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03-201 Essential Fish Habitat Policy

Procedure for Addressing Climate Change in NMFS Essential Fish Habitat Consultations

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I. Introduction

Climate change is the long-term regional or global shift in temperature and weather patterns primarily due to human activities that produce and trap greenhouse gases, and is a defining national and global environmental challenge of our time. In 2009, the U.S. Environmental Protection Agency (EPA) issued a finding that the changes in our climate caused by elevated concentrations of greenhouse gases in the atmosphere are reasonably anticipated to endanger the public health and welfare of current and future generations.[i] In 2021, the EPA again highlighted the urgency of addressing greenhouse gases in the atmosphere.[ii] Effects related to climate change include more frequent and intense heat waves, longer fire seasons and more severe wildfires, degraded air quality, increased drought, greater sea-level rise, an increase in the intensity and frequency of extreme weather events, harm to water resources, harm to agriculture, ocean acidification, shifts in deep ocean currents and cyclical patterns of earth's climate, and harm to wildlife and ecosystems.[iii]

When the essential fish habitat (EFH) provisions[iv] were incorporated into the Magnuson-Stevens Fishery Conservation and Management Act (MSA) by amendment in 1996,[v] climate change was not a common consideration. It is now known that climate change affects fishery habitats, including those designated as EFH, for most managed species by shifting the distribution and characteristics of fish habitat or by exacerbating the vulnerability of habitats from natural and anthropogenic stressors or perturbations.[vi] There are numerous examples of how climate change may have adverse effects that are relevant to an analysis of the effects of an action on EFH, and to designing effective mitigation measures:

- Changes in freshwater stream flow (e.g., reductions in mountain snow packs, shift from snow dominated to rain dominated runoff, alterations to streamflow timing, and increase in droughts) may reduce habitat availability; and elevated water temperatures may reduce migration success.
- Higher ocean temperatures may shift species range or distribution to lower quality habitat, or reduce habitat suitability.
- Increased acidity (lower pH) of ocean water may reduce the growth rates (i.e., calcification) of biogenic habitats such as oysters and corals.
- Changes in food sources (including secondary production, calcium carbonate dependent species, and forage fish species) may exacerbate existing vulnerabilities of marine species.
- Changes in ocean currents and climate oscillations (North Atlantic Oscillation, etc.) may restrict latitudinal and vertical habitat, altering key migratory corridors and pelagic habitats.

The MSA defines EFH as “those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity” (16 U.S.C. § 1802(10); *see also* 50 C.F.R. § 600.10). The MSA requires that fishery management plans “describe and identify essential fish habitat for the fishery based on the guidelines established by the Secretary” (16 U.S.C. § 1853(a)(7)). Once EFH is designated, federal agencies (hereafter referred to as action agencies) are required to consult with the National Marine Fisheries Service (NMFS), on behalf of the Secretary of Commerce, for all actions that they authorize, fund, or undertake that may adversely affect EFH.[vii] The EFH regulations outline the process by which action agencies and NMFS, and the U.S. Regional Fishery Management Councils (hereafter referred to as the Councils) satisfy this consultation requirement.[viii] In such consultations, NMFS recommends measures that the action agency can take to conserve EFH, and the action agency must respond in writing, including a description of measures proposed for avoiding, mitigating, or offsetting the impact of its activity on the EFH, and explaining the reasons it is not following any of the NMFS recommendations (16 U.S.C. §1855(b)(4)(B); 50 C.F.R. § 600.20).

The EFH regulations define adverse effects on EFH as including “direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH.” They also note that “adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.”

Evaluating the effects of an action on EFH may include considering the past and anticipated effects of climate change on EFH as context for the consultation and evaluating the action’s effect on EFH. This approach is consistent with NOAA Fisheries National Climate Science Strategy[ix], the Marine Fisheries Habitat Assessment Improvement Plan,[x] the NOAA Fisheries Ecosystem-Based Fisheries Management Road Map,[xi] and the updated Stock Assessment Improvement Plan.[xii] As such, it is important that action agencies incorporate consideration of climate change into analyzing the effects of an action on EFH and designing conservation measures. NMFS, as the consulting agency, should work with action agencies to ensure they do so and, if necessary, provide conservation recommendations to avoid, minimize, or offset potential adverse effects on EFH, including those exacerbated by climate change.

- Avoid – avoid the adverse effects altogether by not taking a certain action or parts of an action or by modifying the action to avert impacts.
- Minimize – minimize the adverse effects by limiting the degree or magnitude of the impact, action, or its implementation.
- Offset – compensate for the adverse effects by replacing or providing equivalent substitute resources or environments.

II. Objective

This document provides guidance to action agencies, Councils, and consulting NMFS staff on how to incorporate expected climate change effects into EFH assessments and consultations. Doing so should improve outcomes by accounting for expected climate change effects in the action's design and by enhancing avoidance and/or mitigation of the action's adverse effects on EFH.

The information within this document is intended to 1) help action agencies account for climate change in their EFH assessments, 2) select project designs or permit conditions that reduce potential adverse effects of the actions that may be worsened by climate change, and 3) help NMFS improve the specificity of its EFH conservation recommendations. To increase the consistency and efficiency of EFH consultations, NMFS has identified five policy considerations for including climate change in EFH consultations. We provide guidance for the first four policy considerations that are intended for the action agency, and the last one is intended for NMFS staff.

1. Identifying ways that climate change may interact with an action in EFH assessments.
2. Identifying time periods for projecting anticipated climate change effects in EFH assessments.
3. Selecting a climate change emission scenario for EFH assessments.
4. Identifying project design considerations and minimization measures.
5. Determining permitting conditions and EFH conservation recommendations.

Procedures, such as this, must be reviewed regularly and updated if appropriate; and NMFS will make every effort to review this guidance as frequently as needed to include new information and climate considerations in a timely manner.

Some NMFS regional offices provide additional guidance that elaborates on regional climate-related context, issues, and considerations.[xiii]

III. Guidance

1. Identifying ways that climate change may interact with an action in EFH assessments

Climate change is altering EFH and is predicted to continue to have effects on EFH in the future. Climate and habitat are two drivers of potential adverse effects on both fish (vital rates, especially growth, reproduction, mortality, or generally productivity) and their fishery according to NOAA Fisheries' updated Stock Assessment Improvement Plan. Habitat-wide effects from climate change may or may not alter an action's effect on EFH. EFH assessments and consultations should consider the adverse effects of an action in the context of expected environmental changes due to climate change within the action area. For example, the removal of riparian tree cover could exacerbate climate change-induced water temperature increases in EFH that is important for spawning.

The more detailed a description in an EFH assessment, the lower the level of uncertainty and the more accurate the assessment. However, to address uncertainty in data-poor situations or the uncertainty in how climate may interact with the activities of an action in the future, NMFS relies on practical assumptions based on the best scientific information available. In order to identify whether an adverse effect on EFH is altered by expected environmental conditions due to climate change, the following, at a minimum, should be assessed:

- The duration and severity of the action's effects.
- The sensitivity of the habitat to climate change.
- Whether the interaction between climate change and adverse effects from the action is additive, antagonistic, or synergistic.
- Whether the action includes measures to avoid, minimize, mitigate or otherwise offset the adverse effects and consequences of the action in response to changing environmental conditions.

Action agencies should clearly indicate in their EFH assessments the environmental conditions that are likely to change in the future due to climate change (i.e., climate indicators such as temperature, salinity, sea level rise, stream flow, water quality, ocean acidification); whether the action's effects may be affected by those changes; if so, how that may alter the quantity or quality of EFH; and the assumptions that were made in coming to these conclusions.

When available, climate vulnerability assessments (CVA) completed by NOAA[xiv] or other relevant bodies, inclusive of terrestrial and marine CVAs, may help action agencies identify the effects of climate change and any interactions with effects of the action. CVAs identify what species or habitats may be most vulnerable based on their exposure to projected climate change (e.g., warming oceans and ocean acidification) and their sensitivity or adaptability (i.e., resilience) in handling those changes based on their life history characteristics (e.g., reproductive strategies and diet). CVAs also identify the individual and cumulative pressures that pose the most risk to vulnerable resources and dependent communities (Guiding Principle 3b of the NOAA Fisheries Ecosystem-Based Fisheries Management Road Map).CVAs may also help identify areas where additional research and action is needed to reduce risks. However, the overall scale of analysis for CVAs might not be especially helpful for a very localized or small action—since analyses are often done on a 1° x 1° grid. In addition, there has been one habitat-specific CVA evaluated for the Northeast U.S., which provides regional managers and scientists with a tool to inform habitat conservation.[xv]

2. Identifying time periods for projecting anticipated climate change effects in EFH assessments

Action agencies should project the interaction of climate change and adverse effects of the action on EFH for as long as effects of the action can be reasonably expected to occur or persist. For example, an assessment of construction activities should consider the interaction of climate change and adverse effects that occur throughout the anticipated "life" of the project (i.e., not only the period of construction activities, but also the periods of operation, maintenance, and decommissioning of the constructed project). Permits should have conditions to account for climate change in reauthorizations, decommissioning, and restoration actions, which may occur many years after the initial permit is issued.

Climate change should also be considered for actions that are repeated into the future. For example, the NMFS policy directive for dredging of federal navigation channels[xvi] clarifies that EFH consultation reinitiation is typically not necessary for each maintenance cycle if consultations have already been conducted and the assessments account for the recurring dredging actions. In this case, the adverse effects that interact with climate change should be considered throughout all reasonably anticipated maintenance cycles in the consultation.

Post-action recovery of EFH resources may also be affected by climate change and this should be accounted for in the EFH assessment (and through NMFS conservation recommendations). For example, if recovery may take longer than it might have in the past or if recovery is not feasible due to climate change, this should be reflected in the effects analysis. Even when recovery involves restoration activities that are completed fairly quickly, the long-term effects of climate change should be considered to ensure that the restoration will be durable. For example, in the restoration of a salt marsh, the success of the restoration may be partially dependent on the rate of sea level rise and whether local conditions (e.g., upland retreat corridors or sediment supply) allow for and maintain a landward migration. If not, the restoration is not likely to be adequate and other forms of restoration should be considered.

Current climate change information indicates that uncertainty of both climate projections and the degree of risk to habitats from climate change increase over time.[xvii] It is not necessary to know with precision the magnitude of change over the relevant time period. The action agency should use the best available scientific information to account for the interaction of climate change with the action's potential adverse effects and make reasonable and clearly stated assumptions. When feasible, action agencies may use adaptive management approaches to account for the effects (discussed in the following section).

Often, the activities that result in adverse effects on EFH occur for relatively short time periods (i.e., years not decades) and the assessment of effects in the context of expected climate change is unclear, or is not easily determined. Even if the time period when EFH is affected does not appear to include discernable differences in relevant climate indicators, the examples in the appendix may still be useful considerations for your EFH assessment.

3. Selecting a climate change emission scenario for EFH assessments

EFH assessments should be based on a realistic projection of climate change indicators (e.g., temperature, salinity, sea level rise, and pH) for the action area. Action agencies should first determine if local or regional (i.e., downscaled) climate model projections are available for the indicators of interest. Otherwise, emission and climate projection scenarios are available on a global scale from the Intergovernmental Panel on Climate Change (IPCC), and may also be available from other providers. In some cases, it may be helpful for action agencies to produce downscaled model projections to provide a more precise estimate of indicators at the project-specific scale.

The IPCC Sixth Assessment Report (AR6)[xviii] projects climate indicators under five core emissions scenarios (SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0 and SSP5-8.5) that capture whether or not future emission reductions are achieved, given projected global socioeconomic changes such as human population size, economic activity, lifestyle, energy use, land use patterns, technology, and climate policy. The two lowest "green road" emission scenarios assume low challenges to mitigation and adaptation, both predicting that global surface temperatures will either decrease or increase only modestly in the long term. The highest "worst case" emission scenario represents a future with high challenges to mitigation, where emission reduction targets are missed due to either unsuccessful or abandoned mitigation efforts. The intermediate emissions scenario, SSP2-4.5, represents the “middle of the road” scenario in which emissions start to fall mid-century, but do not reach net zero by 2100. SSP3-7.0 represents the high emissions scenario that does not consider actions that mitigate the adverse effects of climate change (i.e., a no-mitigation scenario).

The IPCC did not identify any emissions scenario as being more likely to occur than any other, but they do represent different possible futures from our present outlook. Based on current climate policies and emissions, the International Energy Agency estimated that by mid-century climate indicators are likely to be between those projected by SSP4-6.0, a non-core emission scenario that is not fully developed, and SSP2-4.5.[xix] Our current emissions reality is lower than levels projected by the high emission scenario (i.e., SSP3-7.0), but higher than the intermediate scenario.

The assessment of effects of the action, and the design of conservation measures, should consider the effects of climate change, using the IPCC’s medium to high emissions scenario, SSP3-7.0, which is the second highest climate emission scenario available. This scenario is consistent with that used in NMFS’ environmental review procedures for the Endangered Species Act, which reference the high emissions scenario as an appropriate precaution for regulating species facing extinction.

The majority of EFH consultations cover time periods in the near- and mid-term. When planning after the middle of this century (i.e., 2050), NMFS may provide adaptive EFH conservation recommendations (see Part 5 of this guidance).

4. Identifying project design considerations and minimization measures

When preparing an EFH assessment, action agencies should ensure that measures to avoid, minimize or offset adverse effects of the action on EFH due to climate change are included. EFH assessments that do not consider future climate conditions may not capture the complexity and magnitude of adverse effects on EFH from an action. Action agencies should coordinate early with NMFS during their planning processes, when there is maximum flexibility and time to consider design options.

When planning an action, action agencies should do the following:

- Consider adverse effects on EFH under the best available (downscaled if possible) climate projection and not based solely on historical environmental conditions and resource recovery rates.
- Ensure that avoidance and minimization measures are designed to accommodate climate variability (e.g., seasonal temperature variations and El Niño Southern Oscillation events) and that projects are designed with climate change in mind.
- Ensure that substantial adverse effects that remain after avoidance and minimization measures have been implemented are offset via activities such as restoration or establishment of similar habitat either onsite (usually preferable) or elsewhere.

Action agencies should not base their EFH assessments solely on historical environmental conditions, as historical EFH resource recovery rates are unlikely to reflect future scenarios due to climate change. Using historical data may make the action ineffective or cause increased adverse effects on EFH. For example, a culvert size that does not anticipate changes in water flow (e.g., volume and velocity) due to climate change may fail if it is undersized, making the culvert ineffective and causing preventable adverse effects on EFH as well as other unwanted effects.

Some proposed actions may have a shortened lifespan due to the effects of climate change, such as a proposed action to build a bridge at an elevation that may be underwater in 50 years due to sea level rise. Action agencies should anticipate effects on EFH resulting from all phases of the project—construction, operation, maintenance, and decommissioning—including steps needed to maintain projects that were not originally designed to incorporate climate change. Project design considerations that address long-term effects of climate change may include the following, although this is not exhaustive:

- Modifying project designs to extend the project's useful life to avoid disturbing EFH repeatedly.
- Conducting remediation or other maintenance actions in the near future to maintain project viability.
- Including features such as adaptive management plans as part of their project design.

If the proposed action, EFH recovery, or both, are likely occur over a long time period, action agencies may use an adaptive management plan. This approach is not a replacement for planning that accounts for climate change. Rather, it's a way to reduce the uncertainty inherent in projecting the adverse effects of climate change on EFH, and it's likely to result in more efficient responses to the actual changes that occur, and better success of offset (i.e., compensation) for permanent adverse effects. At a minimum, adaptive management plans that address adverse effects from climate change should include the following:

- Adequate monitoring of appropriate climate indicators and biological responses
- Identification of trigger points related to the climate indicators and biological responses that indicate when additional actions are needed
- Identification of additional parts of the action that should be implemented when the trigger points are met (i.e., if a certain rate of recovery is not met or climate changes are occurring faster than predicted).

There may be situations in which adaptive management plans are not able to adequately avoid and minimize the adverse effects that may be amplified by climate change. For example, a hardened structure like a road or bridge that is built landward of a salt marsh may prevent it from migrating inland as sea level rises. This may lead to inundation and result in habitat degradation, or conversion to another habitat type or open water. In such cases, the action agency can compensate for these effects through an offset such as establishment of habitat elsewhere that meets the same ecological function as the affected habitat. NMFS has established a policy for mitigating for Trust Resources that includes designated EFH. [xx]

In cases in which substantial loss of EFH is likely to occur and adequate mitigation is not feasible, NMFS may recommend against implementing the action.

5. Determining permitting conditions and EFH conservation recommendations

Consistent with NOAA Fisheries Ecosystem-Based Fishery Management Road Map, which calls for including ecosystem considerations into management advice, NMFS has identified general categories of environmental conditions resulting from climate change that may interact with adverse effects from agency actions: increases in temperature, salinity, sea level, stream flow, and acidification; and decreases in water quality (e.g., harmful algal blooms, hypoxia, eutrophication).[xxi] Table 1 presents examples of generalized conservation recommendations and permit conditions. This list is not comprehensive nor is it intended to be prescriptive, as there may be numerous acceptable approaches for avoiding, minimizing, or offsetting adverse effects on EFH.

One project design modification that can often reduce uncertainty associated with the interaction between adverse effects from the action and effects related to climate change is to downscale the scope and extent of an action to lower the magnitude and severity of adverse effects on EFH. Reducing the scope and extent of an action can generally reduce adverse effects on EFH and therefore reduce or avoid effects that are amplified by climate change. An example would be reducing a dredge footprint over time to increase the buffer around EFH resources that are vulnerable to the interaction of climate and the adverse effects from dredging, or use different methodology such as an environmental clamshell bucket dredge.

For actions that are predicted to have adverse effects beyond mid-century, NMFS may provide adaptive EFH conservation recommendations. Each adaptive EFH conservation recommendation should identify the relevant climate indicator (e.g., temperature, salinity, sea level rise, pH) that serves as a trigger for adaptive management in the form of a previously agreed upon conservation recommendation. For example, turbidity from dredging is adverse to coral reefs designated as EFH, as is increased temperature. Turbidity is controlled by floating curtains and distance buffers. As temperature trends up through mid-century, buffers could increase; and when/if temperatures trend down, buffers could decrease.

When NMFS is able to work together with action agencies on project development through early coordination, adaptive management plans may preclude the need for conservation recommendations.

Table 1. Simplified examples of EFH conservation recommendations and permit conditions for climate-related concerns

Activity Effect	Expected Climate Change Condition	Example Recommendation/Permit Condition
Dredging, filling and mining adversely affect water quality by elevating suspended sediment and release of contaminants.	Increased stormwater discharges resulting from storm activity.	Change or establish work-windows associated with weather, and implement more restrictive ambient water quality thresholds.
Wastewater facilities generate sewage discharges that increase nutrient levels and cause eutrophication.	Increased eutrophication/ hypoxia and may amplify ocean acidification.	Install diffusers for outfalls or increase the footprint of existing diffusers to reduce concentrated nutrient levels.
Shoreline construction and hardening alter nearshore runoff and hydrodynamics.	Sea-level rise and flooding.	Construct new facilities with shoreline setbacks and protect existing facilities using nature-based solutions that allow for habitat migration inland.
Industrial discharges release contaminants and reduce water quality.	Increased water temperatures and altered salinity regime.	Schedule releases during the winter when ocean temperatures are cooler, and reduce the discharge rate of freshwater affecting salinity.
Greenhouse gases trap atmospheric heat and reduce water quality	Increased water temperatures and acidification	Use more efficient valves that reduce leakage of methane from offshore oil and gas platforms to reduce the amount of emissions.
Stream diversions reduce stream flow.	Reduced streamflow during drought conditions may disconnect or dewater habitat features.	Identify the minimum streamflow requirements needed under the expected climate change scenario and begin limiting stream diversions above that level.

Appendix: Specific Situations and Regional Examples

These situational and regional examples demonstrate how climate may interact with a proposed project's activities and EFH features. This appendix is not exclusive nor exhaustive, and there are numerous other situations that could be described. This section provides practical considerations that can be applied when considering how to frame climate change effects or interactions in an EFH consultation. These situational examples are particularly useful when the proposed project's activities are planned for the near future, when climate change projections are not dramatically different from one another.

A. Actions that affect the ability of habitats, fish, and invertebrates to migrate with a changing climate

The ability of habitats and species to migrate with a changing climate is predicted to be an important adaptation. Coastal habitats are migrating landward with sea level rise and northward with rising air and ocean temperature, while some managed species are migrating northward and moving into deeper water as ocean temperatures increase. Under projected sea level rise, streamflow, or precipitation patterns, infrastructure projects have the potential to create migratory fish blockages or degrade the function of migratory corridor habitat.

Actions that upgrade existing infrastructure (such as rail or road crossings, shorefront roads, tide gates and water control structures, levees, and dams) offer opportunities to adjust project designs to accommodate projected climate-related changes in water levels, streamflow, and precipitation. Project designs can address waterflow blockages and ensure that these function properly for the expected life of the infrastructure. For example, a dyke bridge with culverts and flapper gates not only restricts normal daily tide flow to a wetland, but can increase mortality of migrating fish and reduce fish passage rates. When replacing this type of structure, the expected lifespan of the new structure should be assessed and the project should be designed to accommodate not only projected sea level rise, but also higher water levels from spring tides, storm surge, and inland flooding from extreme rainfall events that may occur.

Due to sea level rise and inundation, wetland and other sensitive nearshore habitats (i.e., nursery grounds within estuaries) may need to migrate inland to higher elevations or be lost to tidal inundation and erosion. Actions that upgrade existing infrastructure or install new structures (e.g., bulkheads and roads) landward of salt marshes should include designs that allow habitats to shift. This can include ecological buffers that allow habitats, fish, and invertebrates to migrate and adapt to climate-related changes. Living shorelines may act as ecological buffers and provide habitat, reduce erosion, and facilitate migration landward as seas rise. Undeveloped low-elevation shoreline properties may become aquatic habitat on their own, or they may need to be protected and set aside for assisted upland migration in the future, such as removing hardened shorelines or adjusting slopes of shorelines. Habitat restoration projects should accommodate changing water levels, sediment supplies, salinity, streamflow patterns, warming waters, and extreme riverine or coastal flooding.

A warm-water effluent that raises the ambient water temperature in an estuary or stream may result in a thermal barrier for migration as climate change causes additional warming in the future. A large water withdrawal project or multiple water withdrawal projects constructed on a river could reduce the flow, increase water temperatures, and impact the ability of diadromous fish to reach spawning grounds within the watershed, and these effects may be exacerbated by climate change. In both of these cases in which water temperature and flow are altered, conservation recommendations and adaptive management measures may include water temperature thresholds above which certain agreed upon actions are taken. This can protect fish habitat as conditions change.

The following considerations should improve EFH assessments and conservation recommendations that address climate-related concerns related to habitat and species migration:

- Evaluation of the site's vulnerability to sea level rise, the area's dynamics (e.g., waterflow, waves, and sedimentation), and potential changes in the location, availability, function, and quality of habitat over time.
- Assurance that migration corridors inland and north are maintained into the future to provide continued access to habitats that support all life stages.
- Prioritization of areas that could become locations of future habitat, while maintaining or preserving current values and functions of habitat. This can ensure that habitat is available over a broader temporal scale as habitat function and values change.

<u>Regional Example</u>: A project proposes a fish passage barrier located at the mouth of a creek. This creek is one of the few streams in the area without a natural barrier, and is accessible to sea-going fish. A barrier to fish passage is caused by the combination of a driveway embankment and dam on private property, which create a pond on the upstream side. The barrier prevents passage of salmonids, because the two 24-inch culverts located high up on the driveway block access, limit flow, and create a build-up of sediment in the creek.

> <u>Measures to address needs of EFH</u>: The culverts and dam should be replaced with a large culvert to allow for fish passage, and to accommodate high tides and future sea level rise. This modification would restore the creek's natural streamflow and sediment-transport processes.

<u>Regional Example</u>: A project proposes to replace existing bridges along a 2-mile stretch of highway adjacent to a large bay. The highway is located in lower elevations already below the current sea level during higher tides, but the highway is protected by a network of levees. The levees may be compromised or need to be set back within the next 20 years as sea level rise is predicted to exceed the design capacity of the levees. This could have significant implications for the highway and new bridges if they were constructed as proposed.

> <u>Measures to address needs of EFH</u>: Both the bridges and appurtenant roads should be evaluated for longevity and the implications of levee failure or flooding in the future. Relocating the highway to areas further inland or incorporating the use of piers/pilings to suspend the highway in certain locations should be considered, as these may allow for a longer lifespan of the project as well as reduce adverse effects on habitat from avoiding multiple projects (and associated maintenance or emergency repairs) implemented over a short time period. If the highway is designed appropriately, it could also accommodate in-land migration of habitat.

<u>Regional Example</u>: A project proposes to build a large dock paralleling the waterfront along the higher elevation areas of a lagoon/estuary, where survey results have indicated that there is no eelgrass present. Along the West Coast, seagrasses have been identified as a Habitat Area of Particular Concern for Pacific Coast groundfish and Pacific Coast salmon. Projected sea level rise

indicates that the location of the dock, although predominantly located along high elevations, would likely coincide with the future location of eelgrass. Although the dock may not affect the density or spatial extent of eelgrass in the near future, it may prevent eelgrass retreat into higher elevation areas as sea level rises.

> Measures to address needs of EFH: Conservation recommendations should address the future adverse effects on eelgrass caused by the dock and related infrastructure as sea level rises. This might include spacing pilings as far apart as possible, and minimizing the distance that it reaches further in-land to 1) reduce future expansion, 2) minimize pier width so that smaller area is impacted, and 3) include gaps between boards (such ½ inch space between boards) to allow for sunlight to go through.

Regional Example: A project proposes to construct a series of wind turbines within a seasonal foraging ground of highly migratory species. Artificial structures are speculated to increase feeding opportunities of smaller reef- or structure-associated species and possibly serve as waypoints within species migration corridors. Aggregation of prey species and presence of habitat with high vertical relief due to artificial structure may alter the residency and migration patterns of highly migratory species. Changes in migration patterns could lead to modified predator-prey interactions within specific foraging grounds and heightened mortality if there is increased fishing pressure targeting aggregations.

> Measures to address needs of EFH: Conservation recommendations should address knowledge gaps and research needs for understanding the interaction between highly migratory species, prey species, and artificial structure. An important tool for determining the effects of offshore wind energy is long term monitoring in wind energy areas during exploration, surveying, construction, and operation. Continuous, well-developed monitoring frameworks for both oceanographic conditions and the biological community are key for monitoring highly migratory species and finfish due to their life histories, sensory capabilities, and diverse movement ecology. For more information and other measures that could potentially address needs of EFH, please see Fisheries and Offshore Wind Interactions: Synthesis of Science.[xxii]

B. Actions likely to cause erosion, sedimentation, or resuspension of sediments on or near habitats

Erosion, sedimentation, and resuspension of sediments (natural and unnatural) can cause negative effects on riverine, estuarine, and nearshore ecosystems. Increased sedimentation and resuspension of sediments may alter habitat in the following ways:

- Reducing light transmittance.
- Altering submerged aquatic vegetation and other benthic habitats.
- Increasing water temperatures due to changes in turbidity due to particle heat absorption.
- Releasing contaminants.
- Changing stream flow or channel configuration.
- Reducing dissolved oxygen and altering pH.

Actions that alter sedimentation can affect managed species by disrupting respiration, reducing filtering efficiencies of invertebrates, altering egg buoyancy, disrupting ichthyoplankton development, reducing the growth and survival of filter feeders, and decreasing foraging efficiency of sight-feeders.

Although such actions are the same regardless of climate change considerations, as climate change intensifies, erosion, sedimentation, and resuspension may occur more frequently due to intense storms and sea level rise. In addition, there may be an increased need to build or maintain infrastructure intended to withstand extreme weather and sea level rise. When considering how projects that increase sedimentation may exacerbate the effects of climate change on habitats and managed species, action agencies should assess whether or not the projects have built in features that allow for the adversely affected area to adapt to increased storm frequency and intensity, and increased water velocity.

The following considerations should improve EFH assessments and conservation recommendations that address climate-related concerns related to erosion and sedimentation:

- Whether or not shoreline stabilization projects are built above the projected mean sea level.
- Project viability due to increased erosion on existing habitats.
- Whether or not a project can reduce sediment supplies or alter littoral sediment transport that are key to maintaining habitats.
- Measures that account for increased sea level and storm surge, minimize erosion on adjacent shorelines, and address increased water velocity through the structures.
- Whether or not remediation or other maintenance actions might be necessary in the near future to maintain project viability, which may include the development of an adaptive management plan.
- Whether or not the project includes building of new structures (e.g., roads) and, if so, whether they are designed to withstand increased storm frequency and intensity, which would decrease the likelihood of the structure becoming debris.
- Whether the adverse effects on sensitive habitats used by sensitive life stages could be offset through time-of-year recommendations.

Regional Example: A project in Hawai'i proposes to mitigate shoreline erosion along a developed coastline that experiences chronic and episodic coastal erosion leading to shoreline recession, beach narrowing, and a reduction in coastal access. This could adversely affect EFH due to loss of nearshore coral habitat within the action area. To address the coastal erosion, multiple rock T-groins and a reinforced headland structure could be installed. Sand used for beach nourishment should be sourced offshore over the expected lifespan of the project (30 years). In addition, at 50 years, 5% of the stabilizing structures are likely to need replacement. Downscaled (e.g., local) models predict sea level rise to affect most of Hawaii's shorelines through erosion of low lying coastlines and inundation of water, resulting in inland movement of 1 to 24 meters by 2050. In addition, a model of nearshore wave processes indicates that the action is not expected to significantly increase seafloor sand movement as T-groins are predicted to deflect longshore currents around the vicinity of the structures, which may result in a decline in water quality due to reduced flushing and erosion of newly placed sand.

> Measures to address needs of EFH: Actions to address these concerns should include a mitigation plan to address coral habitat loss, potential mitigation and contingency planning for sea-level rise; and a water quality monitoring plan to document and report changes in turbidity, salinity, and nutrients throughout the life of the project (before, during, and after sand and groin placement).

Regional Example: A project proposes to replace a bridge over a tidal stream and the current design of the bridge is to keep the dimensions the same as the original design. The new bridge is expected to have a lifespan of 75 years. The height of the bridge is about 3.6 feet above the existing mean higher-high water line. The proposed structure is likely to be inundated by water on the highest average high tides based on sea level rise projections for the project area. Additionally, the bridge will need to accommodate spring tides, storm surges, and inland flooding from extreme rain events. Over time, the bridge as currently designed is expected to impede the flow of water in a tidal stream and erode and adversely affect adjacent stream banks and wetlands.

> Measures to address needs of EFH: Actions should include a climate assessment and a redesign of the bridge to accommodate future conditions. This will increase the useful lifespan of the project and reduce the potential for eroding the streambank and scouring the streambed.

C. Actions that alter water flow, ground and surface waters

In some areas, climate change is expected to amplify adverse effects on EFH such as higher temperatures, reduced summer streamflow, and extended droughts. Climate interactions with actions that alter water flow, ground water, and surface water can happen at a variety of points. Actions that involve water withdrawals or diversions (e.g., agricultural, dams, and impoundments) may reduce the volume of groundwater, freshwater flow, sediment, and nutrients to downstream estuaries. Climate change may amplify the effects of actions that reduce or alter ground and surface water at the watershed scale, influencing hydrologic processes that support habitat attributes for diadromous fish such as salmonid species. Consequences of climate related high-intensity rainfall and project induced runoff could include extreme flooding, greater streambed scouring, and increased pollutant discharges from a project site. In some cases, as sea level rises and freshwater flow decreases, estuaries may become more saline, and the extent of tidal influence and salinity may change or migrate upstream.

Decreases in ground and surface water may reduce instream flow through hyporheic substrates (saturated interstitial zone of streambed and banks characterized by surface/groundwater exchange) where, in some areas, salmon embryos incubate through winter. This can reduce overwinter embryo survival, which subsequently reduces the number of fry emerging and emigrating to their marine phase.

Large-scale water reductions may also restrict fish migrations and reduce survival. In low-water conditions, fry may fail to reach downstream estuarine and marine habitats. Similarly, adults migrating upstream may not be able to reach freshwater spawning habitat. Lower water levels may also result in warmer temperatures that increase mortality, and can increase the predation risk for fry, juveniles, and adults. Additional anthropogenic and synergistic stressors arise from low-flow conditions, such as concentrated levels of runoff metals and chemicals, reduced biodiversity, limited prey, and increased disease susceptibility.

Salinity change may cause a temporary or permanent loss in wetland or seagrass species, oysters, or other benthic species or shift in the spatial extent/location of habitat, as well as alter water column stratification. In response to salinity changes, species utilization and migration patterns (e.g., spawning, nursery, and foraging) could change, as well as predator and prey interactions. Alternatively, groundwater withdrawals and pumping can lower the water table and cause saltwater intrusion, both of which could affect availability of usable freshwater. Increased groundwater use has the potential to reduce the connectivity of rivers and streams as segments go dry and flow intermittently, as well as decreasing the extent and function of wetlands and lakes. Downstream transport of sediment, nutrients, and biota could be lost or diminished as wetlands, streams, rivers, and lakes become disconnected and lose function.

When evaluating an action, it is important to keep in mind that long-term historical records of rainfall and streamflow may not be reliable representations of the magnitude, frequency, and duration of recent and future precipitation events and trends. Precipitation rates are expected to become more extreme and less predictable compared to historical patterns and some areas are expected to have more drought-like conditions. In addition, existing stormwater control infrastructure designed for controlling historical rainfall and runoff patterns may be ineffective at storing and filtering polluted runoff now and into the future.

The following considerations should improve EFH assessments and conservation recommendations that address climate-related concerns related to altered water flows:

- Habitat evaluations and habitat vulnerability assessments that reflect current and future precipitation patterns, and greater weight is given for projected emission scenarios (e.g., IPCC's high and intermediate emission scenarios) in order to capture possible future conditions including precipitation extremes.
- How impervious surface areas may alter the capacity of peak streamflow and stormwater management systems to handle both the climate-induced increases in background or baseline streamflow as well as the project-induced increases to streamflow.
- Synergistic effects of both the project effects on habitat and climate-induced flow changes (upstream and downstream) and pollutant loads.
- Projected changes in sea level rise and inundation are incorporated for more precise evaluation of how salinity would change in response to a proposed water withdrawal, diversion, or impoundment and whether or when such salinity or inundation could make the proposed project unviable.
- Alternatives modify withdrawal timing during wetter and drier periods to ensure that water flow releases meet seasonal habitat criteria (e.g., recommend releasing more freshwater flows during drier months to ensure better connectivity of rivers or bypassing the release of freshwater to achieve a brackish condition in specific locations).
- Where ideal habitat conditions (e.g., saline, fresh, and brackish) and locations may exist in the future, to help identify where reductions in withdrawal or impoundment may be most effective.

Recommended monitoring and assessment may include the following:

- Seasonal range, distribution, and abundance of target species at various life history stages.
- Habitat attributes (i.e., temperature, chemistry, biology, and trophic dynamics) that support healthy populations within the area of influence for the activity (e.g., watershed).
- Seasonal groundwater recharge, surface water connectivity, and instream flows at the watershed scale.

Regional Example: The first phase of a coal strip-mining operation is proposed for 5,000 acres, to depths of 350 feet, in Alaska in an area that contains pristine salmon-bearing streams. Future phases of the project would likely expand strip mining to between 20,000 to 90,000 acres. The first phase, as well as cumulative adverse effects of subsequent phases, would completely transform ground and surface water hydrodynamics during the active life of the mine. Many anticipated changes would be expected due to temperature-driven increases in evapotranspiration and snowpack. By the end of this century, snowpack is projected to accumulate one to two weeks later and melt one to three months earlier. Such changes in the quantity, timing, and duration of water inputs to the system could result in seasonal adverse effects on soil moisture, groundwater recharge, surface runoff, baseflow, and instream flow. As a result, winter streamflow is projected to increase, and summer streamflow is projected to decrease. The influence of climate change on the timing and contribution of seasonal precipitation patterns further complicate the ability to plan, mitigate, or predict successful restoration of hydrologic processes and protection of regional salmon populations.

> Measures to address needs of EFH: After considering the impacts on EFH, NMFS may recommend that the action agency suspend the project.

Regional Example: A project proposes to improve airport maintenance and upgrade runways and other infrastructure. Due to the increases in impervious areas, the peak flows and volume of runoff routed to receiving waterways would increase, as would the levels of pollutants due to the increase in air traffic and associated use. Upgrading the capacity of stormwater management systems to handle increased magnitude, frequency, and duration of rain or snowfall events that are caused by both climate change and the proposed project, would help ensure the appropriate filtration and removal of pollutants; and would also minimize adverse effects on habitat (on-site and downstream).

> Measures to address needs of EFH: Additional conveyance capacity and erosion control measures could be incorporated for both infrastructure (drains, etc.) as well as within the receiving waterway to minimize bank erosion, scour, and subsequent sedimentation.

Regional Example: A proposed transportation project is expected to affect the tributaries of the Indian River Lagoon in Florida, reducing the transport of freshwater to the estuary. The decrease in freshwater inputs to the estuary is expected to increase salinities throughout nearshore waters, limiting preferred habitat of juvenile shark species. Diminishing suitable habitat for early life stages of finfish and shark species is considered in the analysis of Climate Vulnerability Assessments and may exacerbate the vulnerability of a species or stock to other climate stressors.

> Measures to address needs of EFH: Designing the transportation project to minimize impacts to freshwater inputs through use of bridges, culverts, or other conveyance methods would reduce the impact to the habitat of finfish and shark species early life stages.

D. Actions that interrupt or alter nutrient supply or trophic dynamics

Naturally-occurring levels of carbon, nitrogen, and phosphorus are the essential ingredients that fuel all life on earth, and they are derived from terrestrial or aquatic detritus (i.e., decaying organic matter). These dissolved nutrients drive the primary and secondary production in nearshore fish nursery zones. They allow energy to flow from bacteria and fungi, through phytoplankton, macro-algae, seagrasses, marshes, and mangroves, to zooplankton, invertebrates, reef-forming shellfish and corals, and larval and juvenile life stages of numerous fish species. The reverse flow of nutrients is equally important to inland ecosystems: in regions where anadromous salmon populations remain abundant, decomposing post-spawning salmon provide vast quantities of nutrients to upstream terrestrial and freshwater species.

Highly elevated nutrient levels in polluted runoff from anthropogenic sewage and other sources may cause eutrophication with extensive and often harmful algal blooms that decompose and deplete the dissolved oxygen in bottom waters (i.e., cause hypoxia). Climate induced changes in precipitation quantity, intensity, and frequency; in water column stratification; and in increased air temperature and evaporation may influence nutrient cycles by altering nitrogen and phosphorus ratios, changing levels of dissolved oxygen, and exacerbating hypoxic conditions. If climate change increases dissolved oxygen, nitrification would decrease, resulting in increased ammonium concentrations.

Projects that increase nutrients (nitrogen and phosphorus) may exacerbate climate related changes in nutrient cycles and dissolved oxygen.

Fish nursery habitats can be overwhelmed by excessive nutrient-fueled algal blooms and the resulting oxygen-depleting, acidity-increasing decomposition of algae. Additionally, climate related ocean acidification can affect calcification rates of zooplankton and habitat-building organisms such as oysters and coral reefs by reducing the amount of carbonate ions available to maintain and build their shells or skeletons. When the pH is too low, invertebrate shells and skeletons can dissolve. This can reduce the quality of available habitat and potentially result in an inability of habitat growth to keep up with rising sea levels.

Early coordination is strongly encouraged to avoid siting in important habitats. The following considerations should improve EFH assessments and conservation recommendations that address climate-related concerns related to nutrient availability:

- Whether the action can alter nutrient loads in estuaries and nearshore ecosystems and if the timing of increased nutrient loads can coincide with any expected changes in snowmelt, precipitation, and increased evaporation.
- Whether there are recommendations that can further reduce and mitigate the adverse effects of actions, such as measures that allow for filtration of excess nutrients by providing for increased pervious surfaces.
- Benefits provided by the adversely affected habitat's (e.g., wetland's) natural capacity to assimilate excessive nutrient loads and sequester and store carbon.
- Increasing water temperatures caused by climate change that amplify downstream adverse effects of excessive nutrients.

Regional Example: A proposed project for a new finfish aquaculture system near a fish nursery habitat that is expected to produce nitrogen and phosphorus waste, in addition to any nutrients from excess feed. The nutrient increase may contribute to the enrichment of the water column and benthos, which can lead to reduced water quality and hypoxia if there is inadequate flushing. By the end of the century, the pH of the ocean surface is expected to fall to 8.01 under a moderate-emissions climate scenario and 7.67 under high-emissions scenario. The concern is the interaction between the excess nutrients and acidification resulting in increased hypoxic conditions and additive acidification effects. These effects may be adverse on fish nursery habitats.

> Measures to address needs of EFH: If possible, the project should be moved to an area that allows for more flushing (such as away from embayments) and/or away from nursery habitat. Another approach is to use appropriate stocking densities and using technological advances in feeding systems to minimize excess nutrients.

E. Actions that alter water temperatures (e.g., cooling water intakes; road construction and maintenance; and vegetation removal)

Climate change may exacerbate the adverse effects of projects that have long-term water temperature alterations. Projections for the 21st century suggest surface water temperatures may rise in both riverine and marine ecosystems. Models also project increased variability in annual precipitation levels and form. Adverse effects of surface water temperature change may be amplified at higher latitudes. In northern latitudes of continental North America, projections suggest generally milder winters with less snowfall accumulation and increased precipitation in the form of rain. In southern latitudes of North America, similar models generally suggest consistent seasonal summer precipitation levels; however, under increased atmospheric temperatures, the occurrence of severe storm events and associated flooding are predicted to rise. Some areas may experience higher evapotranspiration rates, which can reduce streamflow and water levels. Overall, projected changes in temperature, precipitation, and hydrologic inputs may have direct and indirect adverse effects on habitats and associated managed fisheries.

The following considerations should improve EFH assessments and conservation recommendations that address climate-related concerns related to water temperature:

- Whether seasonal variation as summertime highs in conjunction with project-related temperature increases are predicted to put sensitive species or habitats above their thermal thresholds.
- The extent to which the project alters shade allowing for increased water temperatures.
- Whether or not adaptive management plans can be implemented to help evaluate the resilience of affected species and managed habitats during short-term periods of thermal stress.

Regional Example: The State of Hawai'i proposes to expand its energy production, increasing its thermal discharge onto coastal reefs. The reef would be surveyed before and after the expansion to determine if a gradient of thermal adverse effects is correlated directly with water temperature and coral species composition. It is anticipated that corals near the outfall where water is greater than 4°C above ambient temperatures may not survive. Corals in waters 2°C to 4°C above ambient may show signs of bleaching and high mortality rates, with damage being most severe in late summer and some recovery of pigmentation during winter months.

> Measures to address needs of EFH: The plant should offset for losses of coral reef habitat directly affected in areas where discharge exceeds ambient temperatures as these areas may experience mortality from thermal stress sooner than non-affected areas. Direct loss and expected future losses of coral can be calculated, and offset strategies can be implemented to retain as much of the ecosystem function as possible. Typical offsets could include coral translocation, marine debris removal, mooring buoy deployment, derelict vessel removal, reef restoration, stormwater management, and afforestation.

F. Actions that leave native habitat susceptible to non-native or invasive habitats and species

Climate change can facilitate the expansion of invasive species to new areas and decrease habitat resistance to invasions. As temperatures increase, thermal barriers that delineate habitats are predicted to break down, allowing species to spread into new areas or restricting them. With regional warming, there is potential for invasive species to successfully colonize, spread, and establish novel populations in increasingly thermally-favorable locations.

The northward shift in the distributions of marine species continues to occur into higher latitudes and human activities can exacerbate this phenomenon. For instance, as a result of warming temperatures and thinning ice in northern regions, increased vessel traffic and human activities has the potential to facilitate the expansion of non-native species introductions that can alter native habitats. Ongoing greenhouse gas emissions continue to contribute to warming rates, and additional oil and gas production and shoreline modifications can create new structures (i.e., rigs or platforms) that invasive species may populate. Additionally, degradation of habitats by fishing and non-fishing activities can decrease their complexity, which could lead to potential competitive exclusions of certain native species by overtaking invaders.

The following considerations should improve EFH assessments and conservation recommendations that address climate-related concerns related to non-native invasions:

- How a project that alters habitat integrity or builds new structures may facilitate establishment or spread of invasive species, and whether climate change is predicted to increase the likelihood of biological invasions.
- Whether adaptive management strategies need to be applied if the project may result in increased proliferation of invasive species.

Regional Example: A project proposes to tow inactive Navy vessels from berthing/operation ports to dismantling facilities for disposal. Towing of these vessels has the potential to spread invasive species unless the hulls are cleaned first. The transfer of invasive species is greatest when vessels are moved from holding sites or port-to-port with similar environmental conditions. In addition, climate change may result in higher water temperatures, and some warm-adapted species living on ship hulls may become viable and invasive where they previously could not survive. Removing the organisms that have colonized the hulls in place may lead to localized eutrophication in tropical waters.

> Measures to address needs of EFH: The Navy should dry dock vessels for cleaning just prior to towing. However, if dry docking is not possible, hulls should be cleaned a little at a time to avoid nutrient loading. Adaptive management strategies may include monitoring of water quality changes at the harbors around inactive ships during hull cleaning with stop-work criteria for nutrient loading.

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