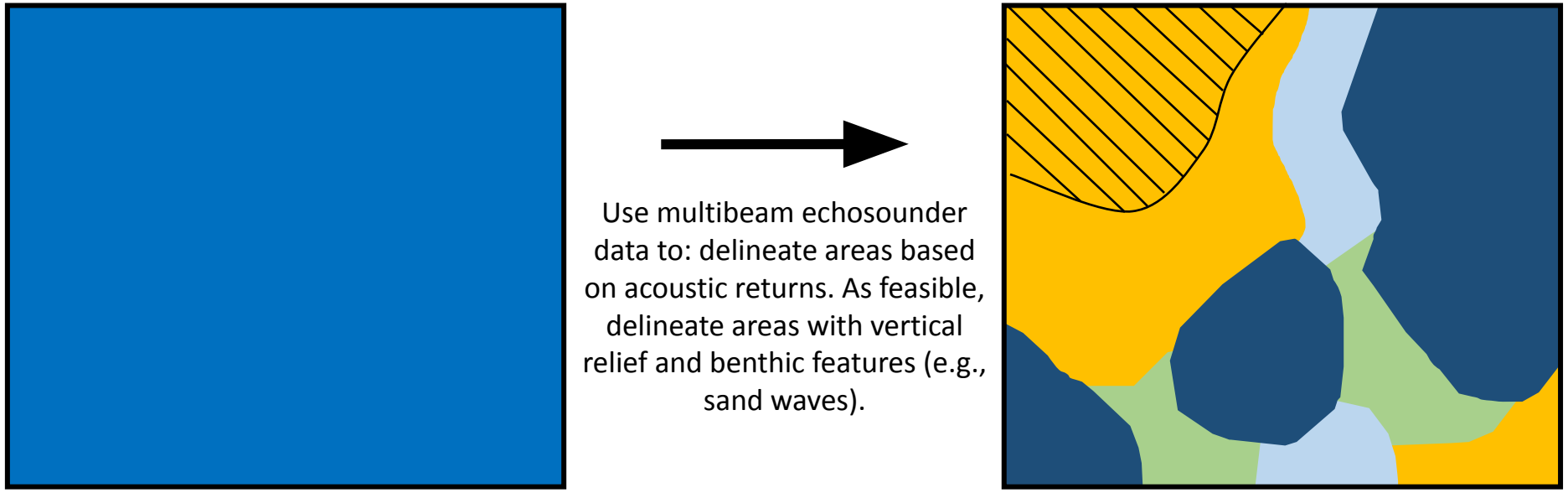


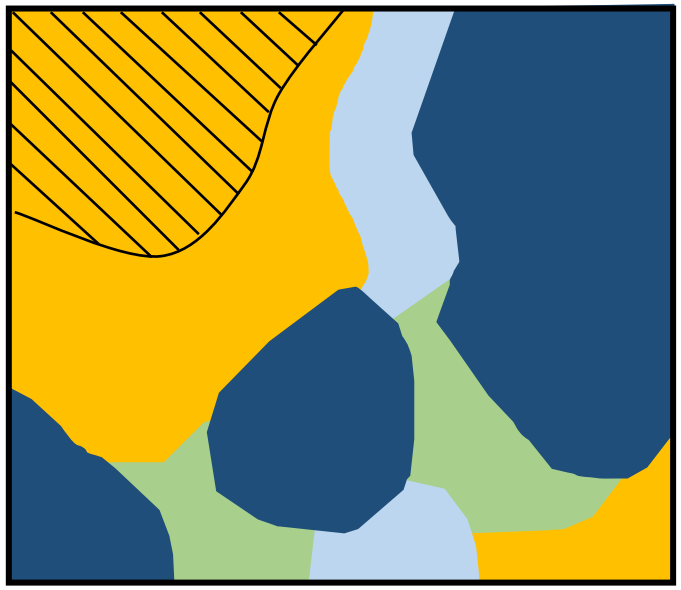
Diagram for Mapping: Use Multibeam Echosounder Data to Create Initial Delineations (Polygons)



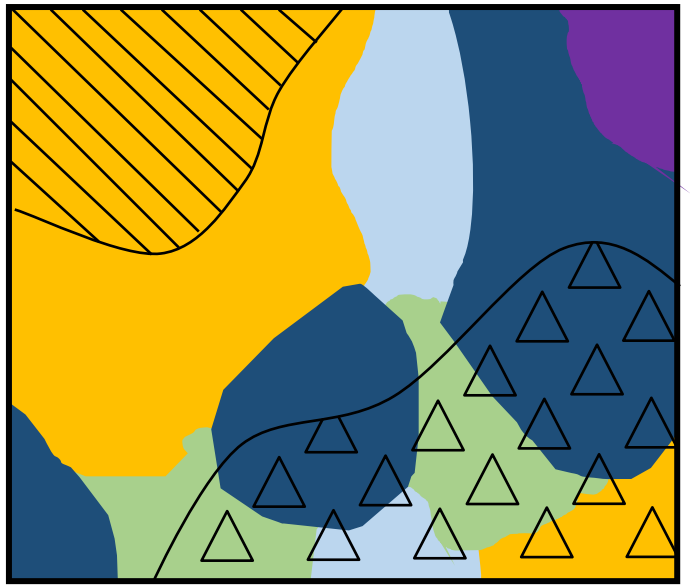
Legend

- Survey area (pre-survey)
- Low return
- Intermediate return
- High return
- High return with vertical relief
- Sand waves

Diagram for Mapping: Use Side-Scan Sonar Data to Refine Boundaries and Delineate Benthic Features



As feasible, use side-scan sonar data to: refine polygon boundaries; confirm and delineate areas of high vertical relief; delineate areas with distinct acoustic signatures; and delineate (and refine boundaries of) benthic features (e.g., sand waves).



Legend

- Low return
- Intermediate return
- High return
- High return with vertical relief
- High return w/ distinct SSS signature
- Sand waves
- Sand Ripples

Diagram for Mapping: Conduct Targeted Seafloor Sampling of Delineated Areas and Benthic Features

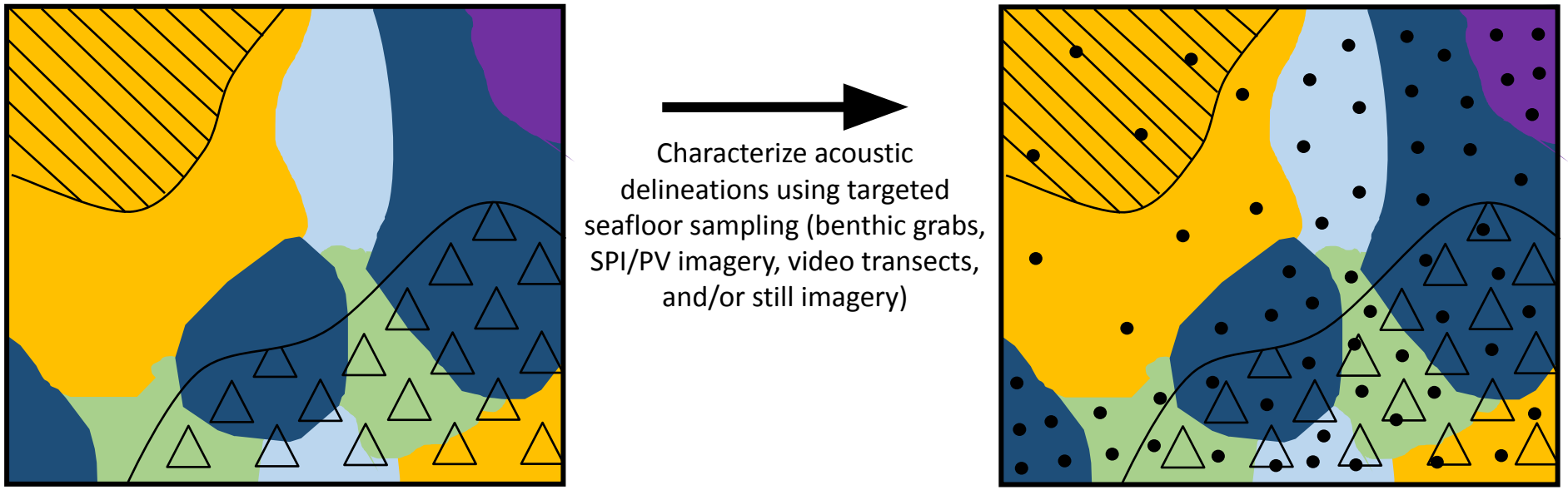
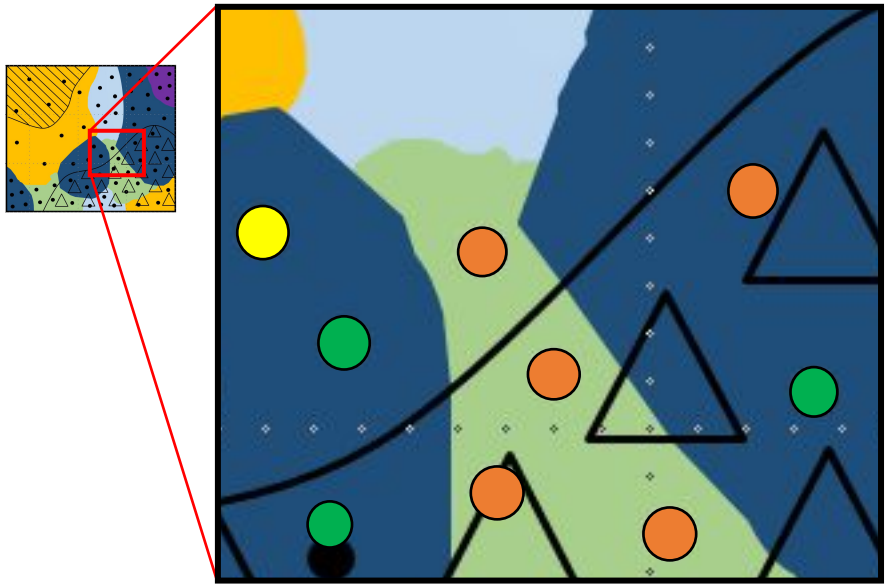


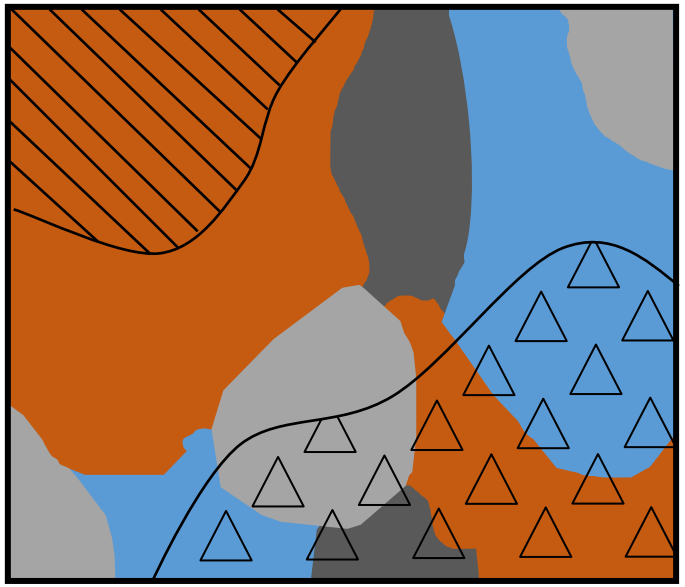
Diagram for Mapping: Produce Habitat Maps to Support EFH Consultation

Transitional Step/Map



Characterize seafloor sample stations and delineated areas. Integrate sample data to create habitat maps that clearly illustrate: soft bottom habitats; complex habitats; heterogeneous complex habitats; large grained complex habitats; and benthic features.

Final Habitat Map



Legend

- Complex station (all samples characterized as complex)
- Complex station (some samples characterized as complex and some samples characterized as soft bottom)
- Soft bottom station (all samples characterized as soft bottom)

Legend

- Soft bottom habitats
- Heterogeneous complex habitats
- Complex habitats
- Large grained complex habitats

Benthic Features

- Sand waves
- Sand Ripples

Coastal and Marine Ecological Classification Standard (CMECS)
Substrate Classifications: Modifiers for EFH Assessments

Asterisks *(*) indicate CMECS classifications that were modified by combining subclasses or subgroups, or where new classifications were added, in order to simplify classification for habitat delineation. See the Coastal and Marine Ecological Classification Standard, p. 104 and figure 7.2*

Grain-size analyses of substrate sediments (grab samples or SPI) should be used to characterize: 1) Gravel Mixes and Gravelly substrate groups; and 2) all groups and subgroups in the Fine Unconsolidated Substrate subclass.

Seabed imagery (video, SPI/PV, still imagery) should be used to characterize: 1) Rock Substrates; 2) Gravels; and 3) the presence of cobble and/or boulder in Gravel Mixes and Gravelly substrate groups. Rock and Gravel substrates are often heterogeneous, therefore, multiple images or transect video should be used for classification. Seabed imagery should also be used to note the presence of bedforms (ripples, megaripples, and sand waves), which are defined based on wave-length and wave-height criteria in BOEM's Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information.

Substrate Class: Rock Substrate: Rock with particle sizes greater than or equal to 4,096 millimeters (mm) in any dimension that cover 50% or greater of the Geologic Substrate surface.

***Substrate Subclass: Bedrock/Megaclast*:** Substrate with mostly continuous formations, or individual rocks of ≥ 4,096 mm, that cover 50% or more of the Geologic Substrate surface.

Substrate Class: Unconsolidated Mineral Substrate: Substrates with <50% cover of Rock Substrate (particles ≥ 4,096 mm in any dimension).

Substrate Subclass: Coarse Unconsolidated Substrate: Geologic Substrates with <50% cover of Rock Substrate (as defined above; Bedrock or Megaclast ≥4,096 mm in any dimension), and ≥ 5% Gravel (particles 2 mm to < 4,096 mm).

Substrate Group: Gravels: Geologic Substrate surface layer[1] contains ≥80% gravel (particles >2 mm to < 4,096 mm diameter).

Larger sized Gravels are not sampled well using conventional grab samples. Seabed imagery should be used to quantify a percent cover estimate by Gravel type. The substrate should be classified by the sediment type with the highest percent cover. Gravel substrates are often heterogeneous, therefore, multiple images or transect video should be used for classification. Submit representative photos.

[1]Substrate types should only be characterized from the layers of substrate that support the majority of multicellular life – the upper layer of hard substrate, or (typically) the upper 15 centimeters of soft substrate.." (as defined in CMECS, page 98, available at: https://www.natureserve.org/sites/default/files/publications/files/cmecs_version_06-2012_final.pdf)

Substrate subgroup: Boulder - Geologic Substrate contains ≥80% Gravel, with a Gravel size of 256 mm to < 4,096 mm.

Substrate subgroup: Cobble - Geologic Substrate contains ≥80% Gravel, with a Gravel size of 64 mm to < 256 mm.

Substrate subgroup: Pebble/Granule - Geologic Substrate contains ≥ 80% Gravel, with a Gravel size of 2 mm to < 64 mm. The presence of cobble and/or boulder should be noted.

Substrate subgroup: Gravel pavement - Geologic Substrate contains ≥ 80% Gravel (Boulder, Cobble, and/or Pebble/Granule), with Gravel sizes from 2 mm- to <4,096 mm. If substrate is composed of Boulders, Cobbles, and/or Granule/Pebble that combined covers ≥80% of the substrate it should be reported as "Gravel pavement."

The composition of Gravel pavements should be noted and described in the EFH Assessment. Specifically, the presence and relative abundance of 1) Boulder 2) Cobble and/or 3) Pebble/Granule should be described. Submit representative photos.

Substrate Group: Gravel Mixes – Geologic Substrate surface layer contains 30% to <80% Gravel (particles 2 mm to < 4,096 mm in diameter).

In this group and in the following three subgroups, the Gravel components must be specified (i.e., Boulders, Cobbles, and/or Granule/Pebble). Provide photos and grain size analyses of surficial sediments.

Substrate Subgroup: Sandy Gravel - Geologic Substrate is 30% to <80% Gravel, with Sand composing ≥90% of the remaining Sand-Mud mix.

Substrate Subgroup: Muddy Sandy Gravel - Geologic Substrate is 30% to <80% Gravel, with Sand composing 50% to ≥90% of the remaining Sand-Mud mix.

Substrate Subgroup: Muddy Gravel - Geologic Substrate is 30% to <80% Gravel, with Mud composing ≥50% of the remaining Sand-Mud mix.

Substrate Group: Gravelly – Geologic Substrate surface layer contains 5% to <30% Gravel (particles 2 mm to < 4,096 mm in diameter).

In this group and in the following three subgroups, the Gravel components must be specified (i.e., Boulders, Cobbles, and/or Granule/Pebble). Provide photos and grain -size analyses of substrate sediments.

Substrate Subgroup: Gravelly Sand - Geologic Substrate is 5% to <30% Gravel and the remaining Sand-Mud mix is ≥90% Sand)

Substrate Subgroup: Gravelly Muddy Sand - Geologic Substrate is 5% to <30% Gravel and the remaining Sand-Mud mix is <50% to ≥90% Sand)

Substrate Subgroup: Gravelly Mud - Geologic Substrate is 5% to <30% Gravel and the remaining Sand-Mud mix is ≥50% Mud)

Substrate Subclass: Fine Unconsolidated Substrate - Geologic Substrate surface layer contains less than 5% Gravel (particles 2 mm to < 4,096 mm in diameter).

Substrate Group: Sand - Geologic Substrate surface layer is composed of ≥90% Sand.

__Substrate subgroup: Very Coarse/Coarse Sand -__ Geologic Substrate surface layer is composed of ≥90% Sand, with a median grain size of 0.5 mm to < 2mm.

Substrate subgroup: Medium Sand - Geologic Substrate surface layer is composed of ≥90% Sand, with a median grain size of 0.25 mm to < 0.5 mm.

Substrate subgroup: Fine/Very Fine Sand - Geologic Substrate surface layer is composed of ≥90% Sand, with a median grain size of 0.0625 mm to < 0.25 mm.

Substrate Group: Muddy Sand - Geologic Substrate surface layer contains 50% to <90% Sand and < 5% Gravel.

Substrate Group: Sandy Mud - Geologic Substrate surface layer contains 10% to <50% Sand and < 5% Gravel.

Substrate Group: Mud - Geologic Substrate surface layer contains ≥90% Mud and < 5% Gravel.

Substrate Class: Shell Substrate

Substrates where percent cover of Biogenic substrate (i.e. shell) exceeds percent cover of Geologic Substrate (i.e shell cover is greater than 50% of the substrate). Biogenic Substrate that is primarily composed of shells or shell particles. Most (but not all) shell-builders are mollusks.

Substrate Subclass: Shell Reef Substrate – Substrate that is dominated by living or non-living cemented, conglomerated, or otherwise self-adhered shell reefs, with a median particle size of 4,096 millimeters or greater in any dimension. Live reef building fauna may or may not be present.

Substrate Group: Clam Reef Substrate – Shell Reef that is primarily composed of cemented or conglomerated clam shells.

Substrate Group: *Crepidula* Reef Substrate – Shell Reef that is primarily composed of conglomerated *Crepidula* shells.

Substrate Group: Mussel Reef Substrate – Shell Reef that is primarily composed of self-adhered or conglomerated mussel shells.

Substrate Group: Oyster Reef Substrate – Shell Reef that is primarily composed of cemented or conglomerated oyster shells.

Substrate Subclass: Shell Rubble – Substrate that is dominated by living or non-living shells (any combination of clam, crepidula, mussel, and/or oysters) forming Rubble, with a median particle size of 64 millimeters to < 4,096 millimeters in any dimension (Cobbles and Boulders). Particles may be either loose, individual shells (whole or broken) or—particularly in the larger Rubble sizes—cemented, conglomerated, or otherwise attached so as to form Boulders of consolidated shell material.

Substrate Subclass: Shell Hash – Surface substrate layers are dominated by loose shell (any combination of clam, crepidula, mussel, and/or oysters) accumulations with a median particle size of 2 millimeters to < 64 millimeters (size of Granules and Pebbles). Shells may be broken or whole.

Biological Information

Biological information is necessary for habitat classification purposes and should be incorporated into the EFH Assessment. While CMECS biotic classifications may be used to the extent practicable, they are not required. For EFH consultations, the following biological information should be collected from grab samples and visual surveys at each station or along individual bottom transects: 1) presence and estimated percent cover of macroalgae, epifauna, and/or infauna/emergent taxa; 2) identification of taxa, in particular long-lived and habitat-forming species that are particularly vulnerable to project impacts (e.g. sponges, anemones, bryozoans, hydrozoans, corals, tunicates, and bivalves) should be noted. For each delineated area, species relative abundance and diversity should be characterized and described, including noting the presence of species that are vulnerable, rare, or dominant/common in terms of numbers and size. This information should be included in the EFH Assessment for all analyzed imagery. Habitat types should then be defined by incorporating the biotic data with the delineated geological substrate types and described in the EFH Assessment. Each imagery location should be noted on the delineated geological substrate maps and should be classified by the identified biological component of interest (e.g., presence of long-lived, soft-bodied, and/or common taxa).

CMECS Geologic Substrate Classifications Retained, Deleted, or Modified for Use in NMFS Offshore Wind Essential Fish Habitat Assessments

Classification	Retained	Deleted	Modified	Comments
Class: Rock Substrate	√			
Subclass: Bedrock/Megaclast			√	Combine two subclasses
Class: Unconsolidated Mineral Substrate	√			
Subclass: Coarse Unconsolidated Substrate	√			
Group: Gravels			√	Changed median to percent cover
Subgroup: Boulder	√			
Subgroup: Cobble	√			
Subgroup: Pebble/Granule			√	Combine two subgroups
Subgroup: Gravel Pavement			√	New subgroup
Group: Gravel Mixes	√			
Subgroup: Sandy Gravel	√			Specify gravel components
Subgroup: Muddy Sandy Gravel	√			Specify gravel components
Subgroup: Muddy Gravel	√			Specify gravel components
Group: Gravelly	√			
Subgroup: Gravelly Sand	√			Specify gravel components
Subgroup: Gravelly Muddy Sand	√			Specify gravel components
Subgroup: Gravelly Mud	√			Specify gravel components
Subclass: Fine Unconsolidated Substrate	√			
Group: Slightly Gravelly		√		
Group: Sand	√			
Subgroup: Very Coarse/Coarse Sand			√	Combine two subgroups
Subgroup: Medium Sand	√			
Subgroup: Fine/Very Fine Sand			√	Combine two subgroups
Group: Muddy Sand	√		√	Delete all subgroups
Group: Sandy Mud	√		√	Delete all subgroups
Group: Mud	√		√	Delete all subgroups
Class: Shell Substrate			√	Deleted “non-living” because of reefs
Subclass: Shell Reef Substrate			√	Delete *Coquina* reef group
Group: Clam Reef Substrate	√			
Group: *Crepidula* Reef Substrate	√			
Group: Mussel Reef Substrate	√			
Group: Oyster Reef Substrate	√			
Subclass: Shell Rubble			√	Delete all groups
Subclass: Shell Hash			√	Delete all groups