DECISION DOCUMENT
NATIONWIDE PERMIT 48

This document discusses the factors considered by the Corps of Engineers (Corps) during the issuance process for this Nationwide Permit (NWP). This document contains: (1) the public interest review required by Corps regulations at 33 CFR 320.4(a)(1) and (2); (2) a discussion of the environmental considerations necessary to comply with the National Environmental Policy Act; and (3) the impact analysis specified in Subparts C through F of the 404(b)(1) Guidelines (40 CFR Part 230). This evaluation of the NWP includes a discussion of compliance with applicable laws, consideration of public comments, an alternatives analysis, and a general assessment of individual and cumulative environmental effects, including the general potential effects on each of the public interest factors specified at 33 CFR 320.4(a).

1.0 Text of the Nationwide Permit

Commercial Shellfish Mariculture Activities. Structures or work in navigable waters of the United States and discharges of dredged or fill material into waters of the United States necessary for new and continuing commercial shellfish mariculture operations (i.e., the cultivation of bivalve molluscs such as oysters, mussels, clams, and scallops) in authorized project areas. For the purposes of this NWP, the project area is the area in which the operator is authorized to conduct commercial shellfish mariculture activities, as identified through a lease or permit issued by an appropriate state or local government agency, a treaty, or any easement, lease, deed, contract, or other legally binding agreement that establishes an enforceable property interest for the operator.

This NWP authorizes the installation of buoys, floats, racks, trays, nets, lines, tubes, containers, and other structures into navigable waters of the United States. This NWP also authorizes discharges of dredged or fill material into waters of the United States necessary for shellfish seeding, rearing, cultivating, transplanting, and harvesting activities. Rafts and other floating structures must be securely anchored and clearly marked.

This NWP does not authorize:

(a) The cultivation of a nonindigenous species unless that species has been previously cultivated in the waterbody;

(b) The cultivation of an aquatic nuisance species as defined in the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990; or

(c) Attendant features such as docks, piers, boat ramps, stockpiles, or staging areas, or the deposition of shell material back into waters of the United States as waste.

Notification: The permittee must submit a pre-construction notification to the district engineer if the activity directly affects more than 1/2-acre of submerged aquatic vegetation. If the operator will be conducting commercial shellfish mariculture activities in multiple contiguous project areas, he or she can either submit one PCN for those contiguous project areas or submit a separate PCN for each project area. (See general condition 32.) (Authorities: Sections 10 and 404)

Note 1: The permittee should notify the applicable U.S. Coast Guard office regarding the project.

Note 2: To prevent introduction of aquatic nuisance species, no material that has been taken from a different waterbody may be reused in the current project area, unless it has been treated in accordance with the applicable regional aquatic nuisance species management plan.

Note 3: The Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 defines "aquatic nuisance species" as "a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural, or recreational activities dependent on such waters."

1.1 Requirements

General conditions of the NWPs are in the Federal Register notice announcing the issuance of this NWP. Pre-construction notification requirements, additional conditions, limitations, and restrictions are in 33 CFR part 330.

1.2 Statutory Authorities

- Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403)
- Section 404 of the Clean Water Act (33 U.S.C. 1344)

1.3 Compliance with Related Laws (33 CFR 320.3)

1.3.1 General

Nationwide permits are a type of general permit designed to authorize certain activities that have no more than minimal individual and cumulative adverse

environmental effects and generally comply with the related laws cited in 33 CFR 320.3. Activities that result in more than minimal individual and cumulative adverse environmental effects cannot be authorized by NWPs. Individual review of each activity authorized by an NWP will not normally be performed, except when pre-construction notification to the Corps is required or when an applicant requests verification that an activity complies with an NWP. Potential adverse impacts and compliance with the laws cited in 33 CFR 320.3 are controlled by the terms and conditions of each NWP, regional and case-specific conditions, and the review process that is undertaken prior to the issuance of NWPs.

The evaluation of this NWP, and related documentation, considers compliance with each of the following laws, where applicable: Section 10 of the Rivers and Harbors Act of 1899; Sections 401, 402, and 404 of the Clean Water Act; Section 307(c) of the Coastal Zone Management Act of 1972, as amended; Section 302 of the Marine Protection, Research and Sanctuaries Act of 1972, as amended; the National Environmental Policy Act of 1969; the Fish and Wildlife Act of 1956; the Migratory Marine Game-Fish Act; the Fish and Wildlife Coordination Act, the Federal Power Act of 1920, as amended; the National Historic Preservation Act of 1966; the Interstate Land Sales Full Disclosure Act; the Endangered Species Act; the Deepwater Port Act of 1974; the Marine Mammal Protection Act of 1972; Section 7(a) of the Wild and Scenic Rivers Act; the Ocean Thermal Energy Act of 1980; the National Fishing Enhancement Act of 1984; the Magnuson-Stevens Fishery and Conservation and Management Act, the Bald and Golden Eagle Protection Act; and the Migratory Bird Treaty Act. In addition, compliance of the NWP with other Federal requirements, such as Executive Orders and Federal regulations addressing issues such as floodplains, essential fish habitat, and critical resource waters is considered.

The evaluation of this NWP is largely a qualitative evaluation that utilizes available information on the categories of activities authorized by this NWPs, the potential environmental impacts of those authorized activities, potential mitigation measures, and the potential benefits of the authorized activities. The Council on Environmental Quality's regulations at 50 CFR parts 1500 to 1508 for implementing the National Environmental Policy Act do not require quantitative analyses for environmental assessments. Since this NWP authorizes activities across the United States, this environmental assessment uses, available national information supplemented with other available information. The U.S. Environmental Protection Agency's regulations for the Clean Water Act Section 404(b)(1) Guidelines (40 CFR part 230) generally do not require quantitative analyses for determining compliance with those guidelines. For the issuance of a general permit under Section 404 of the Clean Water, the one exception is that the cumulative impact analysis for the proposed issuance of a general permit must include an estimate of the number of discharges of dredged or fill material that general permit is anticipated to be authorized by that general permit during the time period it is in effect (see 40 CFR 230.7(b)(3)). Section 230.7(b)(3) does not require the permitting authority to estimate the amounts of permitted impacts and compensatory mitigation required that are

anticipated to occur during the period the general permit is in effect.

1.3.2 Terms and Conditions

Many NWPs have pre-construction notification requirements that trigger case-by-case review of certain activities. Two NWP general conditions require case-by-case review of all activities that may adversely affect Federally-listed endangered or threatened species or historic properties (i.e., general conditions 18 and 20, respectively). General condition 16 restricts the use of NWPs for activities that are located in Federally-designated wild and scenic rivers. None of the NWPs authorize the construction of artificial reefs. General condition 28 addresses the use of an NWP with other NWPs to authorize a single and complete project, to ensure that the acreage limits of each of the NWPs used to authorize that project are not exceeded.

In some cases, activities authorized by an NWP may require other federal, state, or local authorizations. Examples of such cases include, but are not limited to: activities that are in marine sanctuaries or affect marine sanctuaries or marine mammals; the ownership, construction, location, and operation of ocean thermal conversion facilities or deep water ports beyond the territorial seas; activities that result in discharges of dredged or fill material into waters of the United States and require Clean Water Act Section 401 water quality certification; or activities in a state operating under a coastal zone management program approved by the Secretary of Commerce under the Coastal Zone Management Act. In such cases, a provision of the NWPs states that an NWP does not obviate the need to obtain other authorizations required by law. [33 CFR 330.4(b)(2)]

Additional safeguards include provisions that allow the Chief of Engineers, division engineers, and/or district engineers to: assert discretionary authority and require an individual permit for a specific activity; modify NWPs for specific activities by adding special conditions on a case-by-case basis; add conditions on a regional or nationwide basis to certain NWPs; or take action to suspend or revoke an NWP or NWP authorization for activities within a region or state. Regional conditions are imposed to protect important regional concerns and resources. [33 CFR 330.4(e) and 330.5]

1.3.3 Review Process

The analyses in this document and the coordination that was undertaken prior to the issuance of the NWP fulfill the requirements of the National Environmental Policy Act (NEPA), the Fish and Wildlife Coordination Act, and other acts promulgated to protect the quality of the environment.

All NWPs that authorize activities that may result in discharges into waters of the United States require compliance with the water quality certification requirements of Section 401 of the Clean Water Act. Nationwide permits that authorize activities within, or affecting land or water uses within a state that has a Federally-approved

coastal zone management program, must also be certified as consistent with the state's program, unless a presumption of concurrence occurs. The procedures to ensure that the NWPs comply with these laws are described in 33 CFR 330.4(c) and (d), respectively.

1.4 Public Comments and Responses

For a summary of the public comments received in response to the September 15, 2020, Federal Register notice, refer to the preamble in the Federal Register notice announcing the reissuance of this NWP. The substantive comments received in response to the September 15, 2020, Federal Register notice were used to improve the NWP by changing NWP terms and limits, notification requirements, and/or NWP general conditions, as necessary.

The Corps proposed a number of modifications to this NWP. The Corps proposed to change the title of this NWP from "Commercial Shellfish Aquaculture Activities" to "Commercial Shellfish Mariculture Activities" to more accurately reflect where these activities are conducted (i.e., coastal waters). The Corps also proposed to remove the 1/2-acre limit for new activities that have direct effects on submerged aquatic vegetation in project areas that that have not been used for commercial shellfish aquaculture activities during the past 100 years. In addition to the proposed removal of that 1/2-acre limit, the Corps proposed to remove the definition of "new commercial shellfish aquaculture operation" that was adopted in 2017. Also, the Corps proposed to remove both PCN thresholds for this NWP, as well as the paragraph that identifies the additional information that permittees must submit with their NWP 48 PCNs.

The Corps changed the title of this NWP to "Commercial Shellfish Mariculture Activities" because the NWP only authorizes activities in coastal waters. Mariculture is the cultivation of organisms in marine and estuarine open water environments (NRC 2010). The term "aquaculture" refers to a broad spectrum of production of aquatic organisms. In the United States aquaculture activities encompass the production of marine and freshwater finfish, as well as shellfish (bivalve molluscs and crustaceans). Oysters, clams, mussels, and scallops are examples of bivalve molluscs (bivalves). Since aquaculture activities in the United States include both water-based and land-based activities, we use the term "mariculture" in NWPs 48, 55 (seaweed mariculture activities), and 56 (finfish mariculture activities) to make it clear that these NWPs only authorize activities in marine and estuarine waters.

In response to the October 10, 2019 decision of the United States District Court, Western District of Washington at Seattle in the *Coalition to Protect Puget Sound Habitat v. U.S. Army Corps of Engineers et al.* (Case No. C16-0950RSL) and *Center for Food Safety v. U.S. Army Corps of Engineers et al.* (Case No. C17-1209RSL), the Corps has made substantial revisions to the national decision document for NWP 48. The revisions addressed, to the extent appropriate, issues

identified in the district court's decision. A copy of the final national decision document is available in the docket at www.regulations.gov (COE-2020-0002).

The national decision document for the 2021 NWP 48 provides a more thorough discussion of the direct and indirect impacts caused by commercial shellfish mariculture activities. The national decision document also uses a broader set of scientific literature to support that discussion of potential effects to various resources and the human environment. The national decision document does not focus solely on oyster mariculture; rather, it also discusses mariculture activities for other bivalve species, such as clams, mussels, and scallops. The national decision document presents a more detailed discussion of the potential impacts of commercial shellfish mariculture activities on aquatic vegetation other than seagrasses, benthic communities, fish, birds, water quality, and substrate characteristics.

The national decision document provides a more thorough discussion of how the Corps applies its two permitting authorities to commercial shellfish mariculture activities (i.e., Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act). It discusses the types of activities regulated under those authorities and their potential environmental consequences. In addition, the national decision document provides a more rigorous analysis to support a finding, at a national level, that the NWP would authorize only those commercial shellfish mariculture activities that have no more than minimal individual and cumulative adverse environmental effects. The national decision document explains that division engineers retain the authority to modify, suspend, or revoke NWP 48 on a regional basis (see 33 CFR 330.5(c)). It further discusses the authority of district engineers to modify, suspend, or revoke NWP 48 on a case-by-case basis (see 33 CFR 330.5(d)) if impacts of an activity proposed for authorization using NWP 48 has more than a minimal adverse effect on the environment. A copy of the national decision document for the 2021 NWP 48 is available in the www.regulations.gov docket for this rulemaking action (docket number COE-2020-0002).

Commercial shellfish mariculture activities involve the production of bivalves such as oysters, mussels, clams, and scallops. These activities occur in marine and estuarine coastal waters of the United States. As discussed above, the Corps regulates commercial shellfish mariculture activities under two of its permitting authorities: Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act. Under Section 10 of the Rivers and Harbors Act of 1899, the Corps regulates structures and work in navigable waters of the United States. Under Section 404 of the Clean Water Act, the Corps regulates discharges of dredged or fill material into waters of the United States.

Nationwide permit 48 authorizes structures or work in navigable waters of the United States for commercial shellfish mariculture activities when DA permits are required by Section 10 the Rivers and Harbors Act of 1899. The Corps' regulations for Section 10 of the Rivers and Harbors Act of 1899 in 33 CFR part 322 define the

term “structure” as including, “without limitation, any pier, boat dock, boat ramp, wharf, dolphin, weir, boom, breakwater, bulkhead, revetment, riprap, jetty, artificial island, artificial reef, permanent mooring structure, power transmission line, permanently moored floating vessel, piling, aid to navigation, or any other obstacle or obstruction.” [33 CFR 322.2(b)] Commercial shellfish mariculture activities usually involve structures such as cages, racks, nets, pilings, lines, trays, tubes, ropes, and bouchots (i.e., piles wrapped in rope for cultivating mussels) placed in navigable waters to cultivate bivalves.

Oysters may be cultivated using structures such as cages, trays, racks, bags, and lines. Oyster mariculture may be conducted through on-bottom or off-bottom techniques (NRC 2010). Clams are generally cultivated through on-bottom techniques because the commercially produced species are infaunal organisms that grow in the substrate of waterbodies (NRC 2010). Clam mariculture may involve the use of structures such as tubes and anti-predator netting. Mussels may be cultivated by attaching mussel brood stock or seed to ropes, which are suspended in the water column from a floating raft. Mussels may also be grown on ropes attached to pilings (bouchots) (McKindsey et al. 2011), or in cages, trays, or racks. Mussels may also be cultivated through on-bottom or off-bottom culture methods (NRC 2010). For example, mussels may be grown on ropes suspended in the water column from a raft, or via bottom culture. Scallops may be attached to ropes via monofilament lines tied through a small hole drilled into the shell (Robinson et al. 2016), a technique called “ear hanging.”

The installation and use of structures such as racks, cages, bags, lines, nets, and tubes, in navigable waters for commercial bivalve shellfish mariculture activities in navigable waters requires DA authorization under Section 10 of the Rivers and Harbors Act of 1899. Department of the Army authorization is required under Section 10 of the Rivers and Harbors Act of 1899 for all structures and/or work in or affecting navigable waters of the United States, except for activities identified in section 322.4 of the Corps’ section 10 regulations (see 33 CFR 322.3). The exceptions in section 322.4 are limited to: (a) activities that were commenced or completed shoreward of established federal harbor lines before May 27, 1970; and (b) wharves and piers construct in any waterbody, located entirely within one state where the waterbody is a navigable water of the United States solely on the basis of its historical use to transport interstate commerce. None of these exceptions apply to structures or work for commercial shellfish mariculture activities. In the Corps’ section 10 regulations, there is no de minimis exception from the requirement to obtain DA authorization for structures and work in navigable waters of the United States. Any structure or work that alters or obstructs navigable waters of the United States requires section 10 authorization from the Corps. With respect to structures used for shellfish mariculture activities, those structures require section 10 authorization because they alter navigable waters of the United States even though there might be circumstances where they might not obstruct navigation.

Commercial shellfish mariculture structures may be floating or suspended in

navigable waters, placed on the bottom of the waterbody, or installed in the substrate of the waterbody. The placement of mariculture structures in the water column or on the bottom of a waterbody does not result in a discharge of dredged or fill material that is regulated under section 404 of the Clean Water Act. While the presence of these structures in a waterbody may alter water movement and cause sediment to fall out of suspension onto the bottom of the waterbody, that sediment deposition is not considered a discharge of dredged or fill material because those sediments were not discharged from a point source. In general, the placement of bivalve shellfish mariculture structures on the bottom of a navigable waterbody, or into the substrate of a navigable waterbody does not result in discharges of dredged or fill material into waters of the United States that are regulated under Section 404 of the Clean Water Act.

The Corps' section 10 regulations define the term "work" as including, "without limitation, any dredging or disposal of dredged material, excavation, filling, or other modification of a navigable water of the United States." [33 CFR 322.2(c)] Under this NWP, the section 10 authorization applies to discharges of dredged or fill material into waters of the United States that are also navigable waters under Section 10 of the Rivers and Harbors Act of 1899. Commercial shellfish mariculture activities often involve work that requires authorization under Section 10 of the Rivers and Harbors Act, such as harvesting and bed preparation activities. Bed preparation activities may include tilling or harrowing activities, or the placement of shell or gravel to provide substrate suitable for the establishment and growth of bivalves via bottom culture.

Commercial shellfish mariculture activities that only require authorization under Section 10 of the Rivers and Harbors Act of 1899 are evaluated under the Corps' public interest review process at 33 CFR 320.4. The Clean Water Act Section 404(b)(1) Guidelines issued by the U.S. EPA do not apply to activities authorized by the Corps under its section 10 authority because those guidelines only apply to activities that require authorization under Section 404 of the Clean Water Act. The 404(b)(1) Guidelines do not apply to section 10 activities that may directly or indirectly impact special aquatic sites such as vegetated shallows (i.e., submerged aquatic vegetation).

Section 101(a)(2) of the Clean Water Act states that "it is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983." [33 USC 1251(a)(2)] In other words, one of the goals of the Clean Water Act is to promote water quality that supports the propagation of fish and shellfish, in addition to other uses of waters of the United States.

The Clean Water Act regulates discharges of pollutants into waters of the United States. See 33 USC 1311(a). Section 502(6) of the Clean Water Act defines the term "pollutant" as meaning "dredged spoil, solid waste, incinerator residue,

sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water." Section 502(12) of the Clean Water Act defines the terms "discharge of a pollutant" and "discharge of pollutants" as meaning: any addition of any pollutant to navigable waters from any point source, or any addition of any pollutant to the waters of the contiguous zone or the ocean from any point source other than a vessel or other floating craft.

Point source discharges of pollutants are regulated under Sections 402 and 404 of the Clean Water Act. Under Section 402 of the Clean Water Act, the U.S. EPA authorized state agencies to regulate a variety of pollutants that may be discharged into waters of the United States via a point source. Under Section 404 of the Clean Water Act, the Corps regulates discharges of dredged or fill material into waters of the United States. Discharges of dredged or fill material into waters of the United States that require section 404 permits must comply with the Clean Water Act section 404(b)(1) Guidelines issued by the U.S. EPA at 40 CFR part 230.

The term "pollutant" does not include the placement of shellfish seed or bivalves at various stages of growth into jurisdictional waters, or the waste products (e.g., feces or pseudofeces, ammonium) excreted by bivalves. In *Association to Protect Hammersley, Eld, and Totten Inlets v. Taylor Res., Inc.*, 299 F.3d 1007 (9th Cir. 2002), the court concluded that Congress did not intend that living bivalves and the natural chemicals and particulate biological matter they release through normal physiological processes, or the shells that might be separated from living bivalves from time to time, be considered pollutants under the Clean Water Act. In other words, bivalve shells and natural waste products excreted by living bivalves are not "biological materials" under the Clean Water Act's definition of "pollutant" because shells and natural waste products come from the natural growth and development of bivalves and not from a transformative human process.

The EPA's National Summary of State Information, water quality assessment and total maximum daily load (TMDL) information1, provides information on the causes of impairment and probable sources of impairment for the Nation's waters, including bays, estuaries, coastal shorelines, ocean waters, and near coastal waters where commercial shellfish mariculture activities may occur. Twenty-eight causes of impairment were identified for bays and estuaries. The top 10 causes of impairment for bays and estuaries are: polychlorinated biphenyls, nutrients, mercury, turbidity, dioxins, toxic organics, metals (other than mercury), pesticides, pathogens, and organic enrichment/oxygen depletion. For bays and estuaries, the top 10 sources of impairment for bay and estuaries are: legacy/historic pollutants, urban-related runoff/stormwater, unknown sources, atmospheric deposition, municipal discharges/sewage, unspecific non-point sources, other sources, natural/wildlife, agriculture, and industrial.

---

1 https://iaspub.epa.gov/waters10/attains_nation_cy.control (accessed November 27, 2020)

Coastal shorelines were impaired by 16 identified causes, the top 10 of which are: mercury, pathogens, turbidity, organic enrichment/oxygen depletion, pH/acidity/caustic conditions, nutrients, oil and grease, temperature, cause unknown – impaired biota, and algal growth. The top 10 sources of impairment of coastal shorelines are municipal discharges/sewage, urban-related runoff/stormwater, "unknown," recreational boating and marinas, hydromodification, industrial, unspecified non-point source, agriculture, legacy/historic pollutants, and land application/waste sites/tanks.

Ocean and near coastal waters were impaired by 17 identified causes, the top 10 of which are: mercury, organic enrichment/oxygen depletion, pathogens, metals (other than mercury), pesticides, turbidity, nuisance exotic species, total toxics, pH/acidity/caustic conditions, and polychlorinated biphenyls. The top 10 sources of impairment of ocean and near coastal waters are: atmospheric deposition, unknown sources, unspecified non-point sources, other sources, recreation and tourism (non-boating), recreational boating and marinas, urban-related runoff/stormwater, hydromodification, municipal discharges/sewage, and construction.

None of the top 10 sources of impairment of these categories of waters are directly related to commercial shellfish mariculture activities. Commercial shellfish mariculture activities require clean water to produce bivalve shellfish for human consumption. Further, the ability of bivalves to improve water quality is well understood and their presence in an aquatic ecosystem is considered to be beneficial (e.g., NRC 2010).

Mariculture activities can be classified as extensive or intensive. For extensive mariculture, young organisms are allowed to grow naturally using resources (food, inorganic nutrients) available in marine and estuarine waters until they are harvested (Diana et al. 2009). In intensive mariculture, the young organisms are provided feed to promote their growth before they are harvested. Bivalve shellfish mariculture and seaweed mariculture are examples of extensive mariculture, and for such activities there is no addition of materials (e.g., nutrients) through a point source that might trigger a permit requirement. However, in some cases a pesticide might be applied in waters where bivalve shellfish mariculture occurs (NRC 2010, Simenstad and Fresh 1995). The application of pesticides is not regulated by the Corps under Section 404 of the Clean Water Act, but it may be regulated by EPA or approved states under Section 402 of the Clean Water Act. As discussed in the previous paragraph, the bivalves themselves that are seeded in the waterbody, or are added to the waterbody after a limited grow out period in a nursery facility located on-shore or elsewhere, does not trigger a permit requirement the Clean Water Act because those living organisms are not considered to be pollutants under the Act.

Nationwide permit 48 also authorizes discharges of dredged or fill material into waters of the United States. The Corps' regulations define "dredged material" as "material that is excavated or dredged from waters of the United States." [33 CFR

323.2(c)] The term “discharge of dredged material” is defined at 33 CFR 323.2(d)(1) as meaning “any addition of dredged material into, including redeposit of dredged material other than incidental fallback within, the waters of the United States.” The term “discharge of dredged material” includes, but is not limited to: (1) the addition of dredged material to a specified discharge site located in waters of the United States; (2) the runoff or overflow from a contained land or water disposal area; and (3) any addition, including redeposit other than incidental fallback, of dredged material, including excavated material, into waters of the United States which is incidental to any activity, including mechanized landclearing, ditching, channelization, or other excavation. [33 CFR 323.2(d)(1)] Some activities associated with commercial shellfish mariculture may result in a discharge of dredged material under the third instance identified above (i.e., redeposit of dredged material other than incidental fallback).

Some commercial shellfish mariculture activities involve mechanical or hydraulic harvesting techniques that may or may not result in discharges of dredged material that require authorization under Section 404 of the Clean Water Act. If the bivalve harvesting activity would result in only incidental fallback of dredged material into the waterbody, a section 404 permit would not be required. (However, a section 10 permit would be required as “work” in navigable waters). A section 404 permit would be required for a mechanical or hydraulic harvesting activity if that activity results in a regulated discharge of dredged material by having more than incidental fallback. Some harvesting activities associated with commercial shellfish mariculture operations may result in the redeposit of dredged material other than incidental fallback within the waters of the United States. For example, dredge harvesting activities may remove sediment along with the bivalves. If the removed sediment is deposited back into the waterbody in a different location, and is more than incidental fallback, then the harvesting activity may be determined by the district engineer to result in a discharge of dredged material that requires section 404 authorization. On the other hand, if the sediment removed while harvesting the bivalves is redeposited in the same location, then it may be considered to be incidental fallback, and not require section 404 authorization.

The Corps’ regulations at 33 CFR 323.2(e)(1) define “fill material” as meaning “material placed in waters of the United States where the material has the effect of: (1) replacing any portion of a water of the United States with dry land; or (2) changing the bottom elevation of any portion of a water of the United States. Examples of fill material include: “rock, sand, soil, clay, plastics, construction debris, wood chips, overburden from mining or other excavation activities, and materials used to create any structure or infrastructure in the waters of the United States.” [33 CFR 323.2(e)(2)] “Fill material” does not include trash or garbage (see 33 CFR 323.2(e)(3)). Discharges of trash or garbage may be regulated under other federal, state, or local laws and regulations. Fill material does not include the placement or release of living organisms, such as bivalve larvae and juvenile bivalves, into waters of the United States.

The term “shellfish seeding” is defined in Section E of the NWPs as the “placement of shellfish seed and/or suitable substrate to increase shellfish production. Bivalve shellfish seed consists of immature individual shellfish or individual shellfish attached to shells or shell fragments (i.e., spat on shell). Suitable substrate may consist of shellfish shells, shell fragments, or other appropriate materials placed into waters for shellfish habitat.” This definition was adopted in the NWPs in 2007 (see 72 FR 11197). Other materials may be used for bivalve shellfish seeding such as nets, bags, and ropes. Shellfish seed can be produced in a hatchery. Shellfish seed can also be produced in waterbodies where bivalve larvae can attach to appropriate materials, such as shell pieces, bags, or ropes.

Placing shellfish seed on the bottom of a waterbody is not a “discharge of fill material” and thus does not require a section 404 permit. Placing gravel or shell on the bottom of a waterbody to provide suitable substrate for bivalve larvae to attach to is considered to be a “discharge of fill material” and would require section 404 authorization. The shellfish themselves, either growing on the bottom of a waterbody or in nets, bags, or on ropes, are not considered to be “fill material” and do not require a section 404 permit to be emplaced, remain in place, or to be removed from a waterbody.

On-bottom bivalve shellfish mariculture activities may involve placing fill material such as shell or gravel to provide suitable substrate for bivalve larvae to attach to and grow on the bottom of the waterbody. These fill activities may require section 404 authorization. The placement of structures that are used for commercial shellfish mariculture activities, such as cages, bags, racks, tubes, and netting, does not result in discharges of dredged or fill material into waters of the United States and therefore do not require authorization under Section 404 of the Clean Water Act. As discussed above, the placement of cages, bags, racks, tubes, lines, and netting and other structures in navigable waters of the United States for the purposes of commercial shellfish mariculture activities is regulated under Section 10 of the Rivers and Harbors Act of 1899 because they can be potential obstructions to navigation.

In the 2020 Proposal, the Corps proposed to remove the 1/2-acre limit for new commercial shellfish mariculture activities that directly affect submerged aquatic vegetation. The Corps also proposed to remove the definition of “new commercial shellfish mariculture activities.”

Many commenters said that the 1/2-acre limit for direct impacts to submerged aquatic vegetation for new commercial shellfish mariculture activities should be retained because removal of the 1/2-acre could cause significant and permanent losses of submerged aquatic vegetation. One commenter said that allowing new commercial shellfish mariculture activities to directly affect more than 1/2-acre of submerged aquatic vegetation would result in more than minimal adverse environmental effects. A couple of commenters stated that the removal of the 1/2-acre limit for impacts to submerged aquatic vegetation conflicts with submerged

aquatic vegetation goals and restoration efforts in different states. These commenters said that many federal, state, and local agencies are working throughout the country to recover lost submerged aquatic vegetation habitat in support of water quality and ecosystem goals. Removal of the 1/2-acre limit would undermine the investments and progress made to date to recover these important habitats.

The Corps is removing the 1/2-acre limit for new commercial shellfish mariculture activities that directly affect submerged aquatic vegetation in the project area. In place of the 1/2-acre limit, the Corps is substituting a PCN requirement for new and existing commercial shellfish mariculture activities that directly affect more than 1/2-acre of submerged aquatic vegetation. This new PCN requirement accompanies the removal of the definition of “new commercial shellfish aquaculture operation” and will provide activity-specific review of all commercial shellfish mariculture activities that directly affect more than 1/2-acre of submerged aquatic vegetation. In response to a PCN, the district engineer can add conditions to the NWP authorization to require mitigation, such as best management practices or other mitigation measures, to ensure that the individual and cumulative adverse environmental effects are no more than minimal.

Under the 2017 NWP 48, the 1/2-acre limit only applied to new commercial shellfish mariculture activities. After a new commercial shellfish mariculture activities was authorized by the Corps, the 1/2-acre limit no longer applied to the existing commercial shellfish mariculture activity. In this regard, it was less protective than the NWP 48 in this final rule, which would apply a PCN requirement to existing operations seeking reauthorization. The removal of the 1/2-acre limit in this final rule does not affect the authority of other federal agencies or tribal, state, or local governments to adopt and implement protection programs for submerged aquatic vegetation under their authorities.

Submerged aquatic vegetation does not have any special status under the Corps’ regulations for implementing Section 10 of the Rivers and Harbors Act of 1899, which is the statute that applies to most commercial shellfish mariculture activities. Submerged aquatic vegetation is covered by a number of the Corps’ public interest review factors such as conservation, general environmental conditions, fish and wildlife values, and wetlands. While vegetated shallows are special aquatic sites under the Clean Water Act Section 404(b)(1) Guidelines, the Guidelines do not prohibit discharges of dredged or fill material into vegetated shallows. A smaller proportion of commercial shellfish mariculture activities trigger the permit requirements of Section 404 of the Clean Water Act because many commercial shellfish mariculture activities do not involve discharges of dredged or fill material into waters of the United States. Impacts to submerged aquatic vegetation caused by commercial shellfish mariculture activities may also be addressed through Endangered Species Act Section 7 consultations for proposed NWP 48 activities that district engineers determine “may affect” listed species or designated critical habitat, including critical habitat for which submerged aquatic vegetation is a

physical or biological feature. Impacts to submerged aquatic vegetation may also be addressed through the essential fish habitat consultation process when the district engineer determines a proposed NWP 48 activity may adversely affect essential fish habitat, which may include submerged aquatic vegetation beds.

Several commenters recommended that the Corps propose a revised threshold for seagrass impacts based on biological reference points. These commenters said that this is particularly important in regions where additional provisions to protect seagrasses are not in place and state laws do not impose additional restrictions on eelgrass. One commenter stated that the Corps seeks to remove an impact limitation that would otherwise incentivize responsible siting of mariculture operations and minimization of impacts to submerged aquatic vegetation.

The Corps declines to impose an additional threshold for seagrass impacts based on biological reference points because it would be impractical to establish such biological reference points at a national level for activities requiring authorization under section 10 of the Rivers and Harbors Act of 1899 and section 404 of the Clean Water Act. The threshold to require a PCN for new and existing commercial mariculture operations that impact more than 1/2-acre of submerged aquatic vegetation is sufficient for the purposes of ensuring that a project will have no more than a minimal individual or cumulative adverse environmental impact. If a state decides not to take measures to regulate activities in submerged aquatic vegetation within its own waters, it does not create a legal or regulatory requirement for the Corps to address such situations. The requirements of NWP 48 will continue to provide incentives for commercial shellfish mariculture operators to plan and design their activities to qualify for NWP authorization. As discussed above there are other applicable laws that can address impacts to submerged aquatic vegetation in conjunction with the Corps' NWP authorization. In addition, where necessary based on the characteristics of the regional ecosystem, division engineers can add regional conditions to NWP 48 to help ensure that activities authorized by this NWP result in no more than minimal individual and cumulative adverse environmental effects.

Several commenters supported removing the 2017 definition of "new operation" as it is not relevant to a specific date or timeline. One commenter stated that the Corps has not been able to justify why one set of rules should apply to existing commercial shellfish mariculture operators and another set of rules should apply to everyone else, including new commercial shellfish mariculture operators. This commenter said that if there is a conservation justification for protecting eelgrass and other submerged aquatic vegetation, then limitations on impacts to submerged aquatic vegetation should apply to everyone. One commenter said that removal of this definition failed to identify what it would be replaced with and stated that there needs a definition for new commercial shellfish mariculture activities but it must not conflict with tribal treaty reserved rights to take shellfish.

The Corps has removed the definition of "new commercial shellfish aquaculture

operation" from this NWP. The new 1/2-acre PCN threshold will apply to both new and existing commercial shellfish mariculture activities. All activities authorized by NWP 48 must comply with general condition 17, tribal rights.

One commenter said that the removing the distinction for new operations, with the 1/2-acre limit, will result in more impacts. This commenter asserted that the Corps does little to justify the proposed removal of the 1/2-acre limit, given that it added this limit three years ago to ensure impacts from NWP 48 would be no more than minimal. One commenter recommended adding the following definition for an ongoing or existing activity: existing commercial shellfish aquaculture should be defined as the area under cultivation when NWP 48 was first issued in 2007 or where an operator can document that an area is part of a regular rotation of cultivation.

The 1/2-acre limit for new commercial shellfish mariculture activities was added to NWP 48 in 2012 (see 77 FR 10280). The 1/2-acre limit only applied to new commercial shellfish activities, and does not apply when those on-going activities are authorized when NWP 48 is reissued after the current NWP expires. There is no need to add a definition of on-going commercial shellfish mariculture activities, because both new and existing activities are treated the same under this reissued NWP.

One commenter stated that the Corps should identify a clear spatial delineation of what constitutes a waterbody to aid in decision-making and allow the public to determine the scope of this action. One commenter noted that the provision for "project area" could be subject to two differing interpretations. First, it could refer to that area where some entity or agreement specifically authorizes the operator to conduct commercial shellfish aquaculture. Second, it could be read as being that area where a legally binding agreement establishes an enforceable property interest for the operator. This commenter recommended revising the term "project area" to read as follows: "The project area is an area in which the operator conducts commercial shellfish aquaculture activities, as authorized by a lease or permit or other legally binding agreement."

The geographic scope for an NWP 48 activity is the project area, and the term project area is defined in the text of the NWP. The Corps did not change the definition of project area, and it covers both situations identified by the commenter. It is not necessary to and the Corps declines to define, at a national level, what constitutes a waterbody for the purposes of NWP 48. District engineers can identify the geographic extent of waterbodies for the purposes of NWP 48 activities.

In the 2020 Proposal, the Corps proposed to remove the pre-construction notification thresholds for this NWP because most of the direct and indirect impacts caused by the activities authorized by this NWP under its permitting authorities (i.e., Section 10 of the Rivers and Harbors Act of 1899 and, when applicable, Section of the Clean Water Act) are temporary impacts. As discussed in the proposed rule,

NWP 48 activities may require PCNs because of the requirements of paragraph (c) of NWP general condition 18, endangered species. Under paragraph (c) of general condition 18, pre-construction notification is required for non-federal permittees when any listed species or designated critical habitat might be affected by the proposed NWP activity or is in the vicinity of the proposed NWP activity, or if the proposed NWP activity is located in designated critical habitat. In some areas of the country, commercial shellfish mariculture activities are located in waters inhabited by listed species and designated critical habitat. Division engineers may also add regional conditions to this NWP to require PCNs for some or all proposed NWP 48 activities.

Several commenters expressed concern of the removal of the PCN thresholds for new or existing shellfish mariculture activities. These commenters said the removal of the PCN thresholds will result in fewer chances to account for regional differences in submerged aquatic vegetation communities and it will make tracking of individual and cumulative environmental impacts more difficult. One commenter said that the Corps should require PCNs for all shellfish cultivation operations across the country and evaluate sediment enrichment at individual cultivation sites.

After evaluating the comments received in response to the proposed changes to the notification requirements of this NWP, the Corps determined that pre-construction notification should be required for proposed activities that directly affect more than 1/2-acre of submerged aquatic vegetation. The Corps has added a new PCN requirement to NWP 48 to require pre-construction notification for all NWP 48 activities that directly affect more than 1/2-acre of submerged aquatic vegetation. The new PCN threshold will provide district engineers the opportunity to review all new and existing commercial shellfish mariculture activities that directly affect more than 1/2-acre of submerged aquatic vegetation. The Corps does not agree that PCNs should be required for all shellfish mariculture activities because of potential impacts caused by temporary suspension of sediment during harvesting activities or discharges of dredged material that may occur during dredge harvesting activities utilizing hydraulic dredging equipment. The impacts caused by the suspended sediment or discharged sediment are temporary because the sediment will settle to the bottom of the waterbody after a period of time. That period of time may depend on local currents and other factors but is generally understood to be relatively short (Newell et al. 1998) and not ecologically relevant, especially in shallow waters where wave actions frequently cause sediment to be suspended in the water column.

Direct effects of commercial shellfish mariculture activities on submerged aquatic vegetation include the placement of structures such as racks, bags, and cages on the bottom of a waterbody inhabited by submerged aquatic vegetation. Direct effects of commercial shellfish mariculture activities also include harvesting activities, including mechanical and hydraulic dredging and harvesting by hand. Shading of submerged aquatic vegetation by off-bottom bivalve mariculture structures, such as floating racks, bags, and cages, is an indirect effect that would

not trigger this PCN requirement. Changes in water flows caused by the use of long lines for bivalve mariculture cultivation, where slowed water flows cause sediment to fall out of suspension and accumulate on the bottom of the waterbody is another example of a potential indirect effect that would not trigger this PCN requirement. These direct and indirect effects would be caused by structures or work regulated under Section 10 of the Rivers and Harbors Act of 1899.

Direct effects also include discharges of dredged or fill material on the bottom of a waterbody inhabited by submerged aquatic vegetation for on-bottom culture methods, such as the placement of shell or gravel to provide substrate for the bivalves to attach to and grow. Discharges of dredged or fill material into waters of the United States may smother submerged aquatic vegetation, which is a direct effect of those activities. During harvesting activities that include regulated discharges of dredged or fill material, there are likely to be direct effects to submerged aquatic vegetation if those activities occur in seagrass beds. These direct effects would trigger the PCN requirement if they directly affect more than 1/2-acre of submerged aquatic vegetation An example of an indirect effect that might be caused by a discharge of dredged or fill material into waters of the United States for commercial shellfish mariculture activities might be a turbidity plume that reaches areas beyond the discharge site, as suspended sediment is transported by water currents away from that discharge site. This indirect effect would not trigger the PCN requirement.

This pre-construction notification requirement will provide district engineers the opportunity to evaluate each proposed activity that will directly affect more than 1/2-acre of submerged aquatic vegetation and determine whether that activity qualifies for NWP 48 authorization. In response to a pre-construction notification, the district engineer may require mitigation (e.g., on-site avoidance and minimization) to ensure that the authorized activity complies with the no more than minimal adverse environmental effects requirement for the NWPs (see paragraph (a) of NWP general condition 23, mitigation).

The Corps has removed the additional information requirements for PCNs from the text of NWP 48 because the information requirements of NWP general condition 32 cover the information needed for this new PCN requirement. The information requirements for NWP PCNs are listed in paragraph (b) of NWP general condition 32, pre-construction notification. Paragraph (b)(5) of NWP general condition 32 requires the PCN to include a delineation of wetlands, other special aquatic sites (including vegetated shallows, or submerged aquatic vegetation), and other waters.

One commenter supported the removal of the PCN requirements because in many instances bivalve populations have been overharvested or in some cases attacked by diseases or poor water quality. This commenter said that regulation of these activities should not impede the ability to reinvigorate these species and growing them for food production. One commenter supported of removal of the PCN threshold for commercial shellfish mariculture for activities that include a species

that has never been cultivated in the waterbody as long as the NWP continues to prohibit the cultivation of a nonindigenous species unless that species has been previously cultivated in the waterbody, and prohibit the cultivation of an aquatic nuisance species as defined in the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990. One commenter said that state natural resource agencies should be notified for NWP 48 activities that seek to stock a species that has never been cultivated in a waterbody, and applicable state permits be obtained before the NWP 48 authorization becomes effective for a particular commercial shellfish mariculture activity.

The addition of the PCN requirement for commercial shellfish mariculture activities that directly affect more than 1/2-acre of submerged aquatic vegetation should not pose impediments on food production or efforts to reinvigorate these species in waters whether they have been overharvested. The Corps has also removed the PCN threshold for indigenous species that have never been cultivated in the waterbody. While the Corps has removed the PCN threshold, it has modified the NWP to prohibit the cultivation of a nonindigenous species unless that species has been previously cultivated in the waterbody. State natural resources agencies can reach out to Corps districts to request coordination on proposals to cultivate indigenous species that have never been cultivated in the waterbody.

Several commenters stated the PCN requirements should not be removed because tribes require notice and collaboration with the Corps in order to protect their treaty fishing rights. These commenters said that even temporary impacts to eelgrass could result in consequences to tribe's treaty-reserved fish populations and the habitat they rely on. In addition, these commenters stated that removal of the PCN thresholds poses significant problems to assuring protection of salmon, nearshore habitat, and treaty shellfish gathering rights. One commenter recommended adding a PCN requirement for all activities within the U.S. v. Washington (Boldt) case area.

During the process for issuing and reissuing these NWPs, Corps districts have been consulting and coordinating with tribes. Corps districts and tribes can establish coordination procedures to help ensure that NWP 48 activities comply with general condition 17, tribal rights. Division engineers can also add regional conditions to this NWP, where appropriate based on the characteristics of the regional ecosystem, to ensure that the activities authorized by this NWP cause no more than minimal adverse environmental effects to specific resources, including tribal trust resources.

One commenter expressed support for the proposed reissuance of NWP 48. One commenter expressed support for the reissuance of NWP 48 because this NWP could significantly reduce the barriers to entry for emerging mariculture industries, and reduce the timeframes and costs associated with obtaining DA authorization for such activities. One commenter said that the conditions in the text of NWP 48 and NWP A should be consistent and preferably combined into one NWP for cultivating shellfish and seaweeds. One commenter stated that small businesses are supportive of the proposed changes to NWP 48, but acknowledged that there may

be unfavorable litigation outcomes if the changes are finalized. However, these businesses are concerned that small businesses nationwide could be subject to unfavorable litigation outcomes where the environmental analysis and justification for this rulemaking is not sound.

Nationwide permit 48 provides a streamlined authorization process for commercial shellfish mariculture activities that result in no more than minimal adverse environmental effects, and should help reduce regulatory burdens for the mariculture industry. The text of NWPs 48 and A (now designated as NWP 55) has some similarities, as well as some differences. Some of those differences are due to NWP 55 activities potentially occurring in a broader range of waters, including deeper coastal waters more distance from the shoreline and federal waters over the outer continental shelf. Commercial shellfish mariculture activities typically occur in coastal waters new the shoreline. The national decision document for this NWP has been revised to address the 2019 decision of the United States District Court, Western District of Washington at Seattle in the *Coalition to Protect Puget Sound Habitat v. U.S. Army Corps of Engineers et al.* (Case No. C16-0950RSL) and *Center for Food Safety v. U.S. Army Corps of Engineers et al.* (Case No. C17-1209RSL),

Several commenters stated that the Corps should not reissue NWP 48, and if the Corps decides to reissue NWP 48 it should improve its review of PCNs and require documentation of compliance with specific design and operational standards. A few commenters said that the Corps should not reissue NWP 48 as proposed for the same reasons that NWP was found by the United States District Court, Western District of Washington at Seattle to be in non-compliance with National Environmental Policy Act and the Clean Water Act. One commenter said that regional general permits should be issued in Washington State, for specific water bodies and for particular types of shellfish aquaculture.

Nationwide permit 48 authorizes a variety of commercial shellfish mariculture activities under Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act, and a number of different structures can be used to cultivate bivalve molluscs. Project proponents are responsible for designing their projects and for those activities that require pre-construction notification, district engineers evaluate the direct, indirect, and cumulative adverse environmental effects caused by the proposed NWP activity. In the national decision document, the Corps has revised its NEPA analysis and its Clean Water Act Section 404(b)(1) Guidelines analysis. Regional general permits can be issued by district engineers to authorize these activities. Regional general permits can be effective in addressing regional approaches to commercial shellfish mariculture activities and the potential adverse environmental effects those activities may cause.

One commenter noted that a lack of clarity in the proposed rule may lead to permitting delays and uncertainty, both of which have negative effects on small businesses. A couple commenters said that with regards to shellfish mariculture

there needs to be more support from all levels of government to consider first and foremost a food production activity now and in the future to address our seafood deficit and food security for our nation. One commenter recommended that the Corps utilize information in Endangered Species Act and essential fish habitat consultation documents issued in Washington State to support the reissuance of NWP and address environmental issues of concern under the Clean Water Act, the Rivers and Harbors Act of 1899, and the National Environmental Policy Act.

The reissued NWP 48 will provide a streamlined authorization process for commercial shellfish mariculture activities that cause no more than minimal individual and cumulative adverse environmental effects. Commercial shellfish mariculture activities may also be regulated by tribal, state, and local governments. The consultation documents issued by the U.S. FWS and NMFS in Washington State are applicable only to Washington State, and this NWP authorizes commercial shellfish mariculture activities across the country.

One commenter observed that at the national level, Congress passed the National Aquaculture Act of 1980 in response to findings that the nation has potential for significant aquaculture growth, but that this growth is inhibited by many scientific, economic, legal, and production factors. In support of the proposed reissuance of NWP 48, one commenter cited the National Shellfish Initiative's goal of increasing populations of bivalve shellfish in our nation's coastal waters—including oysters, clams, and mussels—through commercial production and conservation activities. One commenter stated that the NWP 48 should require notification to the U.S. Coast Guard.

The reissuance of NWP 48 helps support the growth of the aquaculture industry in the United States by reducing regulatory burdens on growers and providing a streamlined authorization process under Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act. The activities authorized by this NWP will also help increase the numbers of bivalves in the Nation's coastal waters, and the ecological functions and services those bivalve molluscs provide, especially in coast waters where bivalve shellfish populations have significantly declined as a result of overharvesting. The project proponent is responsible for securing any licenses or permits from the U.S. Coast Guard, and complying with U.S. Coast Guard requirements that may apply to structures used for commercial shellfish mariculture activities.

Several commenters supported changing the name of NWP 48 from "commercial shellfish aquaculture activities" to "commercial shellfish mariculture activities." One commenter suggested adding modifying terms to "aquaculture" such as "marine," "coastal marine," or "offshore" to improve specificity and clarity. One commenter suggested clarifying that the terms "mariculture" and "aquaculture" can be used interchangeably. A couple of commenters objected to changing "aquaculture" to "mariculture" in the title and text of NWP 48. They suggested using the term "marine aquaculture" to more closely align with the terms used by industry. One said that

using the term “mariculture” may result in an unintended consequence of confusing or invalidating local and regional policy and regulations. One commenter stated the term “commercial shellfish aquaculture” is not defined and recommended defining that term in a manner that does not conflict with tribes’ treaty-secured rights to take shellfish. One commenter stated that term “shellfish” is not explicitly defined, and recommended adding a definition to clarify whether that term includes lobsters and conches or only bivalves.

The Corps is retaining the use of the term “mariculture” in this NWP. Use of the term “mariculture” in NWP 48, as well as NWPs 55 and 56, will not invalidate any local or regional policies or regulations. The use of the term mariculture is intended to provide clarity, to ensure that project proponents do not attempt to use NWP 48 to authorize the production of other species considered to be “shellfish” (e.g., shrimp, crawfish) in land-based facilities and ponds. The term “mariculture” refers to the cultivation of species for food production, and should not interfere with a tribe’s taking of shellfish from coastal waters. The Corps has modified the first paragraph of this NWP to clarify that the term “shellfish” refers to bivalve molluscs such as oysters, clams, mussels, and scallops.

Several commenters said that the Corps’ proposal fails to properly consider that the impacts authorized by NWP 48 violate the Clean Water Act and the Endangered Species Act. These commenters stated that the impacts of commercial shellfish mariculture activities should be evaluated through environmental impact statements and through formal programmatic ESA consultations. One commenter stated that the Corps has failed to provide adequate documentary support or substantive evidence for its conclusions that permit terms and conditions would be sufficient to ensure that environmental effects would be minimal and not significant. One commenter asserted that the proposed NWP 48 violates the Section 404(e) of the Clean Water Act because it allows unlimited impacts.

Activities authorized by NWP 48 must comply with general condition 18, endangered species. Some Corps districts have developed programmatic ESA section 7 consultations that cover commercial shellfish mariculture activities. Activities authorized by NWP 48 do not require additional NEPA compliance, since the Corps fulfills the requirements of NEPA when it issues its national decision document for the reissuance of that NWP, because that decision document includes and environmental assessment with a finding of no significant impact. Section 404(e) of the Clean Water Act does not require NWPs to have quantified acreage or other limits to ensure that authorized activities result in no more than minimal individual and cumulative adverse effects. Commenters have not provided any substantive evidence to support their opinions that all activities authorized by NWP 48 result in more than minimal adverse environmental effects and should not be authorized by an NWP. The Corps has issued a number of NWPs that do not have quantitative limits, such as NWP 27 (Aquatic Habitat Restoration, Enhancement, and Establishment Activities), NWP 31 (Maintenance of Existing Flood Control Facilities), and NWP 38 (Cleanup of Hazardous and Toxic Waste).

Several commenters said that NWP 48 activities contribute to degradation of waters of the United States by adversely affecting water quality, eelgrass, salmon, birds, herring, and flatfish and causing adverse effects from the introduction of plastics. One commenter recommended prohibiting commercial shellfish mariculture activities in or near marine protected areas or sensitive areas, such as essential fish habitat. This commenter said that the NWP should prohibit the use of plastic equipment or inputs such as pesticides, herbicides, or pharmaceuticals. This commenter also said that NWP 48 activities should require extensive documentation of compliance with design and operation standards, with routine reporting. In addition, this commenter stated that permitted activities should incorporate more rigorous operation, emergency response, and pollution standards, with swift and severe consequences for non-compliance, including revocation of permits.

The potential environmental effects caused by commercial shellfish mariculture activities are discussed in the national decision document for NWP 48. The Corps acknowledges that commercial shellfish mariculture activities may have negative, positive, and neutral effects on various environmental components, including various species. It is generally understood that the presence of bivalves in an aquatic ecosystem is beneficial. Some commenters point out various adverse environmental effects caused by commercial shellfish mariculture activities, but other acknowledge the studies and observations that identify beneficial environmental effects caused by commercial shellfish mariculture activities. If a proposed commercial shellfish mariculture activity may adversely affect essential fish habitat as a result of activity subject to the Corps' legal authority, the district engineer will conduct essential fish habitat consultation with the NMFS, and incorporate as appropriate, essential fish habitat conservation recommendations into the NWP authorization as permit conditions.

The Corps does not have the legal authority to regulate the use of pesticides, herbicides, or pharmaceuticals that may be associated with commercial shellfish mariculture activities. General condition 6 requires the use of suitable material for activities authorized by NWPs. Plastics materials may be used for commercial shellfish mariculture activities and it is the responsibility of the permittee to ensure that structures that may be made with plastics (e.g., tubes for geoducks, anti-predator netting) are properly maintained (see general condition 14). The Corps has no authority to regulate plastics that may wash away from a commercial shellfish mariculture activity. The Corps does not regulate the placement of trash or garbage into waters of the United States (see 33 CFR 323.2(e)(3)). Section 13 of the Rivers and Harbors Act of 1899 (i.e., the Refuse Act) has been superseded by Section 402 of the Clean Water Act (see 33 CFR 320.2(d)).

One commenter requested that the Corps change NWP 48 to remove any unintended competitive edge for wild harvest fisheries, both in terms of allowable gear and harvesting requirements. One commenter stated that they investigated

direct and indirect effects of individual bottom cages on eelgrass, and found that at the current level of mariculture activity, short-term cultivation of oysters has a minimal effect on eelgrass growth, water quality, and sediment characteristics. However, if the cultivation activity expands in terms of gear and/or individual operations, it may result in measurable effects.

The Corps lacks the authority to prevent competition between commercial shellfish mariculture operators and fishers that harvest wild populations of bivalves. The Corps appreciates the information regarding the direct and indirect effects of bottom cages for oyster mariculture on eelgrass. The Corps is finalizing a new PCN threshold for commercial shellfish mariculture activities directly affecting more than 1/2-acre of submerged aquatic vegetation to ensure the effects noted by the commenter are evaluated by district engineers.

One commenter said that commercial shellfish mariculture activities have minimal adverse impacts, and they can have beneficial effects on habitat and water quality, and there is an extensive scientific literature that supports the identification of these benefits. This commenter discussed the structured habitat provided by commercial shellfish mariculture activities that is used by numerous species for refuge, foraging, and predator avoidance, thereby increasing species richness, abundance, and biodiversity. This commenter also said that bivalves ingest and filter suspended materials in the water column, sequestering excess nutrients as protein in their tissue. This commenter also remarked that upon harvesting these bivalve molluscs, nutrients are removed from the marine ecosystem, which improves water quality. This commenter also noted that commercial shellfish mariculture activities can also help to transfer the load of suspended materials from the water column to the benthos through a phenomenon known as benthic-pelagic coupling. In addition, this commenter said that by providing structured habitat, improving water quality, and helping to transfer the load of suspended materials from the water column to the benthos, shellfish can help mitigate adverse impacts caused by several different types of human activities and developments. This commenter stated that for these reasons, shellfish are increasingly being utilized in environmental restoration projects across the United States. The Corps acknowledges these comments on the beneficial effects of commercial shellfish mariculture activities on coastal waters. These beneficial effects have informed the Corps' decision to reissue NWP 48 as discussed because it will have no more than a minimal individual or cumulative adverse environmental effects.

One commenter said that impacts from geoduck farms are insignificant (no more than minimal) for: forage fish spawning areas; consumption of forage fish larvae; juvenile salmon; waves, currents, and sediment transport; microplastics; marine debris; impact to the benthic community; cumulative impacts; recreation and navigation; marine mammals; birds; farm preparation; predator protection netting; harvest activities; density, genetics, diseases, and parasites; and property values. This commenter remarked that the disturbances caused by commercial shellfish mariculture activities are within the range of natural variation experienced by benthic

communities in Puget Sound. This commenter also stated that differences in the structure of mobile macrofauna communities between planted areas with geoduck tubes and nets and nearby reference beaches do not persist after the geoduck tubes and nets removed during the grow-out culture phase. In addition, this commenter said that nutrients released from a typical commercial geoduck operation are low and localized effects are likely to be negligible. Finally, this commenter stated that geoduck aquaculture practices do not make culture sites unsuitable for later colonization by eelgrass. The Corps acknowledges these comments on the beneficial effects of geoduck mariculture activities on coastal waters. These beneficial effects have informed the Corps' decision to reissue NWP 48 as discussed because it will have no more than a minimal individual or cumulative adverse environmental effects.

One commenter said that commercial shellfish mariculture activities have minimal impacts on birds, including foraging, noise, and the potential for net entanglement. This commenter noted that birds forage within mariculture operations, and feed on organisms growing on mariculture equipment, and the shellfish being produced. This commenter stated that noise associated with commercial shellfish mariculture activities could result in temporary displacement of birds from the immediate area, but this is a temporary impact to overall bird populations. Lastly, this commenter asserted that while predator exclusion net entanglement is a possibility for birds, it is likely to be rare and unlikely to result in significant effects to marine bird and bald eagle populations utilizing these areas. The Corps acknowledges these comments on the effects of commercial shellfish mariculture activities on birds, which have informed the Corps' decision to reissue NWP 48 as discussed because it will have no more than a minimal individual or cumulative adverse environmental effects.

One commenter objected to a statement in the proposed rule regarding the placement of shell or gravel on the bottom of the waterbody for on-bottom cultivation of bivalves. The proposed rule stated that this is a permanent impact. This commenter said that the placement of gravel or shell on the bottom of the waterbody causes temporary changes, which is why shellfish farmers frequently need to place gravel or shell in the same area from time to time. According to this commenter, this temporary change has beneficial impacts to species presence and diversity, according to a programmatic biological opinion issued by the NMFS for commercial shellfish mariculture activities in Washington State. This commenter said that placement of shell or gravel on the bottom of the waterbody shifts the benthic community from polychaetes to amphipods and copepods, which are important prey items for juvenile salmon. This commenter requested that the Corps correct or clarify this statement to recognize that the placement of shell or gravel causes temporary, localized changes to the marine environment, and these changes are beneficial.

If the commercial shellfish mariculture operator places shell or gravel on the bottom of the waterbody, and does not remove the shell or gravel, then it is a permanent impact. When an NWP authorizes a temporary impact, the structure or fill has to be

removed after that structure or fill is no longer needed. For a temporarily filled area, after the fill is removed several NWPs require the project proponent to restore the affected area to pre-construction elevations. The Corps acknowledges that a permanent fill may have positive, negative, or neutral environmental effects. For example, the permanent fill may be dispersed by flowing water and transported in the waterbody so that it becomes part of the benthic habitat in that waterbody. That permanent fill may provide habitat for certain aquatic organisms.

Several commenters said they agreed that placing shellfish seed on the bottom of a waterbody is not a “discharge of fill material” and thus does not require a section 404 permit. Regardless of that whether the placement of shellfish seed is done for commercial aquaculture, habitat restoration, or fisheries enhancement, it should not require a section 404 permit unless there is significant placement of materials for reefs/ hummocks in quantities adequate to alter the depth profile and alter the bottom topography. Several commenters noted that while depositing shell with spat already attached is considered seed and regulated “work” under Section 10 of the Rivers and Harbors Act of 1899, the proposed NWP 48 is also defining this as fill regulated under Section 404 of the Clean Water Act. They stated that requiring section 404 authorization is an additional unnecessary burden and these activities do not result in adverse environmental impacts and in actuality have positive impacts to water quality. This method is unlike a restoration project where oyster shell is deposited in large enough quantities to create reefs and foster a permanent non-transient population. This commenter requested that the Corps make a distinction between two different activities: sparsely placing shell on the bottom of the waterbody to catch larvae and hummock building and restoration efforts.

In the 2020 Proposal, the Corps did not state that shellfish seeding activities require authorization under Section 404 of the Clean Water Act. In addition, the Corps did not state that shellfish seeding requires authorization under Section 10 of the Rivers and Harbors Act of 1899. The placement of shell in a waterbody to construct reefs or hummocks for bivalves to settle on and grow requires Clean Water Act section 404 authorization because it raises the bottom elevation of the waterbody and is a discharge of fill material, as that term is defined at 33 CFR 323.2(e). That activity also requires authorization under Section 10 of the Rivers and Harbors Act of 1899 as a structure (e.g., a reef) under 33 CFR 322.2(b) or work under 33 CFR 322.2(c).

One commenter said that placing single shellfish seeds on beds without containment structures is not regulated under Section 10 of the Rivers and Harbors Act of 1899. This commenter asserted that this activity is not subject to regulation under section 10 because it does not involve the use of structures, nor does it constitute work that alters or modifies the navigable capacity of the waters. Juvenile clams bury a few inches into the sediment and are essentially imperceptible, and single-set oysters lie on the bottom of the substrate without meaningfully altering the elevation of the seabed. This commenter said that the placement and grow-out of single set clams and oysters therefore does not require approval under Section 10 of the Rivers and Harbors Act of 1899. This commenter noted that section 10

authorization is required for activities that alter the bottom elevation of waters in a manner to impact their navigable capacity, and that shellfish seeding does not alter the bottom elevation.

In the proposed rule at 85 FR 57334, the Corps stated that on-bottom bivalve shellfish mariculture activities may involve placing fill material such as shell or gravel to provide suitable substrate for bivalve shellfish larvae to attach to and grow on the bottom of the waterbody and that these activities may require section 404 authorization. The proposed rule did not state that depositing shell with spat attached to the shell is considered fill material for the purposes of NWP 48. Discharging shell without bivalve larvae (i.e., spat) into a waterbody for the purposes of enhancing benthic habitat to attract bivalve shellfish larvae may require section 404 authorization if it meets the Corps' definition of "fill material" and "discharge of fill material" at 33 CFR 323.2(e) and (f). Under 33 CFR 323.2(f), the term "discharge of fill material" means the addition of fill material into waters of the United States. The term "discharge of fill material" does not include plowing, cultivating, seeding and harvesting for the production of food, fiber, and forest products (33 CFR 323.2(f)), so shellfish seeding is not considered a "discharge of fill material." If the placement of gravel or shell on the bottom of the waterbody to enhance the substrate of the waterbody to attract shellfish larvae is not removed upon completion of the shellfish cultivation activity, it is considered a permanent fill even though it may increase the habitat value for bivalves, crustaceans, and other aquatic organisms.

A few commenters said that predator nets, and low-profile cages to protect bottom planted seeds should not be considered navigation hazards subject to permitting requirements unless they create a vertical profile of greater than 25% of the water depth. One commenter agreed with the Corps' statements in the proposed rule that most commercial shellfish mariculture activities do not involve discharges of dredged or fill material that require Clean Water Act section 404 authorization. This commenter noted that placing living bivalve shellfish (e.g., clam seed and oyster cultch) in the intertidal zone during bottom-culture activities and their natural by-products are not pollutants, citing the Association to Protect Hammersley, Eld, and Totten Inlets v. Taylor Res., Inc., 299 F.3d 1007 (9th Cir. 2002). One commenter stated that the proposal accurately states that some commercial bivalve shellfish mariculture activities are regulated under section 10 because they include structures such as racks, cages, bags, lines, nets, and tubes, when those structures are placed in navigable waters. This commenter also said that dredging, excavation, and filling activities would also require section 10 authorization, although these activities are relatively rare.

The placement of predator nets and low-profile cages in navigable waters of the United States requires authorization under Section 10 of the Rivers and Harbors Act because those nets and cages are considered structures under 33 CFR 322.2(b) and may be obstructions to navigation. The Corps maintains its views that most commercial shellfish mariculture activities are regulated solely under Section 10 of

the Rivers and Harbors Act of 1899, and a relatively small percentage are also regulated under Section 404 of the Clean Water Act because they involve discharges of dredged or fill material into waters of the United States. The Corps agrees that the placement of living bivalves into waters of the United States does not result in a discharge of a pollutant that requires authorization under Section 404 of the Clean Water Act.

One commenter said that bivalve shellfish harvesting activities do not bring commercial shellfish farming within the regulatory reach of Clean Water Act Section 404. In order for there to be a discharge regulated under Section 404 of the Clean Water Act, there must be an addition of a pollutant to a water of the United States, and that the harvesting commercial shellfish does not involve an “addition” for purposes of the Clean Water Act section 404. This commenter also stated that harvesting shellfish constitutes a “net withdrawal” of material from the water, not an “addition.” This commenter requested that the Corps clarify in the final rule that these commercial shellfish farming activities do not involve discharges of dredged or fill material and hence do not require Clean Water Act Section 404 authorization.

The Corps does not agree that all bivalve shellfish harvesting activities do not require authorization under Section 404 of the Clean Water Act. There may be circumstances where a bivalve shellfish harvesting activity results in a regulable discharge that requires section 404 authorization. Those circumstances depend on how the harvesting activity is conducted, and whether a particular harvesting activity results in an addition of dredged material into, including redeposit of dredged material other than incidental fallback within, the waters of the United States. District engineers apply the definitions of “dredged material” and “discharge of dredged material” at 33 CFR 323.2(c) and (d), respectively to determine whether a discharge requiring section 404 authorization has occurred. The Corps agrees that bivalve shellfish harvesting activities do not normally involve discharges of fill material, as that term is defined at 33 CFR 323.2(f).

One commenter said that aquaculture is not exempt from CWA permitting under Section 404(f) of the Clean Water Act. This commenter said that adding gravel or shell to bags also triggers a section 404 permit requirement even if the bags themselves do not qualify as fill material. Even for activities that do not directly result in discharge of dredge or fill material, the Corps must document secondary effects, and has the authority to impose conditions reasonably related to the purpose of section 404 permits. Another commenter stated that established shellfish farms are exempt from regulation under the Clean Water Act’s farming exemption, and that the reissued NWP 48 should state that established commercial shellfish farming activities do not require CWA Section 404 permits. This commenter said that even if some shellfish farming activities include discharges of dredged or fill material, established shellfish farms are exempt from regulation under section 404(f), which exempts normal farming activities from the requirement to obtain permits under Section 402 and 404 of the Act.

Whether shellfish mariculture qualifies for a section 404(f) exemption is beyond the scope of this rulemaking. The authority for determining whether a particular activity, such as commercial shellfish mariculture activities, is eligible for the Clean Water Act Section 404(f) exemptions lies with the U.S. EPA. See the 1989 Memorandum of Agreement Between the Department of the Army and the U.S. EPA Concerning the Determination of the Section 404 Program and the Application of the Exemptions under Section 404(f) of the Clean Water Act.

One commenter stated that advanced authorization of the broad suite of commercial shellfish mariculture activities afforded by the NWP 48 is impracticable because the blanket authorization cannot take into account important details regarding local ecological conditions at the growing site and specific information about the shellfish cultivation techniques. This commenter recommended that initial authorization should be made on a case-by-case basis and should be subject to ongoing monitoring and periodic review.

Section 404(e) of the Clean Water Act does not specify how broadly or narrowly the Corps has to identify any category of activities for the issuance of a general permit, including the NWPs. Section 404(e) only requires that the activities in that category are similar in nature. Likewise, under the Corps' definition of general permit in its section 10 regulations at 33 CFR 322.2(f), there are no standards regarding how broad or narrow the category has to be. Therefore, the Corps has substantial discretion to determine the categories of activities to be authorized by the NWPs. Nationwide permits are issued by Corps Headquarters to authorize categories of activities across the country, and there is substantial variation in aquatic resources and the functions they provide, as well as the degree to which they perform those functions. Nationwide permits require pre-construction notification for certain activities so that district engineers can assess proposed activities in the context of local ecological conditions and make a case-by-case determination as to whether proposed activities qualify for NWP authorization.

Some commenters mentioned that the scientific literature cited in the proposed rule concerned studies of eelgrass located in Washington State. These commenters stated that despite its broad distribution along the Pacific and Atlantic coasts, eelgrass is a poor choice for a model species to develop a national standard from a regional dataset. One genus should not dictate policy on an entire suite of functionally, taxonomically, and geographically distinct species. These commenters went on to say that while the individual and cumulative impacts to eelgrass meadows in Washington may be temporary, it could be irreversible in areas where environmental conditions are more impaired and submerged aquatic vegetation meadows are declining in areas such as New England, the mid-Atlantic coast, the East coast of Florida, the Gulf of Mexico, and California.

For the 2020 Proposal, the Corps considered scientific literature in coastal ecosystems located nationwide. The Corps also discussed submerged aquatic vegetation in general terms, and only made specific references to eelgrass when a

particular study examined eelgrass. After the reissuance of NWP 48 in 2017, the Corps reviewed a broader range of scientific literature on the interactions between commercial bivalve shellfish mariculture activities and submerged aquatic vegetation, and found that while some permanent impacts to submerged aquatic vegetation may occur, the impacts are often temporary and submerged aquatic vegetation co-exists with bivalve mariculture activities. The Corps examined scientific literature from studies that occurred in other areas of the United States (e.g., Chesapeake Bay), not just Washington State.

One commenter recommended that the Corps require mitigation for impacts to submerged aquatic vegetation at a ratio of at least 1.2:1 (mitigation area to impact area). One commenter said that when the functional value of eelgrass and shellfish are combined, and the seascape matrix of habitats are considered, it is possible that a broader ecosystem perspective would find benefits from the presence of aquaculture. This commenter also stated that commercial shellfish farming activities have minimal negative to beneficial impacts on eelgrass and supports the Corps' proposal to reissue NWP 48. One commenter remarked that interactions between seagrasses and shellfish mariculture must separately be addressed during Endangered Species Act and Essential Fish Habitat consultations for authorizations for shellfish farming activities in Washington State.

Compensatory mitigation requirements for activities authorized by the NWPs are more appropriately determined by district engineers on a case-by-case basis after reviewing PCNs. If the district engineer reviews a PCN and determines the proposed activity will result in more than minimal adverse environmental effects, he or she will notify the applicant and provide an opportunity to the applicant to submit a mitigation proposal (see 33 CFR 330.1(e)(3)). If, after reviewing the mitigation proposal, the district engineer determines the adverse environmental effects of the proposed activity will be no more than minimal, she or he will issue an NWP verification with permit conditions that require implementation of the mitigation. The Corps acknowledges that, when viewed from a seascape perspective, a district engineer may determine that the proposed shellfish mariculture will provide ecological benefits that should be factored in the district engineer's decision regarding whether the proposed activity will result in no more than minimal adverse environmental effects. If the district engineer reviews a PCN for a proposed NWP 48 activity and determines the proposed activity may affect listed species or designated critical habitat, he or she will conduct ESA section 7 consultation with the U.S. FWS and/or NMFS and that section 7 consultation may address potential impacts to seagrasses. If the district engineer reviews a PCN for a proposed NWP 48 activity and determines the proposed activity may adversely affect essential fish habitat, he or she will conduct essential fish habitat consultation with the NMFS and the NMFS may provide the district engineer with essential fish habitat conservation recommendations that may address potential impacts to seagrasses.

Several commenters stated while shellfish mariculture can provide ecosystem services, some of which are similar to seagrasses and other benthic communities,

there is no meaningful effort to discuss the numerous studies regarding impacts of a variety of aquaculture practices on submerged aquatic vegetation. Allowing commercial shellfish activities in new areas that have extensive beds of submerged aquatic vegetation could impact critical habitat for ESA-listed species. A couple commenters stated that tribes in the Puget Sound region have a unique interest in assuring that both salmon and shellfish are allowed to flourish. Consultation between Corps districts, tribes, federal, and state agencies are the appropriate entities to determine how best to protect submerged aquatic vegetation. A couple of commenters said that submerged aquatic vegetation is a critical resource requiring protection and removal of that protection from NWP 48 could create conflicts with other federal or state agencies such as NOAA Fisheries. These commenters asserted that some states, recognizing the need to protect these high-quality habitats have prohibited the siting of new mariculture leases in areas where surveys indicate the presence submerged aquatic vegetation in any one of the past five years.

In the 2020 proposal and the draft decision document for NWP 48, the Corps provided a substantial discussion of the positive and negative impacts that commercial shellfish mariculture activities may have on seagrasses and other benthic organisms. Some of these impacts may be a result of activities under the Corps' legal authorities; however, bivalve shellfish mariculture activities may have impacts that are beyond the scope of the Corps' legal authorities. Under general condition 18, non-federal permittees must submit a pre-construction notification to the district engineer if any listed species or designated critical habitat (or species proposed for listing) might be affected or is in the vicinity of the activity, or if the activity is located in designated or proposed critical habitat, and shall not begin work on the activity until notified by the district engineer that the requirements of the ESA have been satisfied and that the activity is authorized (see paragraph (c) of general condition 18, endangered species). During the rulemaking process, district engineers have conducted consultation or coordination with tribes to identify regional conditions or coordination procedures that could be used to protect tribal trust resources and comply with general condition 17. Other federal agencies, as well as states, can develop regulations and policies to protect submerged aquatic vegetation under their authorities.

A couple of commenters stated that the Corps thinks it is important to protect submerged aquatic vegetation in other contexts, but not under NWP 48. These commenters said that the Clean Water Act regulations provide for protection of special aquatic sites, which include "vegetated shallows" and that submerged aquatic vegetation beds are considered vegetated shallows. One commenter said that while the Corps states that all activities and structures must avoid submerged aquatic vegetation, but it doesn't apply that principle to commercial shellfish mariculture activities.

While the Clean Water Act Section 404(b)(1) Guidelines provide a greater degree of protection to vegetated shallows (submersed aquatic vegetation) as special aquatic

sites compared to aquatic resources that are not special aquatic sites, the Guidelines do not prohibit discharges of dredged or fill material into vegetated shallows (i.e., submerged aquatic vegetation beds). The 404(b)(1) Guidelines only apply to discharges of dredged or fill material. They do not apply to activities authorized under Section 10 of the Rivers and Harbors Act of 1899.

One commenter stated that submerged aquatic vegetation beds provide numerous ecosystem services including improving water quality, providing nursery habitat for commercial and recreationally significant fish and invertebrates, buffering shorelines from erosion, and sequestering carbon. Because of these additional functions performed by submerged aquatic vegetation, this commenter said that bivalve shellfish mariculture cages do not do any of these things and cannot be considered functionally equivalent habitat to submerged aquatic vegetation.

As discussed in the 2020 Proposal and the national decision document for NWP 48, it is the bivalves that perform a number of the same ecological functions as submerged aquatic vegetation, not the structures in which these bivalves are grown. However, commercial shellfish mariculture structures do provide structural habitat for a wide variety of aquatic organisms, including substrate for organisms to attach to, and some aquatic organisms feed on the attached organisms. Structures used for commercial shellfish mariculture activities can slow the movement of water, and help reduce erosion of nearby shorelines. These impacts would be considered during the review of a PCN for a new or existing shellfish mariculture activity.

One commenter noted that the argument that shellfish aquaculture activities only temporarily impact submerged aquatic vegetation is not accurate because leases issued for shellfish aquaculture vary in duration but are generally 5-20 years to ensure any investment in the enterprise is worthwhile. This commenter said that the word “temporary” is a highly relative and generally misleading descriptor.

It is not the duration of the lease for shellfish mariculture activities that determines whether commercial shellfish mariculture activities have temporary impacts on submerged aquatic vegetation. Commercial shellfish mariculture operators might not cultivate bivalve shellfish continuously during the period the lease is in effect. The operator may let some areas within a leased area to go fallow for a period of time, to reduce adverse effects to the benthic community. The Corps agrees that the term “temporary” is a relative term, but disagrees that it is misleading. What constitutes a temporary impact depends in part on how much time it takes an organism or an ecosystem to recover from a disturbance, and how resilient and resistant the species or ecosystems are to disturbances. Coastal waters are highly dynamic environments subjected to periodic disturbances, both natural and man-made.

Several commenters concurred with the Corps’ view that commercial shellfish mariculture activities typically only has temporary impacts on submerged aquatic vegetation and these plants can sustain a healthy coexistence. A few commenters

noted that mechanical harvesting has been found to not negatively impact native eelgrass and may even enhance it. One commenter stated that the positive ecosystem services (e.g., better water quality, habitat creation, and ecosystem studies) provided by bivalve shellfish mariculture activities outweigh the temporary nature of any perceived negative impacts. The habitat created by shellfish aquaculture increases species richness and diversity of both benthic and epibenthic organisms. This three-dimensional habitat is utilized by many commercially valuable species, such as Dungeness crab and flatfishes. The Corps acknowledges these comments. These beneficial effects have informed the Corps' decision to reissue NWP 48 as discussed because it will have no more than a minimal individual or cumulative adverse environmental effects.

One commenter noted that farming methods such as bottom culture propagation tends to focus on the cultivation of larger older shellfish with large time intervals between harvests, which results in short term impacts at harvest with long periods for recovery and result in no permanent losses of submerged aquatic vegetation. This commenter said that the persistence of eelgrass along the coast demonstrates that shellfish mariculture and eelgrass can coexist and have for over a century. Furthermore, commercial shellfish mariculture operators have long understood the best way to propagate eelgrass is to plant oysters, which creates optimal habitat allowing eelgrass to expand due to decreased current over the tide flats. This commenter also said that the bivalve shellfish, as filter feeders, remove large amounts of waterborne nutrients resulting in cleaner water which facilitates photosynthesis, expanding habitable ranges of eelgrass. The Corps acknowledges these comments. These beneficial effects have informed the Corps' decision to reissue NWP 48 as discussed because it will have no more than a minimal individual or cumulative adverse environmental effects.

Several commenters recommended revising the definition of mechanical harvest so that they are not classified as "dredge or fill" activities because it is too broad and lumps many methods together and lacks clarity. These commenters said that mechanical harvesting by dragging a metal basket along the tide flats to gently tumble harvestable oysters does not result in a discharge of dredge or fill material and should be exempt from section 404 jurisdiction. Furthermore, these commenters said that these activities do not create ditches, channels, or substantially redeposit excavated soil material and none of the harvest tools are designed to remove large quantities of material to improve the navigability of waters. These commenters said that the sediment that may be disturbed during harvest should be considered as incidental fallback under 33 CFR §323.2(d)(1).

Mechanical harvesting activities generally do not result in discharges of fill material, as that term is defined at 33 CFR 323.2(f). However, mechanical harvesting activities may result in discharges of dredged material, depending on how they are conducted. The term "discharge of dredged material" is defined at 33 CFR 323.2(d) to include the "addition of dredged material into, including redeposit of dredged material other than incidental fallback within, the waters of the United States." Some

mechanical harvesting activities may result in incidental fallback and not require section 404 authorization while other mechanical harvesting activities may result in additions of dredged material into waters of the United States that are not incidental fallback, and therefore require section 404 authorization. Mechanical and hydraulic harvesting activities that redeposit sediment in a different area of the bottom of the waterbody that the area from which the sediment was removed is considered a "discharge of dredged material" and therefore requires section 404 authorization. These discharges of dredged material into waters of the United States are authorized by NWP 48.

A commenter noted that in the statement "mechanical harvesting can include grading, tilling, and dredging the substrate of the waterbody" that the term "grading" does not describe shellfish culture methods. A couple of commenters suggested that shellfish mariculture harvest activities should be regulated like wild-harvest shellfisheries (e.g., as they are regulated in NWP 4). This commenter said that both wild and cultured shellfish are state-managed resources, with the exception of many tidelands in Washington, and should not require additional oversight and regulation by federal authorities. This commenter also stated that harvesting activities do not involve structures and do not impact navigation in a way that should trigger regulation under the Section 10 of the Rivers and Harbors Act of 1899.

Mechanical harvesting activities may move sediment in a waterbody in a manner that is not considered incidental fallback. These activities would require section 404 authorization under the Corps' definition of "discharge of dredged material." Nationwide permit 4 authorizes discharges of dredged or fill material associated with fish and wildlife harvesting, enhancement, and attraction devices and activities, including clam and oyster digging. The Corps has jurisdictional authority in Washington State for activities regulated under Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act. Mechanical harvesting activities generally meet the definition of "work" at 33 CFR 322.2(c) for the purposes of Section 10 of the Rivers and Harbors Act of 1899, and are authorized by NWP 48.

One commenter requested that the Corps add a statement in the final rule that acknowledges that the accumulation of sediment around shellfish farming gear may be considered beneficial in certain environments, as well as provision of year-round durable, structured three-dimensional habitat. The Corps declines to add the requested statement because the potential benefits would need to be determined on a case-by-case basis, and the durability of those sediment accumulations is influenced because water movements that could cause that sediment to be re-suspended in the water column.

One commenter said that the Corps must comply with ESA Section 7 and the Magnuson-Stevens Act prior to issuing NWP 48. A few commenters stated that in all areas where submerged aquatic vegetation exists, it is designated essential fish habitat under the Magnuson-Stevens Fishery Conservation and Management Act.

These commenters said that removal of the 1/2-acre limit for direct impacts to submerged aquatic vegetation fails to acknowledge submerged aquatic vegetation as essential fish habitat and the need for consultation with NMFS for activities that may adversely affect essential fish habitat. These commenters asserted that the Corps must consult on a nationwide programmatic basis because essential fish habitat is adversely affected by shellfish mariculture activities.

The NWP program's compliance with the essential fish habitat (EFH) consultation requirements of the Magnuson-Stevens Fishery Conservation and Management Act is achieved through EFH consultations between Corps districts and NMFS regional offices. This approach continues the EFH Conservation Recommendations provided by NMFS Headquarters to Corps Headquarters in 1999 for the NWP program. Corps districts that have EFH designated within their geographic areas of responsibility coordinate with NMFS regional offices, to the extent necessary, to develop NWP regional conditions that conserve EFH and are consistent the NMFS regional EFH Conservation Recommendations. If a district engineer determines a proposed NWP 48 activity may adversely affect essential fish habitat, he or she will conduct EFH consultation with NMFS. Where there is a requirement to consult on EFH, consideration of direct impacts to submerged aquatic vegetation caused by new and existing commercial shellfish mariculture activities would occur regardless of the PCN threshold of 1/2-acre. In response to an EFH assessment prepared by the Corps, the NMFS may provide EFH conservation recommendations to address potential impacts to submerged aquatic vegetation. As discussed in Section III.D of this final rule, the Corps has prepared a biological assessment for this rulemaking activity and determined that the issuance of the NWPs has no effect on listed threatened and endangered species and designated critical habitat, as well as species proposed for listing and proposed designated critical habitat.

One commenter stated that significant changes to NWP 48 are not appropriate until the national decision document is finalized and deemed sufficient. This commenter said the draft decision document fails to satisfy the requirements of the National Environmental Policy Act and the Clean Water Act, and that it fails to properly acknowledge the impacts of mariculture on benthic habitat, fish communities, birds, water quality and substrate characteristics. Several commenters stated that the proposed revisions to the national decision document for NWP 48 do not fairly represent the conclusions of authors of the cited literature, in some cases omitting relevant information and in others misrepresenting study results and conclusions.

The purpose of the national decision document is to provide information for the decision on whether to reissue NWP 48. The national decision document discusses the positive and negative impacts of commercial shellfish mariculture activities on benthic habitat, fish communities, birds, water quality and substrate characteristics. The Corps has considered this information and determined that NWP 48 will not have more than a minimal individual or cumulative adverse environmental effects.

One commenter said that the Corps describes no studies in its decision document

to verify its claim that commercially-raised shellfish help improve water quality. One commenter noted that the Corps acknowledges throughout the environmental consequences, public interest, and 404(b)(1) Guidelines Analysis, some negative impacts, but then fails to assess them and instead focuses only on positive impacts. This commenter said that the impacts from mechanical and hydraulic dredging are barely mentioned, with no assessment of their harmful impacts to the same degree as the supposed benefits from shellfish aquaculture.

The Corps discusses, in numerous places, the water quality benefits of filter-feeding bivalves that are cultivated by commercial shellfish mariculture activities. The Corps acknowledges that commercial shellfish mariculture activities cause adverse and beneficial environmental effects. Throughout the draft and final national decision documents, the Corps discusses the negative and positive effects of harvesting activities.

One commenter identified errors in projected use and acreage impacted over the 5-year period NWP 48 is anticipated to be in effect. This commenter notes that the draft NWP 48 decision document states that the Corps estimates this permit will be used approximately 336 times per year on a national basis, resulting in impacts to approximately 13,360 acres of waters of the United States. It then states the Corps estimates that approximately 1,680 activities could be authorized over a five-year period until the NWP expires, resulting in impacts to approximately 40,080 acres. While 1,680 is five times the annual use figure (336), five times the annual acreage figure (13,360) is 66,800. One commenter requested that the Corps provide documentation on the number of permit request over the last 10 years that exceeded the 1/2-acre limit, and of those activities, how many ultimately received a permit through regional or individual permit process, and what conditions were applied to those applications. One commenter stated that the Corps claims to have no duty to use any quantitative data, but has issued NWP 48 since 2007 and should be able after all these years to provide some quantitative data about loss of seagrasses, natural habitats, etc. One commenter recommended that the Corps pursue a quantitative analysis of the environmental effects of shellfish mariculture for habitat alterations, climate change, invasive species, overharvesting and exploitation, and pollution.

Nationwide permit 48 authorizes structures and work in navigable waters of the United States and discharges of dredged or fill material into waters of the United States for both existing (on-going) and new commercial shellfish mariculture activities. Many of the activities authorized by NWP 48 are on-going activities that require reauthorization each time the current NWP 48 expires and is replaced by a reissued NWP 48. Nationwide permits can be issued for period of no more than 5 years (see Section 404(e) of the Clean Water Act). The acreage of projected impacts in the national decision document for NWP 48 includes many on-going commercial shellfish mariculture activities, many of which have been in operation for decades. These on-going commercial shellfish mariculture activities have been part of the current environmental setting for years, and it is the current environmental

baseline against which the degree of severity of adverse environmental effects is assessed to determine eligibility for NWP authorization (i.e., whether the individual and cumulative adverse environmental effects caused by commercial shellfish mariculture activities during the 5-year period the NWP is in effect are no more than minimal).

The Corps has revised the national decision document to correct the errors in its estimates of potential use of this NWP and authorized impacts. However, it should be noted that these are estimates of projected use over the 5-year period the NWP is anticipated to be in effect. With respect to the removal of the 1/2-acre limit for direct impacts to submerged aquatic vegetation caused by new commercial shellfish mariculture activities, the Corps is only required to provide an estimate of the number of activities that might occur during the period this NWP is in effect. It is not necessary to provide data on how many commercial shellfish mariculture activities were authorized by regional general permits or individual permits.

The Council on Environmental Quality's NEPA regulations at 40 CFR parts 1500-1508 do not require quantitative analyses of potential environmental impacts. With respect to the 404(b)(1) Guidelines, 40 CFR 230.7(b)(3) requires cumulative effects to be analyzed by estimating the number of discharges expected to occur under the NWP while it is in effect. The environmental impacts of authorized activities during the period the NWP is in effect is dependent on the current environmental settings in which these activities will occur, and quantitative data on those current environmental settings is not available. It should also be noted that context is important, because these activities are occurring in coastal waters that have been altered by human activities and natural processes for thousands of years, and continue to be impacted by coastal watershed land use, point source pollution, non-point source pollution, fishing activities, recreation, and other disturbances, not just commercial shellfish mariculture activities.

Several commenters stated it is unclear how mitigation can both be unnecessary and something the Corps is relying on to avoid cumulative impacts. Further, several commenters stated that the Corps relies heavily on mitigation at a district level, but fails to actually describe the possible effects (direct, indirect and cumulative) from shellfish aquaculture activities or how these unknown mitigation measures will actually avoid more than minimal adverse impacts. Any individual mitigation measures will only be attached if a permittee is required to submit a pre-construction notification, which will likely be few and far between.

For commercial shellfish mariculture activities, the Corps generally does not require compensatory mitigation because these activities do not cause losses of waters of the United States. Paragraph (a) of general condition 23 requires permittees to design their projects to avoid and minimize adverse effects, both temporary and permanent, to waters of the United State to the maximum extent practicable on the project site. Many of the NWP general conditions consist of mitigation measures to avoid and minimize impacts. When determining whether to require mitigation to

ensure that a particular NWP activity results in no more than minimal individual and cumulative adverse environmental effects, the district engineer will consider the direct, indirect, and cumulative effects, as required by paragraph 2 of Section D, District Engineer's Decision. If the district engineer requires mitigation for an NWP activity, he or she will add conditions to the NWP authorization (see 33 CFR 330.1(e)(3)) that are directly related to the impacts of the proposal, appropriate to the scope and degree of those impacts, and reasonably enforceable (see 33 CFR 325.4(a)).

One commenter stated that the Corps said that "standard and best management practices" can reduce impacts but fails to explain what these are and how they will mitigate impacts. One commenter said that the Corps claims commercially-reared bivalves improve water quality but fails to assess water quality impacts by deferring to district engineers and water quality certifications under Clean Water Act section 401, but impacts to water quality must be assessed before granting NWPs. One commenter said that the Corps fails to discuss the context and intensity factors that might indicate that this proposed NWP will have a "significant impact to the human environment" and thus requires an environmental impact statement.

As stated in the 2020 Proposal, species-specific or regional standards and best management practices for commercial shellfish mariculture activities may be appropriate as regional conditions approved by division engineers (see 85 FR 57331). In the national decision document, the Corps has discussed potential impacts to water quality as well as potential benefits to water quality that may result from commercial shellfish mariculture activities. In addition, the Corps has explained that cultivated bivalves are not considered a pollutant under the Clean Water Act. After considering the information in the national decision document for this NWP, including the potential benefits and detriments caused by commercial shellfish mariculture activities, there is no evidence that these activities cause a significant impact to the human environmental and thus no environmental impact statement is required.

One commenter stated the alternatives analysis is inadequate. The commenter asserts that the Corps lists the "no action" alternative but barely analyzes it, strangely concluding that it would somehow have more substantial adverse environmental consequences. The "national modification" alternative is not an alternative, but the proposed NWP 48 and the "regional modification" is also not an alternative because it includes no conditions or changes from the proposed NWP 48.

The national decision document discusses alternatives. In the Council on Environmental Quality's NEPA regulations that were published in the Federal Register on July 16, 2020, the preamble to the final rule at 85 FR 43323 states that an agency does not need to include a detailed discussion of each alternative in an environmental assessment. In the national decision document, the Corps briefly discussed the environmental consequences of each alternative.

One commenter said that the Corps should impose monitoring requirements that would ensure that NWP terms and conditions, including those resulting from subsequent exercises in discretionary authority, would be adequately policed. In response, Corps districts can conduct compliance inspections for authorized activities, to ensure that those activities are conducted in accordance with any conditions added to the NWP authorization. The Corps district will take appropriate actions to address non-compliance with permit conditions.

Several commenters approved of the reiteration and clarification that the discharge of pesticides is regulated under Section 402 of the CWA and not Section 404. They suggested that the final rule clearly state that operators may be permitted to use pesticides to control agricultural pests and predators instead of just predators. One commenter said that the statement regarding commercial shellfish mariculture operations using chemicals to control fouling organisms is incorrect because chemical use or the potential introduction of toxic materials is regulated by the Interstate Shellfish Sanitation Conference. One commenter said that commercial shellfish mariculture operators may use herbicides to control invasive, noxious weeds on commercial clam beds.

The Corps does not have the authority to control the use of pesticides, herbicides, and antifouling agents in commercial shellfish mariculture activities. Use of some of these chemicals may be regulated under other federal or state laws and regulations administered by other agencies.

One commenter said that while gear sometimes escapes from commercial shellfish farms despite growers' best efforts to ensure it remains secured, shellfish farmers do not discard equipment into the marine environment. This commenter requested that the Corps revise the national decision document to make it clear that growers are not discarding equipment, but equipment may wash away from the project site or move by other mechanisms. This commenter also said that NWP general condition 6 addresses the use of trash in the NWP program. One commenter said that the use of plastics gear for commercial shellfish mariculture activities adds plastic pollution to the ocean and beaches through plastic debris and this plastic can break down further into microplastics, which can impact wildlife, aesthetics, and food safety.

The Corps has revised the national decision document to clarify that some materials used for commercial shellfish mariculture activities may wash away from the project area. General condition 6 does not address trash or garbage that may be associated with commercial shellfish mariculture activities. General condition 6 prohibits the use of trash as fill material. Trash and garbage are not considered fill material for the purposes of section 404 of the Clean Water Act (see 33 CFR 323.2(e)(3)).

2.0 Purpose and Need for the Proposed Action

The proposed action is the issuance of this NWP to authorize structures and work in navigable waters of the United States under Section 10 of the Rivers and Harbors Act of 1899 and discharges of dredged or fill material into waters of the United States under Section 404 of the Clean Water Act for commercial shellfish mariculture activities that result in no more than minimal individual and cumulative adverse environmental effects. This proposed action is needed for efficient implementation of the Corps Regulatory Program, by authorizing with little, if any, delay or paperwork a category of activities that has no more than minimal individual and cumulative adverse environmental effects. The NWP also provides an incentive to project proponents to reduce impacts to jurisdictional waters and wetlands to receive the required authorization under Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act in less time than it takes to obtain individual permits. Issuing an NWP to authorize eligible activities, instead of processing individual permit applications for these activities, will allow the Corps to devote more of its resources towards evaluating proposed activities requiring authorization under Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act that have the potential to cause more substantial adverse environmental effects.

3.0 Alternatives

This evaluation includes an analysis of alternatives based on the requirements of NEPA, which requires a more expansive review than the Clean Water Act Section 404(b)(1) Guidelines. The alternatives discussed below are based on an analysis of the potential environmental impacts and impacts to the Corps, Federal, Tribal, and state resource agencies, general public, and prospective permittees. Since the consideration of off-site alternatives under the 404(b)(1) Guidelines does not apply to specific projects authorized by general permits, the alternatives analysis discussed below consists of a general NEPA alternatives analysis for the NWP.

3.1 No Action Alternative (Do Not Reissue or Modify the Nationwide Permit)

The no action alternative would be to allow this NWP to continue to authorize activities until it expires on March 18, 2022, and not reissue or modify the NWP. After the NWP expires, under the no action alternative activities that were authorized by this NWP would require individual permits, unless Corps districts issued regional general permits to authorize a similar category of activities that the NWP authorized.

3.2 Reissue the Nationwide Permit With Modifications

This alternative consists of modifying and reissuing the NWP while considering the comments received in response to the proposal to reissue this NWP with modifications, including the proposed changes identified by the Corps and changes suggested by commenters. This alternative includes changes to the terms and conditions of this NWP, including quantitative limits for this NWP, pre-construction notification thresholds and requirements, and other provisions of this NWP. This alternative also includes consideration of modifying, adding, or removing general conditions that apply to this NWP. In addition, this alternative includes the mechanisms in the Corps' NWP program regulations at 33 CFR 330.5(c) and (d) where division and district engineers can modify, suspend, or revoke NWP authorizations on a regional or case-by-case basis to ensure that the NWP authorizes only those activities that result in no more than minimal individual and cumulative adverse environmental effects.

In the September 15, 2020, Federal Register notice, the Corps requested comments on the proposed reissuance of this NWP. The Corps proposed to change the title of this NWP from "Commercial Shellfish Aquaculture Activities" to "Commercial Shellfish Mariculture Activities" to more accurately reflect where these activities are conducted (i.e., coastal waters). The Corps also proposed to remove the 1/2-acre limit for impacts to submerged aquatic vegetation in project areas that that have not been used for commercial shellfish aquaculture activities during the past 100 years. In addition, the Corps proposed to remove the definition of "new commercial shellfish aquaculture operation" that was adopted in 2017. The Corps also proposed to remove both PCN thresholds for this NWP, as well as the paragraph that identifies the additional information that permittees must submit with NWP 48 PCNs.

Since the Corps' NWP program began in 1977, the Corps has continuously strived to develop NWPs that only authorize activities that result in no more than minimal individual and cumulative adverse environmental effects. Every five years the Corps reevaluates the NWPs during the reissuance process, and may modify an NWP to address concerns for the aquatic environment. Utilizing collected data and institutional knowledge concerning activities authorized by the Corps regulatory program, the Corps reevaluates the potential impacts of activities authorized by NWPs. The Corps also uses substantive public comments on proposed NWPs to assess the expected impacts.

3.3 Reissue the Nationwide Permit Without Modifications

This alternative consists of reissuing the NWP without any modifications before it expires on March 18, 2022. This alternative also includes the mechanisms in the Corps' NWP program regulations where division and district engineers can modify, suspend, or revoke NWP authorizations on a regional or case-by-case basis to

ensure that the NWP authorizes only those activities that result in no more than minimal individual and cumulative adverse environmental effects (see 33 CFR 330.5(c) and (d)).

4.0 Affected Environment

This environmental assessment is national in scope because the NWP may be used across the country, unless the NWP is revoked or suspended by a division or district engineer under the procedures in 33 CFR 330.5(c) and (d), respectively. For this NWP, the affected environment consists of aquatic ecosystems, including marine and estuarine ecosystems in the United States, as they have been directly and indirectly affected by past and present federal, non-federal, and private activities. The past and present activities include activities authorized by the various NWPs issued from 1977 to 2017, activities authorized by other types of Department of the Army (DA) permits, as well as other federal, tribal, state, and private activities that are not regulated by the Corps. Aquatic ecosystems are also influenced by past and present activities in uplands, because those land use/land cover changes in uplands and other activities in uplands have indirect effects on aquatic ecosystems (e.g., MEA 2005a, Reid 1993). Due to the large geographic scale of the affected environment (i.e., the entire United States), as well as the many past and present human activities that have shaped the affected environment, it is only practical to describe the affected environment in general terms. In addition, it is not possible to describe the environmental conditions for specific sites where the NWPs may be used to authorize eligible activities.

The total land area in the United States is approximately 2,260,000,000 acres, and the total land area in the contiguous United States is approximately 1,891,000,000 acres (Bigelow and Borchers 2017). Land uses in the United States as of 2012 is provided in Table 4.1 (Bigelow and Borchers 2017). Of the land area in the entire United States, approximately 60 percent (1,370,000,000 acres) is privately owned (Bigelow and Borchers 2017). Of the remaining lands in the United States, the federal government hold 28 percent (644,000,000 acres), state and local governments own 8 percent (189,000,000 acres), and 3 percent (63,000,000 acres) is held in trust by the Bureau of Indian Affairs (Bigelow and Borchers 2017).

Table 4.1. Major land uses in the United States – 2012 (Bigelow and Borchers 2017).

Land Use	Acres	Percent of Total
Agriculture	1,186,000,000	52.5
Forest land	502,000,000	22.2
Transportation use	27,000,000	1.2
Recreation and wildlife areas	254,000,000	11.2
National defense areas	27,000,000	1.2
Urban land	70,000,000	3.1
Miscellaneous use	196,000,000	8.5
Total land area	2,260,000,000	100.0

4.1 Quantity of Aquatic Ecosystems in the United States

There are approximately 283.1 million acres of wetlands in the United States; 107.7 million acres are in the conterminous United States and the remaining 175.4 million acres are in Alaska (Mitsch and Hernandez 2013). Wetlands occupy less than 9 percent of the global land area (Zedler and Kercher 2005). According to Dahl (2011), wetlands and deepwater habitats cover approximately 8 percent of the land area in the conterminous United States. Rivers and streams comprise approximately 0.52 percent of the total land area of the continental United States (Butman and Raymond 2011). Therefore, the wetlands, streams, rivers, and other aquatic habitats that are potentially waters of the United States and subject to regulation by the Corps under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899 comprise a minor proportion of the land area of the United States. The remaining land area of the United States (more than 92 percent, depending on the proportion of wetlands, streams, rivers, and other aquatic habitats that are subject to regulation under those two statutes) is outside the Corps' regulatory authority.

Frayer et al. (1983) evaluated wetland status and trends in the United States during the period of the mid-1950s to the mid-1970s. During that 20-year period, approximately 7.9 million acres of wetlands (4.2 percent) were lost in the conterminous United States. Much of the loss of estuarine emergent wetlands was due to changes to estuarine subtidal deepwater habitat, and some loss of estuarine emergent wetlands was due to urban development.

The U.S. Fish and Wildlife Service also examined the status and trends of wetlands in the United States during the period of the mid-1970s to the 1980s, and found that there was a net loss of more than 2.6 million acres of wetlands (2.5 percent) during that time period (Dahl and Johnson 1991). Freshwater wetlands comprised 98 percent of those wetland losses (Dahl and Johnson 1991). During that time period, losses of estuarine wetlands were estimated to be 71,000 acres, with most of that

loss due to changes of emergent estuarine wetlands to open waters caused by shifting sediments (Dahl and Johnson 1991).

Between 2004 and 2009, there was no statistically significant difference in wetland acreage in the conterminous United States (Dahl 2011). According to the 2011 wetland status and trends report, during the period of 2004 to 2009 urban development accounted for 11 percent of wetland losses (61,630 acres), rural development resulted in 12 percent of wetland losses (66,940 acres), silviculture accounted for 56 percent of wetland losses (307,340 acres), and wetland conversion to deepwater habitats caused 21 percent of the loss in wetland area (115,960 acres) (Dahl 2011). Some of the losses occurred to wetlands that are not subject to Clean Water Act jurisdiction and some losses are due to activities not regulated under Section 404 of the Clean Water Act, such as unregulated drainage activities, exempt forestry activities, or water withdrawals. From 2004 to 2009, approximately 100,020 acres of wetlands were gained as a result of wetland restoration and conservation programs on agricultural land (Dahl 2011). Another source of wetland gain is conversion of other uplands to wetlands, resulting in a gain of 389,600 acres during the period of 2004 to 2009 (Dahl 2011). Inventories of wetlands, streams, and other aquatic resources are incomplete because the techniques used for those studies cannot identify some of those resources (e.g., Dahl (2011) for wetlands; Meyer and Wallace (2001) for streams).

Losses of vegetated estuarine wetlands due to the direct effects of human activities have decreased significantly due to the requirements of Section 404 of the Clean Water Act and other laws and regulations (Dahl 2011). During the period of 2004 to 2009, less than one percent of estuarine emergent wetlands were lost as a direct result of human activities, while other factors such as sea level rise, land subsidence, storm events, erosion, and other ocean processes caused substantial losses of estuarine wetlands (Dahl 2011). The indirect effects of other human activities, such as oil and gas development, water extraction, development of the upper portions of watersheds, and levees, have also resulted in coastal wetland losses (Dahl 2011). Eutrophication of coastal waters can also cause losses of emergent estuarine wetlands, through changes in growth patterns of marsh plants and decreases in the stability of the wetland substrate, which changes those marshes to mud flats (Deegan et al. 2012).

The Emergency Wetlands Resources Act of 1986 (Public Law 99-645) requires the U.S. Fish and Wildlife Service (USFWS) to submit wetland status and trends reports to Congress (Dahl 2011). The latest status and trends report, which covers the period of 2004 to 2009, is summarized in Table 4.2. The USFWS status and trends report only provides information on acreage of the various aquatic habitat categories and does not assess the quality or condition of those aquatic habitats (Dahl 2011).

Table 4.2. Estimated aquatic resource acreages in the conterminous United States in 2009 (Dahl 2011).

Aquatic Habitat Category	Estimated Area in 2009 (acres)
Marine intertidal	227,800
Estuarine intertidal non-vegetated	1,017,700
Estuarine intertidal vegetated	4,539,700
All intertidal waters and wetlands	5,785,200
Freshwater ponds	6,709,300
Freshwater vegetated	97,565,300
• Freshwater emergent wetlands	27,430,500
• Freshwater shrub wetlands	18,511,500
• Freshwater forested wetlands	51,623,300
All freshwater wetlands	104,274,600
Lacustrine deepwater habitats	16,859,600
Riverine deepwater habitats	7,510,500
Estuarine subtidal habitats	18,776,500
All wetlands and deepwater habitats	153,206,400

The acreage of lacustrine deepwater habitats does not include the open waters of Great Lakes (Dahl 2011).

The Federal Geographic Data Committee has established the Cowardin system developed by the USFWS (Cowardin et al. 1979) as the national standard for wetland mapping, monitoring, and data reporting (Dahl 2011) (see Federal Geographic Data Committee (2013)). The Cowardin system is a hierarchical system which describes various wetland and deepwater habitats, using structural characteristics such as vegetation, substrate, and water regime as defining characteristics. Wetlands are defined by plant communities, soils, or inundation or flooding frequency. Deepwater habitats are permanently flooded areas located below the wetland boundary. In rivers and lakes, deepwater habitats are usually more than two meters deep. The Cowardin et al. (1979) definition of “wetland” differs from the definition used by the Corps and U.S. EPA for the purposes of implementing Section 404 of the Clean Water Act. The Corps-U.S. EPA regulations defines wetlands as “those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.” [33 CFR 328.3(c)(4); 40 CFR 230.3(o)(3)(iv)] The Cowardin et al. (1979) requires only one factor (i.e., wetland vegetation, soils, hydrology) to be present for an area to be a wetland, while the Corps-U.S. EPA wetland definition

requires all three factors to be present under normal circumstances (Tiner 2017, Mitsch and Gosselink 2015). The NWI produced by applying the Cowardin et al. (1979) definition is the only national scale wetland inventory available. There is no national inventory of wetland acreage based on the Corps' wetland definition at 33 CFR 328.3(c)(16).

There are five major systems in the Cowardin classification scheme: marine, estuarine, riverine, lacustrine, and palustrine (Cowardin et al. 1979). The marine system consists of open ocean on the continental shelf and its high energy coastlines. The estuarine system consists of tidal deepwater habitats and adjacent tidal wetlands that are usually partially enclosed by land, but may have open connections to open ocean waters. The riverine system generally consists of all wetland and deepwater habitats located within a river channel. The lacustrine system generally consists of wetland and deepwater habitats located within a topographic depression or dammed river channel, with a total area greater than 20 acres. The palustrine system generally includes all non-tidal wetlands and wetlands located in tidal areas with salinities less than 0.5 parts per thousand; it also includes ponds less than 20 acres in size. Approximately 95 percent of wetlands in the conterminous United States are freshwater wetlands, and the remaining 5 percent are estuarine or marine wetlands (Dahl 2011).

The National Resources Inventory (NRI) is a statistical survey conducted by the Natural Resources Conservation Service (NRCS) (USDA 2018) of natural resources on non-federal land in the United States. The NRCS defines non-federal land as privately owned lands, tribal and trust lands, and lands under the control of local and state governments. Acreages of palustrine and estuarine wetlands and the land uses those wetlands are subjected to are summarized in Table 4.3. The 2015 NRI estimates that there are 110,638,500 acres of palustrine and estuarine wetlands on non-Federal land and water areas in the United States (USDA 2018). The 2015 NRI estimates that there are 49,598,800 acres of open waters on non-Federal land in the United States, including lacustrine, riverine, and marine habitats, as well as estuarine deepwater habitats.

Table 4.3. The 2015 National Resources Inventory acreages for palustrine and estuarine wetlands on non-federal land, by land cover/use category (USDA 2018).

National Resources Inventory Land Cover/Use Category	Area of Palustrine and Estuarine Wetlands (acres)
cropland, pastureland, and Conservation Reserve Program land	17,300,000
forest land	65,800,000
rangeland	7,800,000
other rural land	14,600,000
developed land	1,500,000
water area	3,600,000
Total	111,000,000

The land cover/use categories used by the 2015 NRI are defined below (USDA 2018). Croplands are areas used to produce crops grown for harvest. Pastureland is land managed for livestock grazing, through the production of introduced forage plants. Conservation Reserve Program land is under a Conservation Reserve Program contract. Forest land is comprised of at least 10 percent single stem woody plant species that will be at least 13 feet tall at maturity. Rangeland is land on which plant cover consists mostly of native grasses, herbaceous plants, or shrubs suitable for grazing or browsing, and introduced forage plant species. Other rural land consists of farmsteads and other farm structures, field windbreaks, marshland, and barren land. Developed land is comprised of large urban and built-up areas (i.e., urban and built-up areas 10 acres or more in size), small built-up areas (i.e., developed lands 0.25 to 10 acres in size), and rural transportation land (e.g., roads, railroads, and associated rights-of-way outside urban and built-up areas). Water areas are comprised of waterbodies and streams that are permanent open waters.

The wetlands data from the Fish and Wildlife Service's Status and Trends study and the Natural Resources Conservation Service's National Resources Inventory should not be compared, because they use different methods and analyses to produce their results (Dahl 2011).

Activities authorized by NWPs will adversely affect a smaller proportion of the Nation's wetland base than indicated by the wetlands acreage estimates provided in the most recent status and trends report, or the NWI maps for a particular region.

Not all wetlands, streams, and other types of aquatic resources are subject to federal jurisdiction under the Clean Water Act (Mitsch and Gosselink 2015). Two

U.S. Supreme Court decisions have identified limits to Clean Water Act jurisdiction. In 2001, in *Solid Waste Agency of Northern Cook County v. Army Corps of Engineers* (531 U.S. 159) the U.S. Supreme Court held that the use of isolated, non-navigable, intrastate waters by migratory birds is not, by itself a sufficient basis for exercising federal regulatory authority under the Clean Water Act (see 80 FR 37056). In the Supreme Court's 2006 decision in *Rapanos* v. *United States,* (547 U.S. 715), one justice stated that waters and wetlands regulated under the Clean Water Act must have a "significant nexus" to downstream traditional navigable waters. Four justices (the plurality) concluded that Clean Water Act jurisdiction applies only to relatively permanent waters connected to traditional navigable waters and to wetlands that have a continuous surface connection to those relatively permanent waters. The remaining justices in *Rapanos* stated that Clean Water Act jurisdiction applies to waters and wetlands that meet either the significant nexus test or the Plurality's test.

There are 94,133 miles of shoreline in the United States (NOAA 1975). Of that shoreline, 88,633 miles are tidal shoreline and 5,500 miles are shoreline along the Great Lakes and rivers that connect those lakes to the Atlantic Ocean. More recently, Gittman et al. (2015) estimated that there are 99,524 miles of tidal shoreline in the conterminous United States.

4.2 Quality of Aquatic Ecosystems in the United States

The USFWS status and trends study does not assess the condition or quality of wetlands and deepwater habitats (Dahl 2011). Information on water quality in waters and wetlands, as well as the causes of water quality impairment, is collected by the U.S. EPA under Sections 305(b) and 303(d) of the Clean Water Act. Table 4.4 provides U.S. EPA's most recent national summary of water quality in the Nation's waters and wetlands.

Table 4.4. National summary of water quality data (U.S. EPA, https://iaspub.epa.gov/waters10/attains_nation_cy.control accessed 11/27/2020).

Category of water	Total waters	Total waters assessed	Percent of waters assessed	Good waters	Threatened waters	Impaired waters
Rivers and streams	3,533,205 miles	1,110,961 miles	31.4	518,293 miles	4,495 miles	588,173 miles
Lakes, reservoirs and ponds	41,666,049 acres	18,629,795 acres	44.7	5,390,570 acres	30,309 acres	13,208,917 acres
Bays and estuaries	87,791 square miles	56,141 square miles	63.9	11,516 square miles	0 square miles	44,625 square miles
Coastal	58,618	4,627	7.9	1,298	0 miles	3,329

shoreline	miles	miles		miles		miles
Ocean and near coastal waters	54,120 square miles	6,944 square miles	12.8	726 square miles	0 square miles	6,218 square miles
Wetlands	107,700,000 acres	1,242,252 acres	1.2	569,328 acres	0 acres	672,924 Acres
Great Lakes shoreline	5,202 miles	4,460 miles	85.7	106 miles	0 miles	4,354 miles
Great Lakes open waters	196,343 square miles	39,231 square miles	20.0	1 square mile	0 square miles	39,230 square miles

Waters and wetlands classified by states as “good” meets all their designated uses. Waters classified as “threatened” currently support all of their designated uses, but if pollution control measures are not taken one or more of those uses may become impaired in the future. A water or wetland is classified by the state as “impaired” if any one of its designated uses is not met. The definitions of “good,” “threatened,” and “impaired” are applied by states to describe the quality of their waters (the above definitions were found in the metadata in U.S. EPA (2015)). Designated uses include the “protection and propagation of fish, shellfish and wildlife,” “recreation in and on the water,” the use of waters for “public water supplies, propagation of fish, shellfish, wildlife, recreation in and on the water,” and “agricultural, industrial and other purposes including navigation.” (40 CFR 130.3). These designated uses are assessed by states in a variety of ways, by examining various physical, chemical and biological characteristics, so it is not possible to use the categories of “good,” “threatened,” and “impaired” to infer the level of ecological functions and services these waters perform.

According to the latest U.S. EPA national summary data, 52.9 percent of assessed rivers and streams, 70.9 percent of assessed lakes, reservoirs, and ponds, 79.5 percent of assessed bays and estuaries, 71.9 percent of assessed coastal shoreline, 89.5 percent of assessed ocean and near coastal waters, 54.2 percent of assessed wetlands, 97.6 percent of assessed Great Lakes shoreline, and 100 percent of Great Lakes open water are impaired.

For rivers and streams, 34 causes of impairment were identified, and the top 10 causes are pathogens, sediment, nutrients, organic enrichment/oxygen depletion, temperature, metals (other than mercury), polychlorinated biphenyls, mercury, habitat alterations, and turbidity. The top 10 primary sources of impairment for the assessed rivers and streams are: unknown sources, agriculture, hydromodification, atmospheric deposition, habitat alterations not directly related to hydromodification, unspecified non-point source, municipal discharges/sewage, natural/wildlife, urban-related runoff/stormwater, and silviculture (forestry).

Thirty-three causes of impairment were identified for lakes, reservoirs, and ponds.

The top 10 causes of impairment for these waters are: mercury, nutrients, polychlorinated biphenyls, turbidity, organic enrichment/oxygen depletion, metals (other than mercury), pH/acidity/caustic conditions, salinity/total dissolved solids/chlorides/sulfates, algal growth, and nuisance exotic species. For lakes, reservoirs, and ponds, the top 10 sources of impairment are: atmospheric deposition, unknown sources, agriculture, natural/wildlife, unspecified non-point source, other sources, urban-related runoff/stormwater, legacy/historic pollutants, municipal discharges/sewage, and hydromodification.

Twenty-eight causes of impairment were identified for bays and estuaries. The top 10 causes of impairment for these waters are: polychlorinated biphenyls, nutrients, mercury, turbidity, dioxins, toxic organics, metals (other than mercury), pesticides, pathogens, and organic enrichment/oxygen depletion. For bays and estuaries, the top 10 sources of impairment are: legacy/historic pollutants, urban-related runoff/stormwater, unknown sources, atmospheric deposition, municipal discharges/sewage, unspecified non-point sources, other sources, natural/wildlife, agriculture, and industrial.

Coastal shorelines were impaired by 16 identified causes, the top 10 of which are: mercury, pathogens, turbidity, organic enrichment/oxygen depletion, pH/acidity/caustic conditions, nutrients, oil and grease, temperature, cause unknown – impaired biota, and algal growth. The top 10 sources of impairment of coastal shorelines are municipal discharges/sewage, urban-related runoff/stormwater, unknown sources, recreational boating and marinas, hydromodification, industrial, unspecified non-point sources, agriculture, legacy/historic pollutants, and land application/waste sites/tanks.

Ocean and near coastal waters were impaired by 16 identified causes, the top 10 of which are: mercury, organic enrichment/oxygen depletion, pathogens, metals (other than mercury), pesticides, turbidity, nuisance exotic species, total toxics, pH/acidity/caustic conditions, and polychlorinated biphenyls. The top 10 sources of impairment of ocean and near coastal waters are: atmospheric deposition, unknown sources, unspecified non-point sources, other sources, recreation and tourism (non-boating), recreational boating and marinas, urban-related runoff/stormwater, hydromodification, municipal discharges/sewage, and construction.

For wetlands, 23 causes of impairment were identified, and the top 10 causes are: organic enrichment/oxygen depletion, mercury, metals (other than mercury), salinity/total dissolved solids/chlorides/sulfates, pathogens, nutrients, toxic inorganics, temperature, pH/acidity/caustic conditions, and turbidity. The 10 primary sources for wetland impairment are: unknown sources, natural/wildlife, agriculture, atmospheric deposition, resource extraction, hydromodification, unspecified non-point sources, other, land application/waste sites/tanks, and groundwater loadings/withdrawals.

For Great Lakes shorelines, 12 causes of impairment were identified, and the top 10

causes are: polychlorinated biphenyls, dioxins, mercury, pesticides, toxic organics, pathogens, nutrients, nuisance exotic species, sediment, and habitat alterations. The 10 primary sources for Great Lakes shoreline impairment are: atmospheric deposition, unknown sources, legacy/historic pollutants, agriculture, municipal discharges/sewage, hydromodification, urban-related runoff/stormwater, habitat alterations (not directly related to hydromodifications), industrial, and unspecified non-point sources.

For Great Lakes open waters, 8 causes of impairment were identified, and those causes are: polychlorinated biphenyls, mercury, dioxins, pesticides, toxic organics, nutrients, metals (other than mercury), and sediment. The 8 sources for Great Lakes open water impairment are: atmospheric deposition, unknown sources, agriculture, municipal discharges/sewage, unspecified non-point sources, industrial, urban-related runoff/stormwater, and legacy/historic pollutants.

Water quality standards are established by states, with review and approval by the U.S. EPA (see Section 303(c) of the Clean Water Act and the implementing regulations at 40 CFR part 131). Under Section 401 of the Clean Water Act States review proposed discharges to determine compliance with applicable water quality standards.

Most causes and sources of impairment identified by states in the water quality summary discussed above are not due to activities regulated under Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act of 1899. Inputs of sediments into aquatic ecosystems can result from erosion occurring within a watershed (Beechie et al. 2013, Gosselink and Lee 1989). As water moves through a watershed it carries sediments and pollutants to streams (e.g., Allan 2004, Dudgeon et al. 2005, Paul and Meyer 2001) and wetlands (e.g., Zedler and Kercher 2005, Wright et al. 2006). Non-point sources of pollution (i.e., pollutants carried in runoff from farms, roads, and urban areas) are largely uncontrolled (Brown and Froemke 2012) because the Clean Water Act only requires permits for point sources discharges of pollutants (i.e., discharges of dredged or fill material regulated under section 404 and point source discharges of other pollutants regulated under section 402). Estuaries across the world have been substantially degraded by human activities (NRC 2010). Habitat alterations as a cause or source of impairment may be the result of activities regulated under section 404 and section 10 because they involve discharges of dredged or fill material or structures or work in navigable waters, but habitat alterations may also occur as a result of activities not regulated under those two statutes, such as the removal of vegetation from upland riparian areas. Hydrologic modifications may or may not be regulated under section 404 or section 10.

The indirect effects of changes in upland land use (which are highly likely not to be subject to federal control and responsibility, at least in terms of the Corps Regulatory Program), including the construction and expansion of upland developments, have substantial adverse effects on the quality (i.e. the ability to

perform hydrologic, biogeochemical, and habitat functions) of jurisdictional waters and wetlands because those upland activities alter watershed-scale processes. Those watershed-scale processes include water movement and storage, erosion and sediment transport, and the transport of nutrients and other pollutants.

Habitat alterations as a cause or source of impairment may be the result of activities regulated under section 404 and section 10 because they involve discharges of dredged or fill material into jurisdictional waters or structures or work in navigable waters, but habitat alterations may also occur as a result of activities not regulated under those two statutes, such as the removal of vegetation from upland riparian areas. Hydrologic modifications may or may not be regulated under section 404 or section 10, depending on whether those hydrologic modifications are the result of discharges of dredged or fill material into waters of the United States regulated under Section 404 of the Clean Water Act or structures or work in navigable waters of the United States regulated under Section 10 of the Rivers and Harbors Act of 1899. When states, tribes, or the U.S. EPA establish total maximum daily loads (TMDLs) for pollutants and other impairments for specific waters, there may be variations in how these TMDLs are defined (see 40 CFR part 130).

As discussed below, many anthropogenic activities and natural processes affect the ability of jurisdictional waters and wetlands to perform ecological functions. Stream and river functions are affected by activities occurring in their watersheds, including the indirect effects of land uses changes (Beechie et al. 2013, Allan 2004, Paul and Meyer 2001). Booth at al. (2004) found riparian land use in residential areas also strongly affects stream condition because many landowners clear vegetation up to the edge of the stream bank. The removal of vegetation from upland riparian areas and other activities in those non-jurisdictional areas do not require DA authorization. Wetland functions are also affected by indirect effects of land use activities in the land area that drains to the wetland (Zedler and Kercher 2005, Wright et al. 2006). Human activities within a watershed or catchment that have direct or indirect adverse effects on rivers, streams, wetlands, and other aquatic ecosystems are not limited to discharges of dredged or fill material into waters of the United States or structures or work in a navigable waters. Human activities in uplands have substantial indirect effects on the structure and function of aquatic ecosystems, including streams and wetlands, and their ability to sustain populations of listed species. It is extremely difficult to distinguish between degradation of water quality caused by upland activities and degradation of water quality caused by the filling or alteration of wetlands (Gosselink and Lee 1989).

4.3 Aquatic Resource Functions and Services

Functions are the physical, chemical, and biological processes that occur in ecosystems (33 CFR 332.2). Wetland functions occur through interactions of their physical, chemical, and biological features (Smith et al. 1995). Wetland functions depend on a number of factors, such as the movement of water through the

wetland, landscape position, surrounding land uses, vegetation density within the wetland, geology, soils, water source, and wetland size (NRC 1995). In its evaluation of wetland compensatory mitigation in the Clean Water Act Section 404 permit program, the National Research Council (2001) recognized five general categories of wetland functions:

- Hydrologic functions
- Water quality improvement
- Vegetation support
- Habitat support for animals
- Soil functions

Hydrologic functions include short- and long-term water storage and the maintenance of wetland hydrology (NRC 1995). Water quality improvement functions encompass the transformation or cycling of nutrients, the retention, transformation, or removal of pollutants, and the retention of sediments (NRC 1995). Vegetation support functions include the maintenance of plant communities, which support various species of animals as well as economically important plants. Wetland soils support diverse communities of bacteria and fungi which are critical for biogeochemical processes, including nutrient cycling and pollutant removal and transformation (NRC 2001). Wetland soils also provide rooting media for plants, as well as nutrients and water for those plants. These various functions generally interact with each other, to influence overall wetland functioning, or ecological integrity (Smith et al. 1995; Fennessy et al. 2007). As discussed earlier in this report, the Corps regulations at 33 CFR 320.4(b) list wetland functions that are important for the public interest review during evaluations of applications for DA permits, and for the issuance of general permits.

Not all wetlands perform the same functions, nor do they provide functions to the same degree (Smith et al. 1995). Therefore, it is necessary to account for individual and regional variation when evaluating wetlands and the functions and services they provide. The types and levels of functions performed by a wetland are dependent on its hydrologic regime, the plant species inhabiting the wetland, soil type, and the surrounding landscape, including the degree of human disturbance of the landscape (Smith et al. 1995).

Ecosystem services are the benefits that humans derive from ecosystem functions (33 CFR 332.2). The Millennium Ecosystem Assessment (2005a) describes four categories of ecosystem services: provisioning services, regulating services, cultural services, and supporting services. For wetlands and open waters, provisioning services include the production of food (e.g., fish, shellfish, game), fresh water storage, food and fiber production, production of chemicals that can be used for medicine and other purposes, and supporting genetic diversity for resistance to disease. Regulating services relating to open waters and wetlands consist of climate regulation, control of hydrologic flows, water quality through the removal, retention, and recovery of nutrients and pollutants, erosion control, mitigating natural hazards such as floods, and providing habitat for pollinators.

Cultural services that come from wetlands and open waters include spiritual and religious values, recreational opportunities, aesthetics, and education. Wetlands and open waters contribute supporting services such as soil formation, sediment retention, and nutrient cycling.

Aquatic ecosystems in the current affected environment provide a wide variety of ecological functions and services to differing degrees (MEA 2005a) to human communities. Degraded ecosystems can provide ecological functions and services that continue to provide some conservation value (Weins and Hobbs 2015).

Examples of services provided by wetland functions include flood damage reduction, maintenance of populations of economically important fish and wildlife species, maintenance of water quality (NRC 1995, MEA 2005a) and the production of populations of wetland plant species that are economically important commodities, such as timber, fiber, and fuel (MEA 2005a). Wetlands can also provide important climate regulation and storm protection services (MEA 2005a).

Marine ecosystems provide a number of ecosystem services, including fish production; materials cycling (e.g., nitrogen, carbon, oxygen, phosphorous, and sulfur); transformation, detoxification, and sequestration of pollutants and wastes produced by humans; support of ocean-based recreation, tourism, and retirement industries; and coastal land development and valuation, including aesthetics related to living near the ocean (Peterson and Lubchenco 1997).

Seagrasses provide ecological services such as organic carbon production, detrital export, nutrient cycling, sediment stabilization, increased biodiversity, habitat for a variety of aquatic organisms (including fish species of recreational and commercial importance), and energy exchanges with other aquatic habitats (Orth et al. 2006).

Bivalve molluscs provide ecological services such as such as improved water quality by reducing water turbidity and nutrients that contribute to eutrophication, facilitating plant growth by providing nutrients, denitrification, carbon sequestration, providing structural habitat for a variety of fish, crustaceans, and epibiotic organisms, and habitat and shoreline stabilization (NRC 2010). Bivalve molluscs also contribute to provisioning services through secondary production that provides food to a variety of aquatic and terrestrial organisms, including people. In coastal waters that have been altered by human activities and where conditions still exist for production of bivalve shellfish that are safe for human consumption, commercial bivalve shellfish mariculture activities can be an alternative means for providing a variety of ecosystem functions and services when resources for traditional restoration activities are not available (Alleway et al. 2019).

Costanza et al. (2014) estimated the value of ecosystem services, by general categories of ecosystem type. Their estimates, based on data analysis conducted in 2011 and using the 2007 value of the U.S. dollar, are provided in Table 4.5. The ecosystem categories providing the highest values of ecosystem services by acre

per year were coral reefs ($142,661 per acre per year), followed by tidal marshes and mangrove wetlands ($78,506 per acre per year). Forested and floodplain wetlands had a value of $10,401 per acre per year.

Table 4.5 – Estimates of the value of ecosystem services, by ecosystem category (Costanza et al. 2014)

Ecosystem category	2007$ per acre per year
Marine	554
open ocean	24
coastal	3,622
• estuaries	11,711
• seagrass/algae beds	11,711
• coral reefs	142,661
• coastal shelf	900
Terrestrial	1,985
forest	1,539
• tropical	2,180
• temperate/boreal	1,270
grass/rangelands	1,687
wetlands	56,770
• tidal marsh/mangroves	78,506
• swamps/floodplains	10,401
lakes/rivers	5,067
desert	-
tundra	-
ice/rock	-
cropland	2,255
urban	2,698

When natural ecosystems are converted to human-dominated ecosystems, there are tradeoffs between the losses in ecosystem services provided by natural ecosystems and the gains in goods and services provided by land use changes, resource extraction, harvesting, and other activities (MEA 2005c). For thousands of years, human communities have altered landscapes and ecosystems to serve their needs, such as food, safety, and commerce, and made trade-offs by increasing certain ecosystem functions and services while reducing other ecosystem functions and services (Karieva et al. 2007).

This NWP authorizes activities in waters of the United States, including navigable waters. The waters in which this NWP would normally be used are the estuarine and marine systems of the Cowardin classification system.

Activities authorized by this NWP will provide a wide variety of goods and services that are valued by society. For example, commercial shellfish mariculture activities provide sources of protein and other nutrients to human populations. Commercial shellfish mariculture activities can also produce other compounds that are used by society. Commercial shellfish mariculture activities can help restore the ecological

services that were historically provided by natural populations of bivalve molluscs before populations of those molluscs were substantially reduced by overfishing and other human activities (NRC 2010). These ecosystem services include improving water quality, carbon sequestration, providing habitat for other aquatic species, and helping to stabilize shoreline habitats (NRC 2010, van der Schatte Olivier et al. 2018). However, benefits will be limited to the time period over which cultivation of shellfish continues because ecosystem services such as water filtration will end once harvest occurs and harvesting techniques may have adverse effects to resources such as benthic habitats. These ecosystem services are complementary to—but not a replacement for—those provided by natural habitats, such as seagrasses or oyster reefs (Alleway et al. 2019).

4.4 Human Activities and Natural Factors that Affect the Quantity and Quality of Aquatic Ecosystems in the United States

The affected environment is the current environmental setting against which the environmental effects of the proposed action is evaluated, to determine whether the issuance of the NWP will have a significant impact on the quality of the human environment. The affected environment is also used as a basis for comparison to determine whether activities authorized by the NWP will result in no more than minimal individual and cumulative adverse environmental effects when added to the current environmental setting.

For thousands of years, humans have caused substantial impacts on ecosystems and the ecological functions and services they provide (Ellis et al. 2010, Evans and Davis 2018). Around the beginning of the 19th century, the degree of impacts of human activities on the Earth's ecosystems began to exceed the degree of impacts to ecosystems caused by natural disturbances and variability (Steffen et al. 2007). All of the Earth's ecosystems have been affected either directly or indirectly by human activities (Vitousek et al. 1997). Over 75 percent of the ice-free land on Earth has been altered by human occupation and use (Ellis and Ramankutty 2008). Approximately 33 percent of the Earth's ice-free land consists of lands heavily used by people: urban areas, villages, lands used to produce crops, and occupied rangelands (Ellis and Ramankutty 2008). For marine ecosystems, Halpern et al. (2008) determined that there are no marine waters that are unaffected by human activities, and that 41 percent of the area of ocean waters are affected by multiple anthropogenic stressors (e.g., land use activities that generate pollution that go to coastal waters, marine habitat destruction or modification, and the extraction of resources). The marine waters most highly impacted by human activities are continental shelf and slope areas, which are affected by both land-based and ocean-based human activities (Halpern et al. 2008). Human population density is a good indicator of the relative effect that people have had on local ecosystems, with lower population densities causing smaller impacts to ecosystems and higher population densities having larger impacts on ecosystems (Ellis and Ramankutty 2008). Human activities such as urbanization, agriculture, and forestry alter

ecosystem structure and function by changing their interactions with other ecosystems, their biogeochemical cycles, and their species composition (Vitousek et al. 1997). Changes in land use reduce the ability of ecosystems to produce ecosystem services, such as food production, reducing infectious diseases, and regulating climate and air quality (Foley et al. 2005).

Ecosystems are not separate from human communities, and they are interdependent and comprise a single social-ecological system (Folke et al. 2011). Social-ecological systems are altered by human activities, as well as natural perturbations and changing environmental conditions, but they possess resilience and adaptive capacities that allow them to continue to provide ecological functions and services when properly managed (Chapin et al. 2010). Social-ecological systems exist at a number of scales, ranging from local to regional to global (Folke et al. 2010). Despite the prevalence of human activities altering landscapes and seascapes and the ecosystems within those landscapes and seascapes over long periods of time, many of those ecosystems continue to provide ecological functions and services to varying degrees (Clewell and Aronson 2013). Disturbances to ecosystems, landscapes, and seascapes may result in those systems recovering to their original state through biotic and abiotic characteristics and processes that provide resilience, or those systems may be transformed to a different ecological state (i.e., an alternative stable state) (van Andel and Aronson 2012). From the perspective of social-ecological systems, resilience is defined by Folke et al. (2010) as the capacity of a social-ecological system to withstand disturbance and undergo changes, while retaining its ability to exhibit similar structure, functions, and interactions. If the ecosystem, landscape, or seascape changes to an alternative stable state, the alternative stable state may be considered an improvement or degradation, depending on the perspective of the person evaluating the change (Backstrom et al. 2018, van Andel and Aronson 2012). This NWP will be used to authorize certain activities that require DA authorization in these social-ecological systems, and the potential environmental consequences of the reissuance of this NWP is evaluated under the current environmental setting and the potential impacts to jurisdictional waters and wetlands that may occur during the 5-year period this NWP is anticipated to be in effect. The environmental consequences of the reissuance of this NWP is also considered for the various public interest review factors in section 6.0 of this document, which include social and ecological components.

Recent changes in climate have had substantial impacts on natural ecosystems and human communities (IPCC 2014). Climate change, both natural and anthropogenic, is a major driving force for changes in ecosystem structure, function, and dynamics (Millar and Brubaker 2006). However, there are other significant drivers of change to aquatic and terrestrial ecosystems. In addition to climate change, aquatic and terrestrial ecosystems are also adversely affected by land use and land cover changes, natural resource extraction (including water withdrawals), pollution, species introductions, and removals of species (NAS and RS 2019, Staudt et al. 2013, Bodkin 2012, MEA 2005a) and changes in nutrient cycling (Julius et al. 2013).

During the past century, changes to ecosystems have been driven primarily by changes in biological factors, such as land use/land cover changes and the spread of non-native species, but in the future changes in abiotic processes, such as climate change and nitrogen deposition, may become predominant drivers of ecosystem change (Radeloff et al. 2015). The current contribution of climate change to changes in ecosystems is small compared to other anthropogenic causes of change to ecosystems (Radeloff et al. 2015, Williams et al. 2019) that are identified above, especially land use and land cover changes.

The affected environment (i.e., the current environmental setting) has been shaped by a wide variety of human activities. Wetlands, streams, and other aquatic resources and the ecological functions and services they provide are directly and indirectly affected by changes in land use and land cover, alien species introductions, overexploitation of species, pollution, eutrophication due to excess nutrients, resource extraction including water withdrawals, climate change, and various natural disturbances (MEA 2005a). A more detailed list of activities is provided below in Table 4.6. Activities regulated and authorized by the Corps under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899 through NWPs, individual permits, letters of permission, and regional general permits comprise a small subset of those activities. The impacts of human activities have altered, to some degree, all ecosystems, including the quantity and quality of wetlands, streams, and other aquatic resources in the United States, and the ecological functions and services they provide. Other federal, non-federal, and private activities also contribute to the current environmental setting by changing the quantity and quality of aquatic resources and the ecological functions and services they provide. Human activities that have affected ecosystems, landscapes, and seascapes may have legacy effects that continue under the current environmental setting and affected the quantity of those resources and the ecological functions and services they provide.

Table 4.6 – Human activities and natural factors that cause changes in aquatic ecosystems and the functions and services they perform

Resource type(s)	Human activities and natural factors that drive ecosystem change	Reference(s)
wetlands and waters (generally)	• land use/land cover changes • alien species introductions • species overexploitation • pollution • eutrophication • resource extraction (e.g., water withdrawals) • climate change • natural disturbances	MEA (2005a)

Resource type(s)	Human activities and natural factors that drive ecosystem change	Reference(s)
wetlands, including estuaries	• wetland conversion through drainage, dredging, and filling • hydrologic modifications that change wetland hydrology and hydrodynamics • pollutants (point source and non-point source), including nutrients and contaminants • waterfowl and wildlife management activities • agriculture and aquaculture activities • flood control and stormwater protection (e.g., severing hydrologic connections between rivers and floodplain wetlands) • silvicultural activities • agricultural activities • urban development • mining activities • water withdrawals, aquifer depletion • river management (e.g., channelization, navigation improvements, dams, locks, weirs) • altered sediment transport • introductions of non-native species • land subsidence, erosion	Mitsch and Gosselink (2015) Mitsch and Hernandez (2013) Wright et al. (2006) Zedler and Kercher (2005) Brinson and Malvárez (2002)
seagrass beds	• dredging • coastal development activities • degradation of water quality • sediment and nutrient runoff from adjacent lands • physical disturbances • natural processes, such as herbivore grazing, physical disturbances caused by waves and tidal currents • invasive species • diseases • commercial fishing activities • aquaculture • algal blooms • low light availability • nutrient limitations • global climate change	Borum et al. (2013) Waycott et al. (2009) Orth et al. (2006)

coral reefs	• overexploitation/overfishing • destructive fishing practices • nutrients, sediments, pesticides, and other pollutants (point source and non-point source) • nutrient loading • changes in storm frequency and intensity • increasing ocean surface temperatures • ocean acidification • coastal land uses, including development and agriculture • coral mining • sea level rise • invasive species • diseases • bleaching • global climate change	Sheppard (2014) MEA (2005a) Hughes et al. (2003)
coastal areas	• development activities, including the construction of residences, commercial buildings, industrial facilities, resorts, and port developments • agricultural and forestry activities • point source and non-point source pollution (nutrients, organic matter, other pollutants) • aquaculture • fishing activities • overharvesting of species • intentional and unintentional introductions of non-native species • dredging • reclamation • shore protection and other structures • habitat modifications • changes to hydrology and hydrodynamics • global climate change • shoreline erosion • pathogens and toxins • debris and litter	Robb (2014) Day et al. (2013) Lotze et al. (2006) MEA (2005b) NRC (1994)
oceans	• pollution (point and non-point source) • fishing activities • changes in sea temperatures • ultraviolet light • ocean acidification • species invasions • commercial activities • other human activities • benthic structures • offshore energy infrastructure (e.g., wind farms, pipelines)	Halpern et al. (2015) Halpern et al. (2008)

Wetlands, streams, and other aquatic resources and the functions and services they provide are directly and indirectly affected by changes in land use and land cover, alien species introductions, overexploitation of species, pollution, eutrophication due

to excess nutrients, resource extraction including water withdrawals, climate change, and various natural disturbances (MEA 2005a). Freshwater ecosystems such as lakes, rivers, and streams are altered by changes to water flow, climate change, land use changes, additions of chemicals, resource extraction, and aquatic invasive species (Carpenter et al. 2011). Cumulative effects to wetlands, streams, and other aquatic resources that form the current environmental setting are the result of landscape-level processes (Gosselink and Lee 1989). As discussed in more detail below, cumulative or aggregate effects to aquatic resources are caused by a variety of activities (including activities that occur entirely in uplands) that take place within a landscape unit, such as the watershed for a river or stream (e.g., Allan 2004, Paul and Meyer 2001, Leopold 1968) or the contributing drainage area for a wetland (e.g., Wright et al. 2006, Brinson and Malvárez 2002, Zedler and Kercher 2005).

There is little national-level information on the current ecological state of the Nation's wetlands, streams, and other aquatic resources, or the general degree to which they perform various ecological functions, although reviews have acknowledged that most of these aquatic resources are degraded to some degree (Zedler and Kercher 2005, Allan 2004) or impaired (U.S. EPA 2015) because of various activities, disturbances, and other stressors. Therefore, the analysis in this environmental assessment is a qualitative analysis.

There is a wide variety of causes and sources of impairment of the Nation's rivers, streams, wetlands, lakes, estuarine waters, and marine waters (U.S. EPA 2015), which also contribute to cumulative effects to these aquatic resources. Many of those causes of impairment are point and non-point sources of pollutants that are not regulated under Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act of 1899. Two common causes of impairment for rivers and streams, habitat alterations and flow alterations, may be due in part to activities regulated by the Corps under Section 404 of the Clean Water Act and/or Section 10 of the Rivers and Harbors Act of 1899. Habitat and flow alterations may also be the caused by activities that do not involve discharges of dredged or fill material or structures or work in navigable waters. For wetlands, impairment due to habitat alterations, flow alterations, and hydrology modifications may involve activities regulated under section 404, but these causes of impairment may also be due to unregulated activities, such as changes in upland land use that affects the movement of water through a watershed or contributing drainage area or the removal of vegetation.

The Millennium Ecosystem Assessment (MEA 2005a) broadly defines wetlands as inland wetlands (e.g., swamps, marshes, lakes, rivers, peatlands, and underground water habitats), coastal and near-shore marine wetlands (e.g., coral reefs, mangroves, seagrass beds, and estuaries), and human-made wetlands (e.g., rice fields, dams, reservoirs, and fish ponds). According to the MEA (2005a), the principal drivers of direct change to estuarine and marine wetlands include the conversion of saltwater marshes, mangroves, seagrass meadows, and coral reefs

to other land uses, diversions of freshwater flows, increased inputs of nitrogen, overharvesting various species, water temperature changes, and species introductions. These changes are indirectly driven by increases in human populations in coastal areas (MEA 2005a). Robb (2014) identified a number of threats to estuaries and estuarine habitats such as salt marshes, seagrass beds, and sand flats. Those threats include land-based activities in surrounding watersheds, such as development activities, agricultural activities, forestry activities, pollution, freshwater diversions, shoreline stabilization, waterway impairments, and inputs of debris and litter. With respect to activities occurring directly in coastal waters, Robb (2014) identified the following threats: shoreline development, the construction and operation of port facilities, dredging, marine pollution, aquaculture activities, resource extraction activities, species introductions, and recreational activities. Changing climate conditions also pose threats to estuaries through sea level rise, changing water temperatures, ocean acidification, and changing precipitation patterns (Robb 2014).

Marine and coastal waters are affected by human activities in the ocean, coastal areas, and watersheds that drain to those marine and coastal waters (Korpinen and Andersen 2016). In marine and coastal environments, human activities and other disturbances that affect resources in those waters can come from a variety of sources, including water-based activities (e.g., transportation, fishing, mariculture, power generation, and tourism) and land-based activities (e.g., urban and suburban development, agriculture, non-point source pollution, forestry activities, power generation, and mining activities) (Clark Murray et al. 2014).

Activities that affect wetland quantity and quality include: land use changes that alter local hydrology (including water withdrawal), clearing and draining wetlands, constructing levees that sever hydrologic connections between rivers and floodplain wetlands, constructing other obstructions to water flow (e.g., dams, locks), constructing water diversions, inputs of nutrients and contaminants, and fire suppression (Brinson and Malvárez 2002). Wetland loss and degradation is caused by hydrologic modifications of watersheds, drainage activities, logging, agricultural runoff, urban development, conversion to agriculture, aquifer depletion, river management, (e.g., channelization, navigation improvements, dams, weirs), oil and gas development activities, levee construction, peat mining, and wetland management activities (Mitsch and Hernandez 2013). Upland development adversely affects wetlands and reduces wetland functionality because those activities change surface water flows and alter wetland hydrology, contribute stormwater and associated sediments, nutrients, and pollutants, cause increases in invasive plant species abundance, and decrease the diversity of native plants and animals (Wright et al. 2006). Many of the remaining wetlands in the United States are degraded (Zedler and Kercher 2005). Wetland degradation and losses are caused by changes in water movement and volume within a watershed or contributing drainage area, altered sediment transport, drainage, inputs of nutrients from non-point sources, water diversions, fill activities, excavation activities, invasion by non-native species, land subsidence, and pollutants (Zedler and

Kercher 2005). According to Mitsch and Gosselink (2015), categories of activities that alter wetlands include: wetland conversion through drainage, dredging, and filling; hydrologic modifications that change wetland hydrology and hydrodynamics; highway construction and its effects on wetland hydrology; peat mining; waterfowl and wildlife management; agriculture and aquaculture activities; water quality enhancement activities; and flood control and stormwater protection.

The ecological condition of rivers and streams is dependent on the state of their watersheds (NRC 1992), because they are affected by activities that occur in those watersheds, including agriculture, urban development, deforestation, mining, water removal, flow alteration, and invasive species (Palmer et al. 2010, Allan 2004). Land use changes affect rivers and streams through increased sedimentation, larger inputs of nutrients (e.g., nitrogen, phosphorous) and pollutants (e.g., heavy metals, synthetic chemicals, toxic organics), altered stream hydrology, the alteration or removal of riparian vegetation, and the reduction or elimination of inputs of large woody debris (Allan 2004). Agriculture is the primary cause of stream impairment, followed by urbanization (Foley et al. 2005, Paul and Meyer 2001). Agricultural land use adversely affects stream water quality, habitat, and biological communities (Allan 2004). Urbanization causes changes to stream hydrology (e.g., higher flood peaks, lower base flows), sediment supply and transport, water chemistry, and aquatic organisms (Paul and Meyer 2001). Leopold (1968) found that land use changes affect the hydrology of an area by altering stream flow patterns, total runoff, water quality, and stream structure. Changes in peak flow patterns and runoff affect stream channel stability. Stream water quality is adversely affected by increased inputs of sediments, nutrients, and pollutants, many of which come from non-point sources (Paul and Meyer 2001, Allan and Castillo 2007).

The construction and operation of water-powered mills in the 17th to 19th centuries substantially altered the structure and function of streams in the eastern United States (Walter and Merritts 2008) and those effects have persisted to the present time. In urbanized and agricultural watersheds, the number of small streams has been substantially reduced, in part by activities that occurred between the 19th and mid-20th centuries (Meyer and Wallace 2001). Activities that affect the quantity and quality of small streams include residential, commercial, and industrial development, mining, agricultural activities, forestry activities, and road construction (Meyer and Wallace 2001), even if those activities are located entirely in uplands.

Waycott et al. (2009) estimated that the areal extent of seagrass beds across the world has declined by nearly 30 percent since the late 19th century. They identified two main categories of causes for that decline: direct impacts from dredging and coastal development activities, and indirect impacts from degradation of water quality. Submersed aquatic vegetation is affected by a wide variety of human activities such as dredging in seagrass meadows, anchoring vessels in seagrass beds, coastal development activities, increased sediment inputs from a variety of sources including land development activities, habitat conversions resulting from mariculture activities, increased nutrient inputs to coastal waters, and climate

change (MEA 2005a). According to Orth et al. (2006), seagrasses are threatened by numerous stressors, such as sediment and nutrient runoff from adjacent lands, physical disturbances, overgrazing, invasive species, diseases, commercial fishing activities, aquaculture, algal blooms, and global climate change. Human activities that contribute to cumulative effects to submerged aquatic vegetation include coastal development, hard shore stabilization structures, land uses changes in surrounding watersheds that increase inputs of sediments, nutrients, and pollutants to waters inhabited (or could be inhabited) by seagrasses, discharges of pollutants directly into waters, aquaculture activities, and boating activities (Orth et al. 2017, Orth et al. 2006). Orth et al. (2017, 2006) did not quantify how frequently each of these stressors pose threats to seagrasses or the relative contributions of each of the identified human activities that affect seagrasses. Submersed aquatic vegetation may be affected by natural processes, such as herbivore grazing, physical disturbances caused by waves and tidal currents, and other stressors such as low light availability, higher temperatures, or nutrient limitations (Borum et al. 2013). Boating activities (e.g., mooring, use of propellers) and fish and shellfish harvesting activities can also contribute to cumulative impacts to submersed aquatic vegetation beds (Fonseca et al. 1998). The recovery of submersed aquatic vegetation from anthropogenic and natural disturbances can vary by species, and is dependent in part on the reproductive mechanisms of those species (Borum et al. 2013, Fonseca et al. 1998). At the meadow or landscape scale, seagrass beds can fully recover after disturbance within 5 years, but recovery can take longer if there are persistent environmental changes persist or seagrass seeds or other propagules are not available to reestablish seagrasses in the affected area (O'Brien et al. 2018).

A variety of human activities have caused, and are continuing to cause declines in corals and coral reefs. Coral reefs are adversely affected by pollution, including sedimentation, excess nutrients, oil discharges, pesticides, and sewage (Sheppard 2014; MEA 2005a; Hughes et al. 2003). Shoreline development activities, development activities in watersheds draining to coastal waters, and agriculture activities in coastal watersheds also contribute to declines in corals and coral reefs (Sheppard 2014; MEA 2005a; Hughes et al. 2003). The pollution may be in runoff from nearby lands or discharged directly into waters inhabited by corals. Corals and coral reefs are also harmed by overexploitation, including overfishing, as well as destructive fishing practices (MEA 2005a) and anchors used by boats (Sheppard 2014). Climate change and associated increases in storm frequency and intensity, diseases, water temperatures, and coral bleaching also contribute to declines in corals and coral reefs (Sheppard 2014; MEA 2005a; Hughes et al. 2003). Invasive species have also affected corals and coral reefs (Sheppard 2014).

For aquatic ecosystems, climate change affects water quality, biogeochemical cycling, and water storage (Julius et al. 2013). Climate change will also affect the abundance and distribution of wetlands across the United States, as well as the functions they provide (Mitsch and Gosselink 2015). Climate change results in increases in water temperatures, more waterbodies with anoxic conditions,

degradation of water quality, and increases in flood and drought frequencies (Julius et al. 2013). The increasing carbon dioxide concentration in the atmosphere also changes the pH of the oceans, resulting in ocean acidification (RS and NAS 2014), which adversely affects corals and some other marine organisms.

In the United States, approximately 39 percent of its population lives in counties that are next to coastal waters, the territorial seas, or the Great Lakes (NOAA 2013). Those counties comprise less than 10 percent of the land area of the United States (NOAA 2013). Humans have been altering estuarine waters and coastal areas for millennia, but those changes have rapidly accelerated over the past 150 to 300 years (Lotze et al. 2006). Coastal waters are also affected by a wide variety of activities. Day et al. (2013) identified the following general categories of human activities that impact estuaries: physical alterations (e.g., habitat modifications and changes in hydrology and hydrodynamics), increases in inputs of nutrients and organic matter (enrichment), releases of toxins, and changes in biological communities as a result of harvesting activities and intentional and unintentional introductions of new species. The major drivers of changes to coastal areas are: development activities that alter coastal forests, wetlands, and coral reef habitats for aquaculture and the construction of urban areas, industrial facilities, and resort and port developments (MEA 2005b). Dredging, reclamation, shore protection and other structures (e.g., causeways and bridges), and some types of fishing activities also cause substantial changes to coastal areas (MEA 2005b). Nitrogen pollution to coastal zones change coral reef communities (MEA 2005b). Adverse effects to coastal waters are caused by habitat modifications, point source pollution, non-point source pollution, changes to hydrology and hydrodynamics, exploitation of coastal resources, introduction of non-native species, global climate change, shoreline erosion, and pathogens and toxins (NRC 1994). Over the course of history, in estuarine waters human activities caused declines of greater than 90 percent of important species, losses of more than 65 percent of seagrasses and wetland habitat, substantially degraded water quality, and facilitated introductions of new species (Lotze et al. 2006).

Substantial alterations of coastal hydrology and hydrodynamics are caused by land use changes in watersheds draining to coastal waters, the channelization or damming of streams and rivers, water consumption, and water diversions (NRC 1994). Approximately 52 percent of the population of the United States lives in coastal watersheds (NOAA 2013). Eutrophication of coastal waters is caused by nutrients contributed by waste treatment systems, non-point sources, and the atmosphere, and may cause hypoxia or anoxia in coastal waters (NRC 1994). Changes in water movement through watersheds may also alter sediment delivery to coastal areas, which affects the sustainability of wetlands and intertidal habitats and the functions they provide (NRC 1994). Most inland waters in the United States drain to coastal areas, and therefore activities that occur in inland watersheds affect coastal waters (NRC 1994). Inland land uses, such as agriculture, urban development, and forestry, adversely affect coastal waters by diverting fresh water from estuaries and by acting as sources of nutrients and pollutants to coastal waters

(MEA 2005b).

Coastal wetlands have been substantially altered by urban development and changes to the watersheds that drain to those wetlands (Mitsch and Hernandez 2013). Coastal habitat modifications are the result of dredging or filling coastal waters, inputs of sediment via non-point sources, changes in water quality, or alteration of coastal hydrodynamics (NRC 1994). Coastal development activities, including those that occur in uplands, affect marine and estuarine habitats (MEA 2005a). The introduction of non-native species may change the functions and structure of coastal wetlands and other habitats (MEA 2005a). Fishing activities may also modify coastal habitats by changing habitat structure and the biological communities that inhabit those areas (NRC 1994).

In order to effectively understand and manage ecosystems, including aquatic ecosystems, it is necessary to take into account how people and societies have reshaped aquatic and terrestrial resources over time (Ellis 2015), through the effects of human activities on those ecosystems. This includes permitting programs that regulate activities in aquatic resources and other types of natural resources. The current state of an ecosystem (e.g., a wetland or an estuary) can range from “near natural” (i.e., minimally disturbed) to semi-natural to production systems such as agricultural lands to overexploited (i.e., severely impaired) (van Andel and Aronson 2012). Degradation occurs when an ecosystem is subjected to a prolonged disturbance (Clewell and Aronson 2013), and the degree of degradation can be dependent, in part, on the severity of disturbance. Disturbances can be caused by human activities or by natural events, such as changes to ecosystems caused by ecosystem engineers (e.g., beavers) and other organisms, storms, fires, or earthquakes. Two important factors that affect how aquatic ecosystems and other ecosystems respond to disturbances are resistance and resilience.

For ecosystems, stability is the ability of an ecosystem to return its starting state after one or more disturbances cause a significant change in environmental conditions (van Andel et al. 2012). Resistance is the ability of an ecosystem to exhibit little or no change in structure or function when exposed to a disturbance (van Andel et al. 2012). Resilience is the ability of an ecosystem to regain its structural and functional characteristics in a relatively short amount of time after it has been exposed to a disturbance (van Andel et al. 2012). Human activities can change the resilience of ecosystems (Gunderson 2000). In some situations, resilience can be a positive attribute (e.g., the ability to withstand disturbances), and in other situations, resilience can be a negative attribute (e.g., when it is not possible to restore ecosystem because it has changed to the degree where it is resistant to being restored) (Walker et al. 2004). The concept of ecological resilience presumes the existence of multiple stable states, and the ability of ecosystems to tolerate some degree of disturbance before transitioning to an alternative (different) stable state (Gunderson 2000). A regime shift (i.e., a change from one stable state to an alternative stable state) can occur when human activities reduce the resilience of an ecosystem, or functional groups of species within that

ecosystem, or when there are changes in the magnitude, frequency, and duration of disturbances (Folke et al. 2004). Folke et al. (2004) and Gunderson (2000) provide examples of aquatic ecosystems that can exist in multiple stable states.

An example of a regime change in an estuary is a shift from an estuary with clear waters and benthic communities dominated by seagrasses, to an estuary with turbid waters dominated by phytoplankton that has insufficient light for seagrasses to grow and persist (Folke et al. 2004). Another example of a regime shift is where an increase in nutrients to a wetland (likely from many sources in the area draining to that wetland) causes a wetland's plant community from a diverse plant community dependent on low nutrient levels to a monotypic plant community dominated by an invasive species that can persist under the higher nutrient levels (Gunderson 2000).

Determining whether an ecosystem altered by human activities is degraded or in an alternative stable state depends on the perspective of the person making that judgment (Hobbs 2016). That judgment is dependent in part on the ecological functions and services currently being provided by the alternative stable state and the value local stakeholders place on those ecosystem functions and services. In other words, different people may have different views on the current ecological state of a particular ecosystem (Hobbs 2016, Walker et al. 2004): some people may think it is degraded and other people may think it continues to provide important ecological functions and services. It is also important to understand that degradation falls along a continuum, ranging from minimally degraded to severely degraded, since all ecosystems have been directly or indirectly altered by human activities to some degree. Degraded ecosystems can continue to provide important ecological functions and services, although they may be different from what they provided historically. In summary, the affected environment or current environmental setting consists of a variety of aquatic and terrestrial resources that have been subjected to varying degrees of disturbance by human activities, and provide different degrees of aquatic resource functions and services.

5.0 Environmental Consequences

5.1 General Evaluation Criteria

This document contains a general assessment of the reasonably foreseeable effects of the individual activities authorized by this NWP and the anticipated cumulative effects of the activities authorized by this NWP during the 5-year period it is anticipated to be in effect. In the assessment of these individual and cumulative effects, the terms and limits of the NWP, pre-construction notification requirements, and the standard NWP general conditions are considered. The NWP general conditions include mitigation measures that reduce individual and cumulative adverse environmental effects. The supplemental documentation provided by division engineers will address how regional conditions affect the individual and

cumulative effects of the NWP.

The environmental effects of proposed activities are evaluated by assessing the direct and indirect effects that those activities have on the current environmental setting (Canter 1996). The current environmental setting is the product of the cumulative or aggregated effects of human activities that have persisted over time, as well as the natural processes that have influenced, and continue to influence, the structure, functions, and dynamics of ecosystems. The current environmental setting includes the present effects of past activities authorized by previously issued versions of this NWP and other NWPs. The current environmental setting can vary substantially in different areas of the country and in different waterbodies. The current environmental setting is dependent in part on the degree to which past and present human activities have altered aquatic and terrestrial resources in a particular geographic area over time. For a particular site in which an NWP may take place, the current environmental setting can range from highly developed/overexploited (e.g., urban areas, where human impacts to ecosystems are highest) to production systems (e.g., agricultural lands) to seminatural (e.g., parks) to near natural (e.g., wilderness areas, where human impacts to ecosystems are lowest) (van Andel and Aronson 2012). Human impacts on semi-natural ecosystems are lower than human impacts to production ecosystems (van Andel and Aronson 2012). Since humans have altered aquatic and terrestrial environments in numerous, substantial ways for thousands of years (e.g., Evans and Davis 2018, Ellis 2015), the current environmental setting takes into account how human activities and changing biotic and abiotic conditions have modified existing aquatic and terrestrial resources.

The terms “cumulative effects” and “cumulative impacts” have been defined in various ways. For example, the National Research Council (NRC) (1986) defined “cumulative effects” as the on-going degradation of ecological systems caused by repeated perturbations or disturbances. MacDonald (2000) defines “cumulative effects” as the result of the combined effects of multiple activities that occur in a particular area that persist over time. Cumulative effects are caused by the interaction of multiple activities in a landscape unit, such as a watershed or ecoregion (Gosselink and Lee 1989). Cumulative effects can accrue in a number of ways. Cumulative effects can occur when there are repetitive disturbances at a single site over time, and the resource is not able to fully recover between each disturbance. Cumulative effects can also occur as a result of multiple activities occurring in a geographic area over time.

Consistent with the definitions cited above, the cumulative impacts of this NWP are the product of how many times this NWP is used to authorize structures and work in navigable waters of the United States and discharges of dredged or fill material into waters of the United States across the country during the 5-year period this NWP is anticipated to be in effect. In section 8.2.2 of this document, the Corps estimates the number of times this NWP will be used during the 5-year period it is expected to be in effect, as well as estimates of the acreage of permanent and temporary impacts,

and the acreage of compensatory mitigation required by district engineers to offset losses of jurisdictional waters and wetlands. The individual and cumulative impacts of activities authorized by this NWP are evaluated against the current environmental setting. This approach is consistent with the Council on Environmental Quality's definition of "effects or impacts" at 40 CFR 1508.1(g): "Effects or impacts means changes to the human environment from the proposed action or alternatives that are reasonably foreseeable and have a reasonably close causal relationship to the proposed action or alternatives." The estimated use of this NWP, as well as the estimated authorized impacts and required compensatory mitigation, over the next 5 years are reasonably foreseeable and have a reasonably close causal relationship to the reissuance of this NWP.

The following evaluation comprises the NEPA analysis, the public interest review specified in 33 CFR 320.4(a)(1) and (2), and the impact analysis specified in Subparts C through F of the 404(b)(1) Guidelines (40 CFR Part 230).

The issuance of an NWP is based on a general assessment of the effects on public interest and environmental factors that are likely to occur as a result of using this NWP to authorize activities in waters of the United States. As such, this assessment must be speculative or predictive in general terms. Since NWPs authorize activities across the nation, projects eligible for NWP authorization may be constructed in a wide variety of environmental settings, and affect waters and wetlands of varying quality, from severely degraded to performing one or more functions to a high degree. Nationwide permit activities may result in permanent or temporary losses of aquatic resources, or partial or complete losses of aquatic resources. Therefore, it is difficult to predict all of the direct and indirect impacts that may be associated with each activity authorized by an NWP. For example, the NWP that authorizes 25 cubic yard discharges of dredged or fill material into various types of waters of the United States may be used to fulfill a variety of project purposes, and the direct and indirect effects may vary depending on the specific activity and the environmental characteristics of the site in which the activity takes place. Therefore, certain NWPs require pre-construction notification for certain activities to provide district engineers the opportunity to review proposed activities on a case-by-case basis and determine whether they will result in no more than minimal individual and cumulative adverse environmental effects.

Indication that a factor is not relevant to a particular NWP does not necessarily mean that the NWP would never have an effect on that factor, but that it is a factor not readily identified with the authorized activity. Factors may be relevant, but the adverse effects on the aquatic environment are negligible, such as the impacts of a boat ramp on water level fluctuations or flood hazards. Consistent with 40 CFR 1501.8(g), only the reasonably foreseeable effects or impacts that have a reasonably close causal relationship to the activities authorized as a result of the reissuance of this NWP are evaluated in detail in the environmental assessment for this NWP. Division and district engineers will impose, as necessary, additional conditions on the NWP authorization or exercise discretionary authority to address

regionally or locally important factors or to ensure that the authorized activity results in no more than minimal individual and cumulative adverse environmental effects. In any case, adverse effects will be controlled by the terms, conditions, and additional provisions of the NWP. For example, Section 7 Endangered Species Act consultation will be required for all activities that may affect endangered or threatened species or critical habitat (see 33 CFR 330.4(f) and NWP general condition 18).

In a specific watershed, division or district engineers may determine that the cumulative adverse environmental effects of activities authorized by this NWP are more than minimal. Division and district engineers will conduct more detailed assessments for geographic areas that are determined to be potentially subject to more than minimal cumulative adverse environmental effects. Division and district engineers have the authority to require individual permits in watersheds or other geographic areas where the cumulative adverse environmental effects are determined to be more than minimal, or add conditions to the NWP either on a case-by-case or regional basis to require mitigation measures to ensure that the cumulative adverse environmental effects of these activities are no more than minimal. When a division or district engineer determines, using local or regional information, that a watershed or other geographic area is subject to more than minimal cumulative adverse environmental effects due to the use of this NWP, he or she will use the revocation and modification procedure at 33 CFR 330.5. In reaching the final decision, the division or district engineer will compile information on the cumulative adverse effects and supplement the information in this document.

The Corps expects that the convenience and time savings associated with the use of this NWP will encourage applicants to design their projects within the scope of the NWP rather than request individual permits for projects which could result in greater adverse impacts to the aquatic environment. The minimization encouraged by the issuance of this NWP, as well as compensatory mitigation that may be required for specific activities authorized by this NWP, is likely to help reduce cumulative effects to the Nation's wetlands, streams, and other aquatic resources.

5.2 Impact Analysis

This NWP authorizes structures, work, and discharges of dredged or fill material into navigable waters of the United States for commercial shellfish mariculture activities. The impact analysis in this environmental assessment focuses on the impacts or effects that are likely to be caused by commercial shellfish mariculture activities that are authorized by the Corps under its permitting authorities (i.e., structures or work in navigable waters regulated under Section 10 of the Rivers and Harbors Act of 1899 and discharges of dredged or fill material into waters of the United States regulated under Section 404 of the Clean Water Act).

The potential impacts of activities authorized by this NWP on the Corps' public interest review factors listed in 33 CFR 320.4(a)(1) are discussed in more detail in section 6.0 of this document. The potential impacts on the aquatic environment that could be caused by discharges of dredged or fill material into waters of the United States authorized by this NWP are discussed, in general terms, in section 8.0 of this document in the Clean Water Act Section 404(b)(1) Guidelines analysis.

The terms of this NWP, including any acreage limits or any other quantitative limits in the text of the NWP, the protections provided by many of the NWP general conditions, plus any regional conditions imposed by division engineers and activity-specific conditions imposed by district engineers will help ensure that the activities authorized by this NWP result in no more than minimal individual and cumulative adverse environmental effects. An additional safeguard is the ability of district engineers to exercise discretionary authority and require project proponents to obtain individual permits for proposed activities whenever a district engineer determines that a proposed activity will result in more than minimal individual or cumulative adverse environmental effects after considering any mitigation proposed by the applicant (see 33 CFR 330.1(e)(3)).

The Council on Environmental Quality's NEPA regulations at 40 CFR 1508.1(g) defines "effects or impacts' as "changes to the human environment from the proposed action or alternatives that are reasonably foreseeable and have a reasonably close causal relationship to the proposed action or alternatives, including those effects that occur at the same time and place as the proposed action or alternatives and may include effects that are later in time or farther removed in distance from the proposed action or alternatives." Furthermore, 40 CFR 1508.1(g)(2) states that:

> [a] "but for" causal relationship is insufficient to make an agency responsible for a particular effect under NEPA. Effects should generally not be considered if they are remote in time, geographically remote, or the product of a lengthy causal chain. Effects do not include those effects that the agency has no ability to prevent due to its limited statutory authority or would occur regardless of the proposed action.

Therefore, the impact analysis in this environmental assessment focuses on the impacts or effects that are reasonably foreseeable and have a reasonably close causal relationship to the activities authorized by this NWP under the Corps' permitting authorities (i.e., work in navigable waters regulated under Section 10 of the Rivers and Harbors Act of 1899 and/or discharges of dredged or fill material into waters of the United States regulated under Section 404 of the Clean Water Act).

This NWP authorizes structures or work in navigable waters of the United States. Structures or work in navigable waters of the United States that may alter the ecological functions and services performed by those navigable waters. The Corps'

regulations for Section 10 of the Rivers and Harbors Act of 1899 in 33 CFR part 322 define the term “structure” as including, “without limitation, any pier, boat dock, boat ramp, wharf, dolphin, weir, boom, breakwater, bulkhead, revetment, riprap, jetty, artificial island, artificial reef, permanent mooring structure, power transmission line, permanently moored floating vessel, piling, aid to navigation, or any other obstacle or obstruction.” [33 CFR 322.2(b)] The Corps’ section 10 regulations define the term “work” as including, “without limitation, any dredging or disposal of dredged material, excavation, filling, or other modification of a navigable water of the United States.” [33 CFR 322.2(c)] Under this NWP, the section 10 authorization applies to discharges of dredged or fill material into waters of the United States that are also navigable waters under Section 10 of the Rivers and Harbors Act of 1899.

Structures or work in navigable waters of the United States does not typically result in losses of navigable waters, but they may change the ecological functions and services performed by those waters. Examples of exceptions would include fills in navigable waters to create fast land along the shoreline, or artificial islands. Structures and work in navigable waters may alter the physical, chemical, and biological characteristics of those waters, but they generally do not result in a loss in the quantity of navigable waters. Structures and work in navigable waters may alter the ecological functions and services provided by those waters. Those alterations will vary, depending on the specific characteristics of the specific activity authorized by this NWP and the environmental setting in which the NWP activity may occur. The environmental setting will vary from site to site, and from region to region across the country.

Certain commercial bivalve shellfish mariculture activities involve structures regulated under section 10, such as racks, cages, bags, lines, nets, and tubes, when those structures are placed in navigable waters. Dredging activities for commercial shellfish mariculture activities, including dredging for harvesting and bed preparation, are regulated under section 10 as work. Placing fill material in navigable water, including shell or gravel to provide suitable substrate for bivalve shellfish larvae to attach to and grow, is also regulated under section 10 as “work.” This is an on-bottom cultivation technique that can involve placing a relatively thin layer of shell, gravel, or other suitable material on the bottom of the waterbody, or placing that fill material to create mounds that reduce the likelihood of sedimentation that could smother bivalve shellfish larvae or older shellfish.

The installation and use of structures such as racks, cages, bags, lines, nets, and tubes, in navigable waters for commercial bivalve shellfish mariculture activities in navigable waters requires DA authorization under Section 10 of the Rivers and Harbors Act of 1899. Those structures may be floating or suspended in navigable waters, placed on the bottom of the waterbody, or installed in the substrate of the waterbody. The placement of mariculture structures in the water column or on the bottom of a waterbody does not result in a discharge of dredged or fill material that is regulated under section 404. While the presence of these structures in a waterbody may alter water movement and cause sediment to fall out of suspension

onto the bottom of the waterbody, that sediment deposition is not considered a discharge of dredged or fill material because those sediments were not discharged from a point source. In general, the placement of bivalve shellfish mariculture structures on the bottom of a navigable waterbody, or into the substrate of a navigable waterbody does not result in discharges of dredged or fill material into waters of the United States that are regulated under Section 404 of the Clean Water Act.

This NWP also authorizes discharges of dredged or fill material into waters of the United States. The Corps' regulations define "dredged material" as "material that is excavated or dredged from waters of the United States." [33 CFR 323.2(c)] The term "discharge of dredged material" means "any addition of dredged material into, including redeposit of dredged material other than incidental fallback within, the waters of the United States." [33 CFR 323.2(d)(1)] The term "discharge of dredged material" includes, but is not limited to, (1) the addition of dredged material to a specified discharge site located in waters of the United States; (2) the runoff or overflow from a contained land or water disposal area; and (3) any addition, including redeposit other than incidental fallback, of dredged material, including excavated material, into waters of the United States which is incidental to any activity, including mechanized land clearing, ditching, channelization, or other excavation. [33 CFR 323.2(d)(1)]

Under 33 CFR 323.2(d)(2), the term "discharge of dredged material" does not include any of the following:

> (1) discharges of pollutants into waters of the United States resulting from the onshore subsequent processing of dredged material that is extracted for any commercial use (other than fill). These discharges are subject to section 402 of the Clean Water Act even though the extraction and deposit of such material may require a permit from the Corps or applicable State section 404 program.
>
> (2) Activities that involve only the cutting or removing of vegetation above the ground (e.g., mowing, rotary cutting, and chainsawing) where the activity neither substantially disturbs the root system nor involves mechanized pushing, dragging, or other similar activities that redeposit excavated soil material.
>
> (3) Incidental fallback.

The term "fill material" is defined at 33 CFR 323.2(e)(1) as meaning "material placed in waters of the United States where the material has the effect of: (1) replacing any portion of a water of the United States with dry land; or (2) changing the bottom elevation of any portion of a water of the United States. Examples of fill material include: "rock, sand, soil, clay, plastics, construction debris, wood chips, overburden from mining or other excavation activities, and materials used to create any

structure or infrastructure in the waters of the United States." [33 CFR 323.2(e)(2)] "Fill material" does not include trash or garbage (see 33 CFR 323.2(e)(3)). Discharges of trash or garbage may be regulated under Section 402 of the Clean Water Act or other federal, state, or local laws and regulations.

The Corps' regulations define the term "discharge of fill material" as meaning "the addition of fill material into waters of the United States." [33 CFR 323.2(f)] Examples of discharges of fill material provided in section 323.2(f) include, but are not limited to, the following activities: (1) the placement of fill that is necessary for the construction of any structure or infrastructure in a water of the United States; (2) the building of any structure, infrastructure, or impoundment requiring rock, sand, dirt, or other material for its construction; (3) site-development fills for recreational, industrial, commercial, residential, or other uses; (4) causeways or road fills; (5) dams and dikes; (6) artificial islands; (7) property protection and/or reclamation devices such as riprap, groins, seawalls, breakwaters, and revetments; (8) beach nourishment; (9) levees; (10) fill for structures such as sewage treatment facilities, intake and outfall pipes associated with power plants and subaqueous utility lines; (11) placement of fill material for construction or maintenance of any liner, berm, or other infrastructure associated with solid waste landfills; (12) placement of overburden, slurry, or tailings or similar mining-related materials; and (13) artificial reefs. Under 33 CFR 323.2(f), the term "discharge of fill material" does not include plowing, cultivating, seeding and harvesting for the production of food, fiber, and forest products.

Discharges of dredged or fill material into a jurisdictional water or wetland authorized under Section 404 of the Clean Water Act may result in the complete or partial loss of stream bed, wetland area, or area of another type of aquatic resource. That complete or partial loss of aquatic ecosystem area may result in a complete or partial loss of aquatic resource functions and services. The direct effects to jurisdictional waters and wetlands caused by activities authorized by this NWP may change those waters and wetlands to components of the built environment or uplands, convert an aquatic resource type to another aquatic resource type, or alter the functions and services provided by those waters and wetlands. The direct effects to jurisdictional waters and wetlands caused by activities authorized by this NWP may be permanent or temporary. The indirect effects to jurisdictional waters and wetlands caused by activities authorized by this NWP may also convert an aquatic resource type to another aquatic resource type. The indirect effects to jurisdictional waters and wetlands caused by activities authorized by this NWP may be permanent or temporary. The contribution of activities authorized by this NWP to cumulative or aggregate effects to ocean waters, estuarine waters, lakes, wetlands, streams, and other aquatic resources is also dependent on the degree or magnitude to which the potentially affected aquatic resources perform ecological functions and services. Nearly all ocean waters, estuaries, lakes, wetlands, streams, and other aquatic resources have been directly and indirectly affected by human activities over time (e.g., Halpern et al. 2008 for oceans, Lotze et al. 2006 for estuaries, Zedler and Kercher (2005) for wetlands, Allan 2004 for streams), including land

uses in areas that drain to these aquatic resources.

Discharges of dredged or fill material into waters of the United States authorized by this NWP may alter the ecological functions and services performed by those jurisdictional waters and wetlands. Some ecological functions and services may be enhanced, some ecological functions and services may be diminished or eliminated, and other ecological functions and services might not be affected by specific activities authorized by this NWP. Some discharges of dredged or fill material into jurisdictional waters and wetlands authorized by this NWP may convert those waters and wetlands to dry lands while other discharges of dredged or fill material may change the structure and functions of those waters and wetlands, while allowing those waters and wetlands to continue to exist as waters of the United States and provide some ecological functions and services.

Some commercial shellfish mariculture activities involve mechanical or hydraulic harvesting techniques that may result in discharges of dredged material into jurisdictional waters and wetlands. As discussed above, on-bottom bivalve shellfish mariculture activities may involve placing fill material such as shell or gravel to provide suitable substrate for bivalve shellfish larvae to attach to and grow on the bottom of the waterbody. These fill activities may require section 404 authorization.

The term “shellfish seeding” is defined in Section E of the NWPs as the “placement of shellfish seed and/or suitable substrate to increase shellfish production. Shellfish seed consists of immature individual shellfish or individual shellfish attached to shells or shell fragments (i.e., spat on shell). Suitable substrate may consist of shellfish shells, shell fragments, or other appropriate materials placed into waters for shellfish habitat.” This definition was adopted in the NWPs in 2007 (see 72 FR 11197). Other materials may be used for bivalve shellfish seeding such as nets, bags, and ropes. Shellfish seed can be produced in a hatchery. Shellfish seed can also be produced in waterbodies where bivalve larvae can attach to appropriate materials, such as shell pieces, bags, or ropes.

Placing shellfish seed on the bottom of a waterbody is not a “discharge of fill material” and thus does not require a section 404 permit. Placing gravel or shell on the bottom of a waterbody to provide suitable substrate for bivalve larvae to attach to is considered to be a “discharge of fill material” and would require section 404 authorization. The shellfish themselves, either growing on the bottom of a waterbody or in nets, bags, or on ropes, are not considered to be “fill material” and do not require a section 404 permit to be emplaced, remain in place, or to be removed from a waterbody.

Discharges of dredged or fill material that convert wetlands, estuarine waters, marine waters, and other aquatic resources to upland areas may result in permanent losses of aquatic resource functions and services. Temporary fills and fills that do not convert waters or wetlands to dry land may cause short-term or partial losses of aquatic resource functions and services.

The individual environmental impacts are the environmental impacts caused by an activity authorized by this NWP, including the direct and indirect impacts caused by the specific NWP activity at the project site. When multiple PCNs are submitted by an applicant for contiguous project areas, the Corps' analysis will consider the cumulative effects of the commercial shellfish mariculture activities across those contiguous project areas, as well as other NWP 48 activities in the waterbody. In the context of the Corps' public interest review (33 CFR 320.4(a)(1) and Section 404(e) of the Clean Water Act, the cumulative environmental impacts are the environmental impacts caused by the activities authorized by this NWP during the 5-year period the NWP is anticipated to be in effect. Both the individual and cumulative environmental impacts are evaluated against the current environmental setting, which is described at a national scale in section 4.0 of this document. The current environmental setting varies substantially throughout the United States. In some areas of the country, the current environmental setting is the result of substantial alteration of waterbodies and other ecosystems by various human activities, but in other areas of the country, the current environmental setting has been less affected by various human activities, and those alterations are more subtle and more difficult to discern (Clewell and Aronson 2013). The categories of human activities that have altered aquatic ecosystems are discussed in section 4.4 of this document, and are summarized in Table 4.6. The types of ecological functions and services provided by aquatic ecosystems also vary considerably by region and by specific ecosystems, with some ecosystems performing ecological functions and services to a high degree, and other ecosystems performing ecological functions and services to a lesser degree.

The analysis of environmental consequences in this environmental assessment is a qualitative analysis because of the lack of quantitative data at a national scale on the various human activities and natural factors that may concurrently alter the current environmental setting during the 5-year period this NWP is expected to be in effect. As discussed in section 4.4, the activities authorized by this NWP are just one category among many categories of human activities and natural factors that affect ocean waters, estuarine waters, lakes, wetlands, streams, and other aquatic resources, and the ecological functions and services they provide.

As discussed in section 4.0 of this document and the Millennium Ecosystem Assessment (2005c), all ecosystems have been affected by human activities to some degree. According to Clewell and Aronson (2013), anthropogenic and natural disturbances to ecosystems can be placed in three categories: (1) stress with maintenance of ecosystem integrity; (2) moderate disturbance where the ecosystem can recover in time through natural processes; and (3) impairment, which may result in a more severe disturbance that may require human intervention (e.g., restoration) to prevent the ecosystem from changing into an alternative, perhaps less functional ecological state. Ecosystems can often tolerate gradual changes and continue to provide ecological functions and services before those changes reach a threshold, that when crossed, causes the ecosystem to change abruptly into an

alternative stable state (Scheffer et al. 2001). For some ecosystems, multiple impacts or disturbances can cause an ecosystem to pass a threshold can result in substantial changes to that ecosystem, but for other ecosystems the changes may be more subtle (Folke et al. 2004). It is difficult to predict where these thresholds are, and ecosystems may exhibit little change before that threshold is reached (Scheffer et al. 2009).

The severity of potential impacts to aquatic resources caused by NWP activities is dependent, in part, on ecosystem resilience and resistance, whether the permitted impacts are temporary or permanent, and how the affected resources respond to the permitted impacts. Impacts to aquatic resources caused by NWP activities may result in a partial, total, or no loss of aquatic resource functions and services, depending on the specific characteristics of the NWP activity and the environmental setting in which those impacts occur. In addition, the duration of the adverse effects (temporary or permanent) caused by NWP activities, can be influenced by the resilience and resistance of the aquatic resource to disturbances caused by those NWP activities. Since there is considerable variation across the country in terms of the types of aquatic resources, the ecological functions and services they provide, and their resilience and resistances to disturbances caused by NWP activities, other human activities, and natural disturbances, the environmental consequences of the issuance of this NWP will vary by site and by region. Given the geographic scope in which this NWP can be used to authorize activities that require DA authorization and the wide variability in aquatic resource structure, functions, and dynamics from site to site and from region to region, the analysis of environmental consequences is a qualitative analysis.

The environmental effects or impacts that are likely to be caused by individual activities authorized by this NWP are evaluated against the current environmental setting (i.e., the affected environment, which is described at a national scale in section 4.0 of this document). The current environmental setting is the result of human activities altering ecosystems over thousands of years (Perring and Ellis 2013), as well as natural changes in environmental conditions that have occurred over time. Since historical baselines (i.e., the state of ecosystems in the absence of modifications caused by human activities) no longer exist in most areas, ecosystem management decisions should be made by using contemporary baselines that acknowledge how humans have dominated and changed ecosystems over long periods of time (Kopf et al. 2015). Permit decisions are an example of management decisions for ecosystems such as oceans, estuaries, lakes, rivers, streams, and wetlands, where the proposed impacts that require a permit are evaluated against the current environmental setting to decide whether the permit (e.g., an NWP authorization) should be issued by the regulatory authority.

The impacts of activities authorized by this NWP during the 5-year period it is anticipated to be in effect are evaluated against the current affected environment, to determine the potential severity of those anticipated impacts in light of the human alterations and natural changes to aquatic ecosystems that have occurred over time

and space. This evaluation takes into account how the activities authorized by this NWP might affect aquatic ecosystems, the resilience of aquatic ecosystems, and the ability of aquatic ecosystems to continue to provide ecological functions and services after the authorized activities have occurred. When evaluating pre-construction notifications, district engineers should be taking into account the current environmental setting, as well as how the jurisdictional waters and wetlands might respond as a result of conducting the NWP activity, including how resilient those waters and wetlands are to disturbances caused by discharges of dredged or fill material and/or structures or work in navigable waters.

Compensatory mitigation required by district engineers for specific activities authorized by this NWP may help reduce the contribution of those activities to the cumulative effects caused by NWPs on the Nation's wetlands, streams, and other aquatic resources, by providing ecological functions to partially or fully replace some or all of the aquatic resource functions lost as a result of those activities. Mitigation requirements, including compensatory mitigation requirements for the NWPs, are described in general condition 23. Compensatory mitigation projects must also comply with the applicable provisions of 33 CFR part 332. District engineers will establish compensatory mitigation requirements on a case-by-case basis, after evaluating pre-construction notifications. Compensatory mitigation requirements for individual NWP activities will be specified through permit conditions added to NWP authorizations. When compensatory mitigation is required, the permittee is required to submit a mitigation plan prepared in accordance with the requirements of 33 CFR 332.4(c). Credits from approved mitigation banks or in-lieu fee programs may also be used to satisfy compensatory mitigation requirements for NWP authorizations. Monitoring is required to demonstrate whether the permittee-responsible mitigation project, mitigation bank, or in-lieu fee project is meeting its objectives and providing the intended aquatic resource structure and functions. If the compensatory mitigation project is not meeting its objectives, adaptive management will be required by the district engineer. Adaptive management may involve taking actions, such as site modifications, remediation, or design changes, to ensure the compensatory mitigation project meets its objectives (see 33 CFR 332.7(c)).

The estimated use of this NWP during the 5-year period the NWP is expected to be in effect and the estimated impacts to wetlands, streams, and other aquatic resources in the United States, plus the estimated acreage of compensatory mitigation, is provided in section 8.2.2 of this document. Division and district engineers will monitor the use of this NWP on a regional and case-specific basis, and under their authorities in 33 CFR 330.5(c) and (d), modify, suspend, or revoke NWP authorizations in situations when the use of the NWP will result in more than minimal cumulative adverse environmental effects. Because the activities authorized by this NWP constitute only a small proportion of the categories of human activities that directly and indirectly affect ocean waters, estuarine waters, lakes, wetlands, streams, and other aquatic resources, the activities authorized by this NWP over the next 5 years are likely to result in only a minor incremental change to the current environmental setting for ocean waters, estuarine waters,

lakes, wetlands, streams, and other aquatic resources and the ecological functions and services they provide.

Under 33 CFR 330.4(f)(2), for an NWP activity proposed by a non-federal permittee, the district engineer will review the pre-construction notification and if she or he determines the proposed NWP activity may affect listed species or designated critical habitat, section 7 consultation will be conducted with the U.S. Fish and Wildlife Service (U.S. FWS) or National Marine Fisheries Service (NMFS) depending on which species the district engineer determined may be affected by the proposed NWP activity. During the ESA section 7 consultation process the U.S. FWS or NMFS will evaluate the effects caused by a proposed NWP activity, the environmental baseline, the status of the species and critical habitat, and the effects of any future state or private activities that are reasonably certain to occur within the action area. For formal ESA section 7 consultations, the U.S. FWS or NMFS will formulate their opinion as to whether the proposed NWP activity is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat (see 50 CFR 402.14(g)). The ESA section 7 consultation requirements may also be fulfilled through informal consultation, when the U.S. FWS or NMFS provide their written concurrence that the proposed activity is not likely to adversely affect endangered or threatened species or their designated critical habitat (see 50 CFR 402.13(c)). The project proponent may be required to obtain separate incidental take authorizations under the Marine Mammals Protection Act.

When determining whether a proposed NWP activity will cause no more than minimal individual and cumulative adverse environmental effects, the district engineer will consider the direct and indirect effects caused by the NWP activity. He or she will also consider the cumulative adverse environmental effects caused by activities authorized by the NWP and whether those cumulative adverse environmental effects are no more than minimal. The district engineer will also consider site specific factors, such as the environmental setting in the vicinity of the NWP activity, the type of resource that will be affected by the NWP activity, the functions provided by the aquatic resources that will be affected by the NWP activity, the degree or magnitude to which the aquatic resources perform those functions, the extent that aquatic resource functions will be lost as a result of the NWP activity (e.g., partial or complete loss), the duration of the adverse effects (temporary or permanent), the importance of the aquatic resource functions to the region (e.g., watershed or ecoregion), and mitigation required by the district engineer. If an appropriate functional or condition assessment method is available and practicable to use, that assessment method may be used by the district engineer to assist in the minimal adverse environmental effects determination. These criteria are listed in the NWPs in Section D, “District Engineer’s Decision.” The district engineer may add case-specific special conditions to the NWP authorization to address site-specific environmental concerns.

Additional conditions can be placed on proposed activities on a regional or case-by-

case basis by division or district engineers to ensure that the activities have no more than minimal individual and cumulative adverse environmental effects. Regional conditions added to this NWP will be used to account for differences in aquatic resource functions, services, and values across the country, ensure that the NWP authorizes only those activities with no more than minimal individual and cumulative adverse environmental effects, and allow each Corps district to prioritize its workload based on where its efforts will best serve to protect the aquatic environment. Regional conditions can prohibit the use of an NWP in certain waters (e.g., high value waters or specific types of wetlands or waters. Specific NWPs can also be revoked on a geographic or watershed basis where the individual and cumulative adverse environmental effects resulting from the use of those NWPs are more than minimal.

Commercial shellfish mariculture activities can have temporary and permanent impacts on the aquatic environment, including the species that inhabit coastal waters. These impacts are discussed in more detail below. The severity of the impacts, both negative and positive, can vary as a result of scale and location of the bivalve shellfish mariculture operation(s), the species being cultivated, the equipment and techniques used by the grower, and the hydrodynamic and physical characteristics of the bivalve mariculture site (NRC 2010). In its 2010 report titled "Ecosystem Concepts for Sustainable Bivalve Mariculture" the National Research Council (NRC) recommended that the impacts should be evaluated in a policy context that examines the relative costs and benefits of seafood production for human consumption and altering aquatic ecosystems. In their examination of oyster mariculture activities on the west coast, Simenstad and Fresh (1995) found that many disturbances caused by these activities were within the natural range of variation for disturbances to estuarine ecosystems. Intensive bivalve shellfish mariculture activities can cause larger scale disturbances to species that are not being cultivated, but impacts to those species should be assessed in the context of their ability to tolerate disturbances (Simenstad and Fresh 1995). Bivalve shellfish mariculture activities cause disturbances that are within the range of natural disturbances (such as severe storms) that occur in coastal waters, and seagrasses are naturally adapted to that range of disturbances (Dumbauld and McCoy 2015). While species of submerged aquatic vegetation can be relatively sensitive to disturbances, they also have the ability to recover from disturbances through various reproductive mechanisms (e.g., Tallis et al. 2009, O'Brien et al. 2018). O'Brien et al. (2018) identified four paths by which seagrasses could recover after disturbance(s) are removed rapid recovery (within 1 year), full recovery within 5 years, delayed recovery (longer than 5 years), and recalcitrant degradation. Recalcitrant degradation occurs when the cause(s) of seagrass bed degradation persists and prevent seagrasses from recolonizing the affected area. Recalcitrant degradation can be viewed as a permanent loss, even though there may be potential for recovery (O'Brien et al. 2018).

Temporary impacts may include temporary structures placed in navigable waters, such as bags, cages, trays, and racks; stakes; and long lines that are supported by

stakes or piles. However, some of these structures may be installed in waters for longer periods of time (e.g., months or years) and may be considered permanent impacts when in place for long periods of time, Temporary impacts also include dredging, and the duration of those impacts can vary depending on the intensity and duration of dredging. Permanent impacts can include permanent structures such as piles that are installed in the waterbody to provide a permanent structure to attach equipment to, and shell or gravel that is discharged into the waterbody to provide suitable substrate for larval bivalve shellfish to attach to and grow. The species cultivated by commercial shellfish mariculture activities also affect the aquatic environment and other species, for example by altering water quality through suspension feeding or competition for space. Those impacts can be positive, negative, or neutral, and can vary the techniques used for commercial shellfish mariculture activities. There is a growing body of scientific literature regarding the interactions between commercial shellfish mariculture activities and submerged aquatic vegetation that has shown that the impacts of these activities on submerged aquatic vegetation can in certain instances be temporary, some of which is discussed below. Additional research is needed to evaluate the magnitude and duration of these impacts for all regions of the United States and for all species of submerged aquatic vegetation.

Commercial shellfish mariculture activities can disturb benthic plants and animals, modify biogeochemical processes, change water flows, alter substrate composition, and provide structures with hard habitat that attracts fish and invertebrates, which may include both native and non-native species (NRC 2010). Impacts to submerged aquatic vegetation caused by oyster cultivation activities can be reduced through by using cultivation techniques that result in fewer impacts or by reducing oyster planting densities (Tallis et al. 2009). Commercial shellfish mariculture activities are similar to other food production activities, in that they involve trade-offs with the ecosystems being affected by those activities (Tallis et al. 2009), in order to provide food for people. Appropriate siting of commercial shellfish mariculture activities can allow for active avoidance of many trade-offs and ensure activities occur in areas with the least potential impact (Wickliffe et al. 2019). Standards and best management practices can be implemented by growers to minimize the adverse environmental effects of commercial shellfish mariculture operations (NRC 2010). Such standards and best management practices may added to DA permits as permit conditions if they satisfy the criteria for permit conditions at 33 CFR 325.4(a): that is they are necessary to satisfy legal requirements, and are directly related to the impacts of the proposal, appropriate to the scope and degree of those impacts, and reasonably enforceable.

As discussed above, commercial shellfish mariculture activities have both positive and negative environmental effects, including effects on certain species that inhabit coastal waters. The severity of those impacts can vary by the bivalve mariculture method and location, as well as the intensity and duration of the operation (NRC 2010). Commercial shellfish mariculture techniques vary, and some species can be grown through a variety of techniques. Commercial shellfish mariculture techniques

include on-bottom and off-bottom culture methods, and some bivalve shellfish mariculture methods involve dredging whereas others do not. The adverse effects of dredging associated with commercial shellfish mariculture activities, including harvesting, vary with intensity and duration of the dredging, as well as the type of substrate and which species are present in the area (NRC 2010). Both on-bottom and off-bottom bivalve shellfish mariculture techniques may involve the use of bags, racks, cages, and trays. The various commercial shellfish mariculture methods can exhibit substantial differences in impacts to the aquatic environment, and to species that inhabit coastal waters. Commercial shellfish mariculture operations may use chemicals to control fouling organisms (NRC 2010). Operators may also use pesticides to control predators, but the discharge of pesticides into navigable waters is regulated under Section 402 of the Clean Water Act, not section 404.

On-bottom commercial shellfish mariculture techniques include adding shell, gravel, or other material to create substrate for larval bivalve molluscs to attach to and grow until they are harvested, either by dredging or by hand. The shell, gravel, or other material may be deposited in a manner to create hummocks, or the material may be deposited so that it is relatively flat. On-bottom methods also involve placing cages, racks, and bags on the bottom of the waterbody. When the bivalves are ready to be harvested, the cages, racks, and bags are removed until they are ready to be used for the next growing cycle. In general, dredging is not used with bottom culture that uses cages, racks, and bags (NRC 2010). On-bottom culture using cages, racks, and bags usually does not involve substantial disturbance of the substrate. The placing of shell, gravel, or other material for bottom culture generally has longer lasting impacts compared to the use of cages, racks, and bags. The deposited shell or gravel can bury submerged aquatic vegetation and other benthic organisms. Cages, racks, and bags can also cover submerged aquatic vegetation and other benthic organisms, but with a lesser degree of disturbance where recovery can occur more quickly than when dredging is used during commercial shellfish mariculture operations. There may also be foot traffic in intertidal areas where bags and racks are used for bottom culture, to maintain those structures and to harvest the bivalve shellfish. The use of cages, bags, and racks can also alter water flow through the site, and well as sediment deposition (NRC 2010). The placement of bags in the intertidal zone may also reduce foraging habitat for shorebirds (NRC 2010), and those adverse effects may cease after the bags are removed. On-bottom culture is used for clam, including geoducks. Geoducks are cultivated in the intertidal zone in plastic tubes covered by netting to keep predators from eating the geoduck (Dumbauld et al. 2009). Geoducks are harvested by jetting water into the substrate and pulling out the geoduck (NRC 2010).

Off-bottom commercial shellfish mariculture techniques involve the use of floating containers, suspended containers, or lines. These methods are typically used in deeper waters (Dumbauld et al. 2009). The floating or suspended containers may be bags, cages, and racks that are supported in the water column. Off-bottom cultivation methods can shade submerged aquatic vegetation and other benthic organisms but they typically do not disturb the substrate. Anchors and moorings

used for off-bottom cultivation methods can disturb the substrate. Shading effects associated with floating or suspended containers will cease after they are removed, but the ability of submerged aquatic vegetation to recover depends on multiple factors. Shading from in-water structures also leads to effects that may be short- or long-term, depending on the length of time shading occurs and the species of submerged aquatic vegetation affected. The shading impacts will cease after the floating or suspended containers are removed. They can also interfere with navigation. The suspended and floating containers can act as attractants for fish and large crustaceans (e.g., crabs), which may feed on the fouling (epibiotic) organisms that attach to the bags, cages, racks, and lines (NRC 2010). These off-bottom structures may also have positive and negative effects on birds, marine mammals, and marine turtles (NRC 2010), such as attracting prey species that those organisms can feed on or by posing a risk of entanglement and drowning. Long lines can be used to cultivate oysters and mussels, where the long line is supported by stakes, and other lines hang vertically in the water column that hold the seeds of the bivalves to be cultivated so that they can feed and grow (Dumbauld et al. 2009). Long lines can alter the hydrodynamics in the vicinity of the commercial shellfish mariculture operation, and increase sedimentation in the area (NRC 2010). After the long lines are removed, the hydrodynamics and sedimentation are likely to recover. When long lines are used for commercial shellfish mariculture activities, harvesting is usually done by hand (Dumbauld et al. 2009).

Structures used for commercial shellfish mariculture activities can provide habitat for a wide variety of organisms, and serve as attractants for fish, mobile crustaceans, birds, and other organisms (NRC 2010, Gentry et al. 2020) over the time the structures are in place or prior to any harvesting activities. Harvesting activities may result in disturbance of benthic habitats that could negate any short-term benefits. Fouling organisms such as barnacles, tunicates, sponges, and bryozoans may establish and grow on these structures, and provide food for fish and motile crustaceans (Hosack et al. 2006, Forrest et al. 2009), as well as birds NRC (2010). They can also provide hiding places to avoid predators. Lines and nets used for commercial shellfish mariculture activities may pose a risk of entanglement for birds, marine mammals, and marine turtles (NRC 2010, Price et al. 2016).

Commercial shellfish mariculture techniques may involve dredging, and the duration and intensity of the impacts of dredging can vary by substrate type (NRC 2010). Submerged aquatic vegetation can recover after being impacted by dredging for commercial shellfish mariculture activities, and recovery may take a few years or longer, or may not occur (Dumbauld et al. 2009). Compared to other techniques, commercial shellfish mariculture activities that involve dredging can have more substantial impacts on estuaries and the organisms that inhabit those estuaries. Oysters can be harvested by hand or by using machines (Tallis et al. 2009). Mechanical harvesting can include grading, tilling, and dredging the substrate of the waterbody. Floating and bottom culture commercial shellfish mariculture techniques that use lines, cages, bags, rafts, and racks do not require dredging of the substrate (NRC 2010). Recovery of areas disturbed by these floating and bottom culture

commercial shellfish mariculture techniques that do not involve dredging can in some instances occur rather quickly as long as there is minimal disturbance of the substrate, depending on the submerged aquatic vegetation species affected, environmental setting, and other factors. For example, shading effects are typically quickly reversed after the bags, cages, racks, and long lines are removed from the waterbody, however the ability of submerged aquatic vegetation to recover depends on multiple factors.

Impacts to estuarine ecosystems caused by commercial shellfish mariculture activities, such as seeding and harvesting, that have been evaluated in previous studies tend to be mostly short-term, pulse disturbances (i.e., temporary impacts), with few long-term, press disturbances (i.e., permanent impacts) (Dumbauld et al. 2009). Commercial shellfish mariculture activities conducted using structures such as cages, racks, and bags, including on-bottom and suspended culture, have less severe impacts on the substrate (NRC 2010) because they are either placed on the substrate without minimal disturbance or they are suspended or floating above the substrate. If commercial shellfish mariculture activities cease in an estuary inhabited by submerged aquatic vegetation, the submerged aquatic vegetation that was impacted by those commercial shellfish mariculture activities may recover within a few years, depending upon the degree of disturbance, other stressors in the area, and the species of seagrass affected (sensu Dumbauld et al. 2009). These situations occur when the grower is letting the bottom of the waterbody go fallow for a period of time or has decided to cease commercial shellfish mariculture operations altogether in that area. After disturbance, recovery of submerged aquatic vegetation may be through asexual reproduction (i.e., the spread of rhizomes) or sexual reproduction (i.e., the production of seeds and subsequent germination) (Wisehart et al. 2007). Both natural and human-induced disturbances, including commercial shellfish mariculture and harvesting activities, stimulate sexual reproduction of some submerged aquatic vegetation species (NRC 2010). Tallis et al. (2009) observed that eelgrass exhibited higher growth rates in areas where shellfish were dredged or hand-picked from the bottom than eelgrass inhabiting areas where no bivalve shellfish harvesting was occurring.

Commercial shellfish mariculture activities have been occurring in the United States for more than 100 years (NRC 2010), and submerged aquatic vegetation has continued to persist in waterbodies where there these activities are conducted (Ferriss et al. 2019). Submerged aquatic vegetation beds are dynamic, and often vary from year to year even in waters where water quality is high (Orth et al. 2006), so changes in submerged aquatic vegetation beds may result from anthropogenic and/or natural causes at various temporal and spatial scales. This depends on the species of seagrass and geographic location due to physical factors such as temperature. In some cases, while there may not be evidence of seagrass on the seafloor, a seed bank is present that will be lost if dredging occurs. Dumbauld et al. (2009) concluded that eelgrass and bivalve shellfish mariculture have co-existed in west coast estuaries for decades. These west coast estuaries had substantial populations of native oysters, and after those native oysters were overharvested,

they did not recover (Dumbauld et al. 2009) to historic population sizes. Tallis et al. (2009) concluded that there are trade-offs to be considered when evaluating commercial shellfish mariculture activities and their impacts on submerged aquatic vegetation. When district engineers evaluate permit applications and general permit verification requests for commercial shellfish mariculture activities requiring DA authorization, they should consider the ecological functions and services provided by the cultivated bivalves and the ecological functions and services provided by submerged aquatic vegetation and other species inhabiting the affected waterbodies. That evaluation can occur during the public interest review for an individual permit or when determining whether to exercise discretionary authority for a proposed general permit activity.

If commercial shellfish mariculture activities occur within estuarine or marine waters inhabited by submerged aquatic vegetation, there will be competition between the bivalves and submerged aquatic vegetation for space (Ferriss et al. 2019), unless the commercial shellfish mariculture activities can avoid areas inhabited by submerged aquatic vegetation (i.e., through improved siting (Wickliffe et al. 2019)). Competition for space in estuaries and coastal waters between bivalve molluscs and seagrasses has occurred naturally because both of these groups of organisms have historically been present in these waters. Competition for space is a natural ecological process (Odum and Barrett 2005), and it can be affected by human activities such as habitat modifications and overexploitation of species such as oysters, mussels, clams, and scallops. As oysters, clams, and other bivalves have been harvested and overexploited over the centuries (e.g., Zu Ermgassen et al. 2012, Lotze et al. 2006), their removal has created openings for seagrasses and other organisms to colonize benthic habitats that were previously occupied by bivalves. However, loss of natural oyster reefs and other bivalves that have historically provided water clarification benefits paired with other synergistic environmental stressors (e.g., eutrophication) have also contributed to degraded water quality conditions that have reduced suitable habitat for, and extent of, seagrasses and other benthic species (Beck et al. 2011, Sharma et al. 2016).

In west coast estuaries, eelgrass co-exist with shellfish on intertidal flats at the low densities typically practiced for commercial shellfish mariculture activities (Dumbauld et al. 2009). Tallis et al. (2009) observed that eelgrass density decreased with increasing commercial shellfish mariculture activity density because of competition for space. Introduced Pacific oysters now occupy areas that were historically extensive beds of native oysters (Dumbauld et al. 2009), so this competition for space has occurred under both natural conditions and during shellfish mariculture operations. In the Chesapeake Bay, expanding oyster mariculture efforts can compete with submerged aquatic vegetation for space in shallow waters (Orth et al. 2017), but current oyster populations in that waterbody are approximately 1 percent of their historical level (using the early 1800s as a baseline) because of overfishing, habitat loss, and disease (Wilberg 2011). If commercial shellfish mariculture activities cease temporarily (e.g., during fallow periods) or permanently (e.g., by terminating those activities), the submersed

aquatic vegetation is likely to recover unless other stressors (e.g., increased turbidity) prevent submerged aquatic vegetation beds from re-establishing themselves.

The responses of one genus of submerged aquatic vegetation (*Zostera* spp.) to bivalve mariculture activities varies by region and by mariculture techniques (Ferriss et al. 2019). In waterbodies inhabited by submerged aquatic vegetation where commercial shellfish mariculture activities are conducted, seagrass is in dynamic equilibrium with those mariculture activities (Dumbauld et al. 2009). The amount of time it takes for submerged aquatic vegetation to recover from disturbances caused by commercial shellfish mariculture activities varies by plant species, the extent of the disturbance, the intensity of the disturbance, the seasonal timing of disturbance, and sediment characteristics (NRC 2010). In their review of the effects of commercial shellfish mariculture activities on seagrasses in estuaries on the west coast of the United States, Dumbauld et al. (2009) found that the amount of time it took eelgrass to recover to pre-disturbance levels varied from less than 2 years to more than 5 years. In estuaries on the west coast of the United States, commercial shellfish mariculture activities have been undertaken for over a century and have not been found to cause estuarine waterbodies to change to an alternative state or exhibit a decreased ability to recover from disturbances (Dumbauld et al. 2009).

Pre-construction notification is required for commercial shellfish mariculture activities that directly affect more than 1/2-acre of submerged aquatic vegetation. The pre-construction notification requirement provides the district engineer with an opportunity to review those activities on a case-by-case basis and assess potential impacts on submerged aquatic vegetation and ensure that the authorized activity results in no more than minimal adverse environmental effects. The activities authorized by this NWP would also require pre-construction notification if one of the pre-construction notification thresholds in one of the NWP general conditions is triggered. For example, paragraph (c) of general condition 18, endangered species, requires a non-federal permittee to submit a pre-construction notification if any listed species or designated critical habitat might be affected by the proposed NWP activity or is in the vicinity of the proposed NWP activity, or if the activity is located in designated critical habitat.

Activities authorized by this NWP may directly and indirectly alter ecosystems and the functions and services they provide, through permanent and temporary impacts caused by discharges of dredged or fill material into jurisdictional waters and wetlands, and structures or work in navigable waters of the United States. Direct impacts to ecosystems may include permanent or temporary losses of ecological functions and services performed by those ecosystems. Direct impacts to ecosystems may result in complete or partial losses of ecological functions and services. Indirect impacts to ecosystems may occur later in time, or at some distance from the direct impacts authorized by this NWP, and they may be permanent or temporary in duration, or result in complete or partial losses of ecological functions and services.

The potential effects of activities authorized by this NWP on the Corps' public interest review factors listed in 33 CFR 320.4(a)(1) are discussed in more detail in section 6.0 of this document.

The pre-construction notification requirement allows district engineers to review proposed activities on a case-by-case basis to ensure that the individual and cumulative adverse environmental effects of those activities are no more than minimal. If the district engineer determines that the individual and cumulative adverse environmental effects of a particular project are more than minimal after considering mitigation, then discretionary authority will be asserted and the applicant will be notified that another form of DA authorization, such as a regional general permit or individual permit, is required (see 33 CFR 330.4(e) and 330.5).

When making minimal adverse environmental effects determinations the district engineer will consider the direct and indirect effects caused by the NWP activity. He or she will also consider the cumulative adverse environmental effects caused by activities authorized by NWP and whether those cumulative adverse environmental effects are no more than minimal. The district engineer will also consider site specific factors, such as the environmental setting in the vicinity of the NWP activity, the type of resource that will be affected by the NWP activity, the functions provided by the aquatic resources that will be affected by the NWP activity, the degree or magnitude to which the aquatic resources perform those functions, the extent that aquatic resource functions will be lost as a result of the NWP activity (e.g., partial or complete loss), the duration of the adverse effects (temporary or permanent), the importance of the aquatic resource functions to the region (e.g., watershed or ecoregion), and mitigation required by the district engineer. If an appropriate functional or condition assessment method is available and practicable to use, that assessment method may be used by the district engineer to assist in the minimal adverse environmental effects determination. These criteria are listed in the NWPs in Section D, "District Engineer's Decision." The district engineer may add case-specific special conditions to the NWP authorization to address site-specific environmental concerns.

Additional conditions can be placed on proposed activities on a regional or case-by-case basis to ensure that the activities have no more than minimal individual and cumulative adverse environmental effects. Regional conditioning of this NWP will be used to account for differences in aquatic resource functions, services, and values across the country, ensure that the NWP authorizes only those activities with no more than minimal individual and cumulative adverse environmental effects, and allow each Corps district to prioritize its workload based on where its efforts will best serve to protect the aquatic environment. Regional conditions can prohibit the use of an NWP in certain waters (e.g., high value waters or specific types of wetlands or waters), lower pre-construction notification thresholds, or require pre-construction notification for some or all NWP activities in certain watersheds or types of waters. Specific NWPs can also be revoked on a geographic or watershed basis where the

individual and cumulative adverse environmental effects resulting from the use of those NWPs are more than minimal.

In high value waters, division and district engineers can: 1) prohibit the use of the NWP in those waters and require an individual permit or regional general permit; 2) impose an acreage limit on the NWP; 3) lower the notification threshold of the NWP to require pre-construction notification for activities with smaller impacts in those waters; 4) require pre-construction notification for some or all NWP activities in those waters; 5) add regional conditions to the NWP to ensure that the individual and cumulative adverse environmental effects are no more than minimal; or 6) for those activities that require pre-construction notification, add special conditions to NWP authorizations, such as compensatory mitigation requirements, to ensure that the adverse environmental effects are only minimal. Nationwide permits can authorize activities in high value waters as long as the individual and cumulative adverse environmental effects are no more than minimal.

The construction and use of fills for temporary access for construction may be authorized by NWP 33 or regional general permits issued by division or district engineers. The related activity must meet the terms and conditions of the specified permit(s). If the activity is dependent on portions of a larger project that require an individual permit, this NWP will not apply. [See 33 CFR 330.6(c) and (d)]

5.3 Impact Analysis for Alternatives to the Proposed Action

5.3.1 No Action Alternative (Do Not Modify or Reissue the Nationwide Permit)

The no action alternative would not achieve one of the goals of the Corps' Nationwide Permit Program, which is to regulate with little, if any, delay or paperwork certain activities having minimal impacts (33 CFR 330.1(b)). The no action alternative would also reduce the Corps' ability to pursue the current level of review for other activities that have greater adverse effects on the aquatic environment, including activities that require individual permits as a result of division or district engineers exercising their discretionary authority under the NWP program. The no action alternative would also reduce the Corps' ability to conduct compliance actions.

If this NWP is not available, substantial additional resources would be required for the Corps to evaluate these minor activities through the individual permit process, and for the public and federal, tribal, and state resource agencies to review and comment on the large number of public notices for these activities. In a considerable majority of cases, when the Corps publishes public notices for proposed activities that result in no more than minimal adverse environmental effects, the Corps typically does not receive responses to these public notices from either the public or federal, tribal, and state resource agencies. Therefore, processing individual permits for these minimal impact activities is not likely to result

in substantive changes to those activities. Another important benefit of the NWP program that would not be achieved through the no action alternative is the incentive for project proponents to design their projects so that those activities meet the terms and conditions of an NWP. The Corps believes the NWPs have significantly reduced adverse effects to the aquatic environment because most applicants modify their activities that require DA authorization to comply with the NWPs and avoid the longer permit application review times and larger costs typically associated with the individual permit process.

Under the no action alternative, district engineers may issue regional general permits or programmatic general permits to authorize similar categories of activities that would have no more than minimal adverse environmental effects that could have been authorized by this NWP. However, those regional general permits or programmatic general permits may have different quantitative limits, different restrictions, and other permit conditions, and those quantitative limits, restrictions, and permit conditions may result in the authorization of activities that have greater, similar, or lesser adverse environmental effects than the activities that would have been authorized by this NWP. Under the no action alternative, there may be differences in consistency in implementation of the Corps Regulatory Program among Corps districts. District engineers can tailor their regional general permits and programmatic general permits to effectively address the specific categories of aquatic resources found in their geographic areas of responsibility, the specific categories of activities that occur in those geographic areas, and the ecological functions and services those categories of aquatic resources provide. The environmental consequences of this aspect of the no action alternative are more difficult to predict because of the potential variability of regional general permits and programmatic general permits among Corps districts across the country, when such general permits are available to authorize a similar category of activities as this NWP authorizes.

If this NWP is not reissued, districts would have to draft, propose, and issue regional general permits or programmatic general permits through the public notice and comment process and prepare applicable environmental documentation to support their decisions on whether to issue those regional general permits or programmatic general permits. It would take a substantial amount of time to issue those regional general permits and programmatic general permits, and in the interim proposed activities would have to be authorized through the individual permit process.

5.3.2 Reissue the Nationwide Permit With Modifications

This NWP was developed to authorize structures and work in navigable waters of the United States and discharges of dredged or fill material into waters of the United States for commercial shellfish mariculture activities that have no more than minimal individual and cumulative adverse environmental effects. The Corps has considered changes to the terms and conditions of this NWP suggested by comments received

in response to the proposed rule, as well as modifying or adding NWP general conditions, as discussed in section 1.4 of this document and the preamble of the Federal Register notice announcing the modification and reissuance of this NWP.

Changing the terms and conditions of this NWP would likely result in changes the number of activities authorized by this NWP, and the environmental impacts of authorized activities. The environmental consequences of changing the terms and conditions of this NWP may vary, depending on whether modifications for the reissued NWP are more restrictive, less restrictive, or is similarly restrictive compared to previously issued versions of this NWP. The environmental consequences of changing the terms and conditions of this NWP are also dependent on the application of existing tools used to ensure that activities authorized by this NWP will only have no more than minimal adverse environmental effects. Those tools include the quantitative limits of the NWP, the pre-construction notification process, and the ability of division and district engineers to modify, suspend, or revoke this NWP on a regional or case-by-case basis.

Changing the national terms and conditions of this NWP may change the incentives for project proponents to reduce their proposed impacts to jurisdictional waters and wetlands to qualify for NWP authorization, and receive the required DA authorization for regulated activities in less time than it would take to receive individual permits for those activities. Under the individual permit process, the project proponent may request authorization for activities that have greater impacts on jurisdictional waters and wetlands, and may result in larger losses of aquatic resource functions and services.

The environmental consequences of division engineers exercising their discretionary authority to modify, suspend, or revoke this NWP on a regional basis may be a reduction in the number of activities that could be authorized by this NWP in a region or more NWP activities requiring pre-construction notification through regional changes in the PCN requirements for this NWP. The environmental consequences are likely to include reduced losses of waters of the United States because regional conditions can only further condition or restrict the applicability of an NWP (see 33 CFR 330.1(d)). The modification, suspension, or revocation of this NWP on a regional basis by division engineers may also reduce the number of activities authorized by this NWP, which may increase the number of activities that require standard individual permits. If more activities require standard individual permits, permitted losses of jurisdictional waters and wetlands may increase because standard individual permits have no quantitative limits.

An environmental consequence of regional conditions added to the NWPs by division engineers is the enhanced ability to address differences in aquatic resource functions, services, and values among different regions across the nation. Corps divisions may add regional conditions to the NWPs to enhance protection of the aquatic environment in a region (e.g., a Corps district, state, or watershed) and address regional concerns regarding jurisdictional waters and wetlands and other

resources (e.g., listed species or cultural resources) that may be affected or impacted by the activities authorized by this NWP. Division engineers can also revoke an NWP in a region if the use of that NWP results in more than minimal adverse environmental effects, especially in high value or rare waters or wetlands. When an NWP is issued or reissued by the Corps, division engineers issue supplemental documents that evaluate potential impacts of the NWP at a regional level, and assess cumulative impacts caused by this NWP on a regional basis during the period this NWP is in effect. [33 CFR 330.5(c)]

An environmental consequence of district engineers modify, suspending, or revoking this NWP on a case-by-case basis is the ability of district engineers to address site-specific conditions, including the degree to which aquatic resources on the project site provide ecological functions and services. Activity-specific modifications may also address site-specific resources (e.g., listed species or cultural resources) that may be affected by NWP activities. The environmental consequences of modification of this NWP on an activity-specific basis by district engineers may be further reductions in losses of waters of the United States for specific activities authorized by NWP because of mitigation required by district engineers during their reviews of PCNs to ensure that those activities result in no more than minimal individual and cumulative adverse environmental effects (see 33 CFR 330.1(e)(3)). Examples of mitigation that may be required by district engineers include permit conditions requiring compensatory mitigation to offset losses of waters of the United States or conditions added to the NWP authorization to prohibit the permittee from conducting the activity during specific times of the year to protect spawning fish and shellfish. If a proposed NWP activity will result in more than minimal adverse environmental effects, then the district engineer will exercise discretionary authority and require an individual permit. The individual permit review process requires a project-specific alternatives analysis, including the consideration of off-site alternatives, and a public interest review.

5.3.3 Reissue the Nationwide Permit Without Modifications

Retaining the current terms and conditions of this NWP would likely result in little or no changes in the number of activities authorized by this NWP, and the environmental impacts of authorized activities. Project proponents would likely continue to design their project to qualify for NWP authorization. Retaining the current national terms and conditions of this NWP would likely continue to provide incentives for project proponents to reduce their proposed impacts to jurisdictional waters and wetlands to qualify for NWP authorization, and receive the required DA authorization for regulated activities in less time than it would take to receive individual permits for those activities. Under this alternative, for those activities that require individual permits project proponents may request authorization for activities that have greater impacts on jurisdictional waters and wetlands, and may result in larger losses of aquatic resource functions and services.

Under this alternative, the environmental consequences of division engineers

exercising their discretionary authority to modify, suspend, or revoke this NWP on a regional basis would be similar to the environmental consequences discussed in section 5.3.2. Corps divisions may add regional conditions to the NWPs to enhance protection of the aquatic environment in a region (e.g., a Corps district, state, or watershed) and address regional concerns regarding jurisdictional waters and wetlands and other resources (e.g., listed species or cultural resources) that may be affected or impacted by the activities authorized by this NWP. Division engineers can also revoke an NWP in a region if the use of that NWP results in more than minimal adverse environmental effects, especially in high value or rare waters or wetlands. When an NWP is issued or reissued by the Corps, division engineers issue supplemental documents that evaluate potential impacts of the NWP at a regional level, and assess cumulative impacts caused by this NWP on a regional basis during the period this NWP is in effect. [33 CFR 330.5(c)]

Under this alternative, the ability of district engineers to modify, suspended, or revoke this NWP on a case-by-case to address site-specific conditions, including the degree to which aquatic resources on the project site provide ecological functions and services, is likely to have environmental consequences similar to the environmental consequences of the alternative identified in section 3.2. Activity-specific modifications under this alternative may also address site-specific resources (e.g., listed species or cultural resources) that may be affected by NWP activities. Activity-specific modifications may also include mitigation requirements similar to the potential mitigation requirements discussed in section 5.3.2.

The modification and reissuance of this NWP adopts the alternative identified in section 3.2 of this document. The Corps has considered the comments received in response to the proposed rule, and made changes to the NWPs, general conditions, and definitions to address those comments. Division engineer may add regional conditions to this NWP to help ensure that the use of the NWPs in a particular geographic area will result in no more than minimal individual and cumulative adverse environmental effects. District engineers may also add regional conditions to this NWP to help ensure compliance with other applicable laws, such as Section 7 of the Endangered Species Act, Section 106 of the National Historic Preservation Act, and the essential fish habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act. Division engineers may also add regional conditions to this NWP to fulfill its tribal trust responsibilities.

Corps divisions and districts also monitor the use of this NWP and the authorized impacts identified in NWP verification letters. At a later time, if warranted, a division engineer may add regional conditions to further restrict or prohibit the use of this NWP to ensure that it does not authorize activities that result in more than minimal adverse environmental effects in a particular geographic region (e.g., a watershed, landscape unit, or seascape unit). To the extent practicable, division and district engineers will use regulatory automated information systems and institutional knowledge about the typical adverse effects of activities authorized by this NWP, as well as substantive public comments, to assess the individual and cumulative

adverse environmental effects resulting from regulated activities authorized by this NWP.

6.0 Public Interest Review

6.1 Public Interest Review Factors (33 CFR 320.4(a)(1))

For each of the 20 public interest review factors, the extent of the Corps consideration of expected impacts resulting from the use of this NWP is discussed, as well as the reasonably foreseeable cumulative adverse effects that are expected to occur. The Corps decision-making process involves consideration of the benefits and detriments that may result from the activities authorized by this NWP.

(a) Conservation. The activities authorized by this NWP are likely to result in minor changes to the natural resource characteristics of the project area, since the NWP authorizes commercial shellfish mariculture activities. Commercial shellfish mariculture activities can contribute to conservation efforts in estuaries and other coastal waters as restorative measures (NRC 2010) because they perform many of the same ecological functions and services that were provided by natural populations of bivalve molluscs before those bivalves were overfished by humans over the centuries (van der Schatte Olivier et al. 2020). Mitigation measures may be required by district engineers to minimize impacts to conservation values. Dumbauld and McCoy (2015) recommend examining the effects of oyster mariculture activities on eelgrass at the scale of estuarine ecosystems because such a perspective indicates that those mariculture activities have relatively small impacts on seagrasses and that seagrasses recover quickly after disturbance. Simenstad and Fresh (1995) concluded that the many of the impacts of commercial shellfish mariculture activities on coastal waters were within the range of natural variation for these dynamic ecosystems.

Commercial shellfish mariculture activities may help restore ecological functions and services to coastal waters in areas where overexploitation of bivalve molluscs has substantially reduced populations of those organisms (NRC 2010). The cultivated species can provide many of the same ecosystem functions and services as wildly occurring species (Froehlich et al. 2017), which may have been overharvested by local communities over time. Estuarine and marine habitats are often substantially degraded and it might not be feasible to conduct traditional restoration efforts for these aquatic ecosystems, so bivalve shellfish mariculture activities have potential to improve a variety of ecosystem services that might not otherwise be enhanced in these waterbodies (Alleway et al. 2019). Some mariculture activities can help restore biogenic habitats that can help improve ecosystems functions and services (Froehlich et al. 2017).

Commercial shellfish mariculture activities may facilitate the introduction of non-

native species (NRC 2010) to a waterbody or region. For example, in a review of the environmental effects of mussel mariculture activities, McKindsey et al. (2011) stated that these activities can facilitate introduction of non-native species to coastal waters, including invasive tunicate, ascidian, algal, and molluscan species. Aquaculture activities, including commercial shellfish mariculture activities, has been the cause of numerous introductions of non-native species of seaweeds, fish, invertebrates, parasites, and pathogens (Naylor 2001). With respect to commercial bivalve shellfish mariculture activities, during the past several decades there have been no introductions of non-native bivalve species into U.S. waters for commercial production activities (NRC 2010).

Non-native bivalve shellfish species used for commercial mariculture activities can have effects on native species communities and ecological processes, with subsequent ecological and economic impacts (NRC 2010). The effects of non-native species on ecological processes, as well as biodiversity, can be positive, negative, or neutral (Shackelford et al. 2013). Non-native species can provide important ecological functions and services, especially in ecosystems that have been severely modified through human activities and native species are less abundant because of those human modifications (Ewel and Putz 2004). Decisions regarding management of non-native species should be based on impacts, not origin (Davis et al. 2011).

Heck et al. (2003) examined the potential nursery functions (abundance, growth, and survival of juvenile aquatic animals) of seagrass beds and compared them to the potential nursery functions of other structured habitats such as oyster reefs or macroalgal beds. They found few significant differences existed in juvenile animal abundance, growth or survival when comparing seagrass beds with the structured habitats. Thus, the enhanced survival of organisms in seagrass beds compared to unvegetated habitats appeared to be the result of the availability of structural habitat, which can provide aquatic organisms places to hide from predators and places for food sources (e.g., epibiotic organisms) to establish and grow.

Standards and best management practices can be implemented by growers to minimize the adverse environmental effects of commercial shellfish mariculture operations (NRC 2010). Standards and best management practices would be more appropriately developed for certain species or regions (Simenstad and Fresh 1995) because these standards and practices can vary in effectiveness for different species or groups of species. Species-specific or regional standards and best management practices may be appropriate as regional conditions approved by division engineers through the processes at 33 CFR 330.5(c). Species-specific or resource-specific conditions can be added to individual NWP authorizations through permit conditions imposed by district engineers (33 CFR 330.5(d)). Such standards and best management practices may added to DA permits as permit conditions if they satisfy the criteria for permit conditions at 33 CFR 325.4(a): that is they are necessary to satisfy legal requirements, and are directly related to the impacts of the proposal, appropriate to the scope and degree of those impacts, and reasonably

enforceable. Thoughtfully planned and sustainable mariculture activities can help provide conservation values (Froehlich et al. 2017).

(b) Economics. Commercial shellfish mariculture activities will have positive impacts on the local economy. These activities will generate jobs and revenue for local growers as well as revenue to supply companies that sell materials used for these activities. Commercial shellfish mariculture activities supply seafood for restaurants and other consumers, which can provide economic benefits for entities that sell bivalves to restaurants and food markets, and the people that work in restaurants and food markets. The authorized mariculture activities will also benefit the community by improving the local economic base, which is affected by employment, tax revenues, community services, and property values. Bivalve shellfish mariculture activities can provide materials for a variety of beneficial uses, such as shell used for building materials (e.g., lime for cement), medicines, and substrate for restoration activities, (Alleway et al. 2019). Bivalve shellfish mariculture activities can provide jobs and other economic benefits in isolated communities, as well as communities that are impoverished or otherwise disadvantaged (Alleway et al. 2019). Both mariculture industry representatives and members of the public that are not directly involved in the mariculture industry recognize the economic benefits of bivalve mariculture (D'Anna and Murray 2015).

(c) Aesthetics. Commercial shellfish mariculture activities may alter the visual character of some waters of the United States. The extent and perception of these changes will vary, depending on the size and configuration of the mariculture activity, the nature of the surrounding area, and the public uses of the area. The use of the project area and the surrounding land may also alter local aesthetic values. Impacts on aesthetics can be positive, negative, or neutral, and may depend on the perspectives of people who live in the vicinity of the commercial shellfish aquaculture activity, or are visitors to the area. In areas where commercial shellfish mariculture activities have been conducted for many years, long-term residents may view the aesthetic impacts as positive or neutral because they have become accustomed to those activities (NRC 2010). In these areas, newer residents may consider the effects of these activities on aesthetics to be negative because they do not want to see these activities in waters near the places they live and work (NRC 2010). Commercial shellfish mariculture equipment, such as PVC tubes, plastic lines, and canopy nets may break away from the operation and may impair the aesthetics of the waters and shoreline in the vicinity of the operation. Some regulatory authorities may require mariculture equipment to be marked to identify the operator so that equipment that went astray can be returned to the operator. Operators of commercial shellfish mariculture activities can work with local communities to reduce the visual impacts of these activities (NRC 2010).

General condition 13 requires, to the maximum extent practicable, the removal of temporary structures after their use has been discontinued. Under Section 404 of the Clean Water Act, the Corps does not regulate the placement of trash or garbage into waters of the United States, because trash or garbage is specifically excluded

from the definition of “fill material” at 33 CFR 323.2(e). Discharges of trash or garbage into waters of the United States, including navigable waters, may be regulated by EPA and approved states under Section 402 of the Clean Water Act.

The commercial shellfish mariculture activities authorized by this NWP may affect various aesthetic characteristics of coastal areas, such as visual, noise, and smell. Coastal property owners may perceive that these activities have positive, negative, or neutral effects on local aesthetics. Some property owners may object to commercial shellfish mariculture activities occurring in coastal waters near their homes or businesses (NRC 2010).

(d) General environmental concerns. Activities authorized by this NWP will likely have positive, negative, or neutral effects on general environmental concerns, such as water, air, noise, and land pollution. Commercial shellfish mariculture activities can have positive and negative environmental effects on coastal waters (NRC 2010). By consuming phytoplankton and converting nutrients into biomass, the cultivated bivalves can help reduce eutrophication in coastal waters and reduce some of the adverse effects of eutrophication (NRC 2010, Gentry et al. 2020). The authorized activities may also affect the physical, chemical, and biological characteristics of the aquatic environment. Bivalve mariculture industry representatives and members of the public have different perceptions of the environmental impacts of bivalve mariculture activities, with industry members generally having positive views (while acknowledging some negative environmental impacts) and non-industry members of the public having negative or uncertain views of environmental impacts (D’Anna and Murray 2015). The adverse effects of the activities authorized by this NWP on general environmental concerns are likely to be minor since district engineers retain discretionary authority to require individual permits for proposed activities that have more than minimal adverse environmental effects. Sustainable mariculture activities can be conducted through careful and thoughtful site selection, establishing an appropriate size for the mariculture operation, and selecting appropriate species to cultivate (Froehlich et al. 2017).

At moderate population densities, commercially produced shellfish populations may improve general environmental concerns, such as water and habitat quality, within navigable waters by removing suspended materials and plankton from the water column in waters subject to eutrophication and by providing physical structure to the waterbody that can be used as habitat by some aquatic organisms (Dumbauld et al. 2009, Forrest et al. 2009). Adverse effects to the chemical composition of the aquatic environment will be controlled by general condition 6, which states that the material used for construction must be free from toxic pollutants in toxic amounts. General condition 23 requires mitigation to minimize adverse effects to the aquatic environment through avoidance and minimization at the project site. Mitigation, such as best management practices and on-site avoidance and minimization measures may be required by district engineers through the addition of conditions to the NWP authorization to ensure that the net adverse effects on the aquatic environment are

minimal. Production of bivalve molluscs through commercial shellfish mariculture operations can sequester carbon through shell formation and growth (NRC 2010). Specific environmental concerns are also addressed in other sections of this document.

The impacts of commercial shellfish mariculture activities on the environment are dependent on the species being cultivated, the characteristics of the affected waterbody, and the scale of the commercial shellfish mariculture activity (NRC 2010), as well as the cultivation techniques that are used and the other types of aquatic organisms living in or near the project area. Some commercial shellfish mariculture activities involve the use of protective structures such as fences and netting that can alter water flows, increase sediment deposition, and provide structural habitat to which fouling organisms can attach (NRC 2010).

Pesticides may be used for bivalve mariculture activities (NRC 2010, Simenstad and Fresh 1995). Herbicides may be used to control invasive plants that may interfere with bivalve mariculture activities (Patten 2014). The application of pesticides and herbicides into waters of the United States may be regulated by the U.S. EPA or approved states under Section 402 of the Clean Water Act. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the U.S. EPA may also regulate pesticide distribution, sale, and use. The Corps does not have the legal authority to regulate the use of pesticides, herbicides, and other chemicals such as antifouling agents, that may be used during the operation of commercial shellfish mariculture activities to control other organisms, such as diseases and fouling organisms. Antifouling agents may be used to clean structures used for bivalve mariculture activities. The Corps does not have the authority to prevent the use of antifouling agents during commercial shellfish mariculture operations.

The Corps does not have the legal authority to control the placement of trash or garbage in navigable waters of the United States. The placement of trash or garbage into navigable waters of the United States may be regulated under Section 402 of the Clean Water Act. The Corps' regulations at 33 CFR 323.3(e)(3) state that trash and garbage are not considered "fill material" for the purposes of Section 404 of the Clean Water Act. Therefore, the Corps does not have the legal authority to control the placement of trash or garbage into waters of the United States. However, the Corps does have the legal authority to require that temporary structures placed in navigable waters of the United States and temporary discharges of dredged or fill material into waters of the United States to be removed after completion of the authorized work. Some regulatory authorities may require the mariculture operator to periodically retrieve debris. General condition 13 requires temporary structures to be removed after their use has been discontinued.

Materials used for commercial shellfish mariculture activities may become dislodged because of storms or strong water movements, and they may be abandoned or left to litter the waterbody or the shoreline. Section 13 of the Rivers and Harbors Act of 1899 (33 U.S.C. 407), also known as the Refuse Act, required permits for

discharges of refuse into navigable waters. The Corps' permitting authority under section 13 has been superseded by the permitting authority provided to the U.S. Environmental Protection Agency and states under Sections 402 and 405 of the Clean Water Act. Therefore, trash or garbage from commercial shellfish mariculture activities is not regulated by the Corps under is permit authorities, and may be regulated by U.S. EPA and the states under other sections of the Clean Water Act. Under Section 404 of the Clean Water Act, the term "fill material" does not include trash or garbage (see 33 CFR 323.2(e)(3)).

When evaluating the individual and cumulative effects of shellfish mariculture activities on estuarine and marine ecosystems, including submerged aquatic vegetation, several investigators have recommending conducting these evaluations at an ecosystem or landscape/seascape scale (e.g., NRC 2010, Simenstad and Fresh 1995, Dumbauld et al. 2015), rather than focusing on only the immediate site where the shellfish mariculture activities are occurring. The geographic scope for the assessment of cumulative effects can be a waterbody or a portion of a large waterbody. Using an ecosystem or landscape/seascape scale approach for assessing the cumulative effects of shellfish mariculture activities helps take into account the highly dynamic nature of coastal waters, and the various ecological components of those waters (e.g. water quality, seagrasses, finfish species, and invertebrate species) and how they change over time and space as a result of natural and anthropogenic disturbances. A cumulative effects analysis would also provide context on the degree to which commercial shellfish mariculture activities, compared to A cumulative effects analysis should also take into account how other human activities such as urban, suburban, and agricultural land uses in coastal watersheds, forestry activities in coastal watersheds, shoreline alteration activities, and point and non-point sources of pollution, have shaped the current environmental setting (i.e., the environmental baseline) in a waterbody or a specific area of coastal waters. An ecosystem or landscape/seascape approach for assessing the cumulative effects of shellfish mariculture activities would provide a better understanding of the scale and intensity of the effects of those mariculture activities on the structure, functions, and dynamics of coastal waters (NRC 2010), and assist the Corps in determining whether NWP 48 activities are resulting in no more than minimal cumulative adverse environmental effects. Further discussion of cumulative effects analysis for activities authorized by this NWP is provided elsewhere in this document.

A cumulative effects analysis will be particularly important in a waterbody or specific area of coastal waters where an applicant submits multiple PCNs for projects in contiguous areas, and where other entities are conducting commercial shellfish mariculture activities authorized by NWP 48. However, it will be important to determine the geographic scale at which a robust cumulative effects assessment can be conducted. For example, it would be inappropriate to analyze cumulative effects across an entire region if commercial shellfish mariculture operations are being concentrated in specific waterbodies or other smaller geographic areas. Cumulative effects analyses for NWP 48 activities should take into account other

human activities that result in similar stressors to those that may result from commercial shellfish mariculture operations, such as the use of vessels, changes in water quality in coastal and nearshore areas from point and non-point sources of pollution, and in-water construction and operation of in-water structures.

McKindsey at al. (2011) identified a number of environmental effects that floating and suspended mussel mariculture activities have on coastal waters, and they recognize that some of those effects are negative and some of those effects are positive. They stated that it is important to consider the trade-offs of the various positive and negative effects of these activities and what is important in terms of making management decisions for these coastal waters. There are social aspects that need to be considered for management decisions, including the values different segments of society place on coastal waters and the ecological functions and services (including food production through commercial shellfish mariculture activities) coastal waters can provide. From the Corps' perspective the public interest review is a mechanism for making permit decisions for activities that require DA authorization under Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act. The Corps' public interest review is a framework for evaluating the benefits which reasonably may be expected to accrue from an activity requiring Corps authorization against its reasonably foreseeable detriments (see 33 CFR 320.4(a)(1)). Reasonably foreseeable impacts to one or more public interest review factors can be a basis for a division or district engineer exercising discretionary authority to modify, suspend, or revoke NWP authorizations (33 CFR 330.1(d)). Locating commercial shellfish mariculture activities in degraded coastal waters has the potential to help improve the ability of those waters to provide ecosystem services such as habitat and nutrient reduction (water quality) (Alleway et al. 2019). Structures used for commercial shellfish mariculture activities, such as long lines and floating racks and cages, may alter current patterns and water circulation in the vicinity of the operation (NRC 2010). Dredging for bivalve shellfish harvesting can have adverse effects on coastal habitat and the organisms that utilize those habitats (NRC 2010).

The design of commercial shellfish mariculture activities, along with operational standards (e.g., stocking densities, rotational practices, biosecurity measures), can help reduce the adverse effects of these activities on marine and coastal environments and facilitate production of ecosystem services (Alleway et al. 2019). Some of these operational standards may be added to NWP 48 authorizations through conditions added by district engineers, or regional conditions imposed by division engineers, when those operational standards apply to the activities authorized by the Corps and are reasonably enforceable by the Corps. For those commercial shellfish mariculture activities that require ESA Section 7 consultation, additional conditions may be imposed on the operator to avoid and minimize potential effects to ESA-listed species or designated critical habitat. In cases where mariculture activities are likely to adversely affect ESA-listed species, measures will be required to minimize incidental take of endangered or threatened species. In cases where mariculture activities are likely to adversely affect critical habitat, the

proposed commercial shellfish mariculture activity cannot destroy or adversely modify designated critical habitat. For commercial shellfish mariculture activities that may adversely affect essential fish habitat designated under the provisions of the Magnuson-Stevens Fishery Conservation and Management Act, district engineers may add permit conditions to avoid, minimize, or offset impacts to essential fish habitat to conserve the habitat of fish species subject to approved fishery management plans.

Some activities authorized by this NWP may adversely affect macroalgae if the commercial shellfish mariculture activity is conducted in a waterbody inhabited by macroalgae. The bivalve molluscs cultivated through commercial shellfish mariculture activities will consume plankton, which includes macroalgae suspended in the water column. Planktonic microalgae is consumed through the filter feeding by bivalves, which convert the microalgae into biomass and energy, for metabolism, growth, and reproduction. Consumption of planktonic microalgae by bivalve molluscs can also improve water clarify and reduce eutrophication (NRC 2010).

(e) Wetlands. This NWP does not authorize activities in non-tidal wetlands or waters, so it is unlikely that the activities authorized by this NWP will adversely affect non-tidal waters and wetlands. The commercial shellfish mariculture activities authorized by this NWP may result in impacts to emergent tidal wetlands. However, impacts to emergent tidal wetlands are likely to be minor since these activities generally occur in subtidal or intertidal waters, seaward of fringe tidal wetlands. However, in some areas of the country, commercial shellfish mariculture activities may occur in intertidal areas, which may be inhabited by seagrasses (Ferriss et al. 2019). In many cases the impacts to tidal wetlands and intertidal seagrasses will be temporary since commercial shellfish mariculture activities primarily utilize temporary structures. This NWP does not authorize attendant features that might result in the permanent loss of fringe emergent wetlands, such as boat ramps, stockpiles, or staging areas. Those activities may be authorized by other NWPs, regional general permits, or individual permits, and the effects to emergent tidal wetlands will be evaluated through those other permitting processes. Emergent tidal wetlands may also be adversely affected by shellfish harvesting activities, and many of those impacts may be temporary as the tidal wetlands recover after disturbance.

Wetlands provide habitat, including foraging, nesting, spawning, rearing, and resting sites for aquatic and terrestrial species. The loss or alteration of wetlands may alter natural drainage patterns. Wetlands reduce erosion by stabilizing the substrate. Wetlands also act as storage areas for stormwater and flood waters. The loss of wetland vegetation will adversely affect water quality because these plants trap sediments, pollutants, and nutrients and transform chemical compounds. Wetland vegetation also provides habitat for microorganisms that remove nutrients and pollutants from water. Wetlands, through the accumulation of organic matter, act as sinks for some nutrients and other chemical compounds, reducing the amounts of these substances in the water.

The activities authorized by this NWP may result in impacts to submersed aquatic vegetation (e.g., seagrasses) that inhabit intertidal and subtidal waters. This NWP requires pre-construction notification for commercial shellfish mariculture activities that directly affect more than 1/2-acre of submerged aquatic vegetation. This pre-construction notification requirement provides the district engineer with an opportunity to review those activities and assess potential impacts on submerged aquatic vegetation and ensure that the authorized activity results in no more than minimal adverse environmental effects.

Discharges of dredged or fill material into waters of the United States for commercial shellfish mariculture activities may cover submersed aquatic vegetation, when on-bottom culture methods involve discharges of shell, gravel, and other materials to create flats or mounds to which bivalve shellfish larvae can attach to and grow. Seagrasses may also be disturbed or removed through regulated bivalve shellfish harvesting activities, such as hydraulic and mechanical dredging and harvesting cultivated shellfish by hand or hand tools. Submerged aquatic vegetation impacted by bivalve harvesting activities may recover, although the time frame for recovery can vary and is dependent on a number of factors (e.g., Ferriss et al. 2019, Tallis et al. 2009). In a study of oyster mariculture in a west coast estuary, Dumbauld and McCoy (2015) determined that eelgrass can recover within one to four years after mechanical disturbances occur, with the rate of recovery dependent on the severity of the impact, the location in the estuary, and the reproductive mechanism used (e.g., seed germination versus vegetative reproduction through rhizomes). Dredge harvesting activities can stimulate growth of submersed aquatic vegetation (Tallis et al. 2009), even though it breaks the stems, leaves, and rhizomes of seagrasses and reduces seagrass density. which can negatively impact seagrass beds. Mechanical harvesting techniques can have greater impacts on seagrasses than hand harvesting methods, as well as longer seagrass recovery times (Ferriss et al. 2019). Long lines and hand harvesting generally have less impact on submersed aquatic vegetation than dredge harvesting (Tallis et al. 2009). The responses of one genus of submerged aquatic vegetation (i.e., *Zostera* spp.) to bivalve mariculture activities varied regionally and by cultivation methods (Ferriss et al. 2019).

For on-bottom bivalve shellfish mariculture techniques that involve the placement of structures such as long-lines, bags, and cages on the bottom of the waterbody, submersed aquatic vegetation may be covered by those structures. Seagrasses may grow in subtidal and intertidal waters between the structures. Long lines, suspended bags, and floating bags used for commercial shellfish mariculture activities can shade submersed aquatic vegetation, but the severity of those shading effects on seagrasses depends on the configuration of those structures (Skinner et al. 2014). In a global metanalysis of interactions between bivalve mariculture activities and eelgrass, Ferriss et al. (2019) found that on-bottom bivalve mariculture was associated with significant increases in eelgrass growth rates and reproduction, with decreases eelgrass density and biomass—indicators of negative overall impacts to eelgrass. General condition 13 requires, to the maximum extent

practicable, the removal of temporary structures after their use has been discontinued, and seagrasses may be able to grow back in the affected area after those structures are removed, depending on multiple factors.

Off-bottom bivalve shellfish mariculture techniques, such as floating bags, racks, and cages, may shade submerged aquatic vegetation, affecting its distribution and abundance (e.g., NRC 2010). Those adverse effects on seagrass distribution and abundance may be temporary if seagrasses are able to successfully recover after the floating structures are removed. Seagrasses may also grow and persist in areas between the floating or suspended shellfish mariculture structures, where light can penetrate the water column between those structures. Off-bottom bivalve mariculture practices caused significant decreases in density, percent cover, and reproduction for a genus of seagrasses (*Zostera* spp.) (Ferriss et al. 2019), as a result of shading.

In some west coast estuaries, seagrasses coexist with commercial oyster mariculture activities (Dumbauld et al. 2015). The removal of burrowing shrimp as a result of control methods used for commercial shellfish mariculture activities can increase seagrasses in those areas (Tallis et al. 2009, Simenstad and Fresh 1995). Nutrients in biodeposits or excreta from cultivated bivalve shellfish can enhance growth of seagrasses (NRC 2010), and may contribute to productivity in coastal waters with lower nutrient levels. These benthic invertebrates may be consumed by fish and large, motile crustaceans such as crabs.

Seagrasses provide important ecological functions and services such as organic carbon production and export, nutrient cycling, sediment stabilization, enhanced biodiversity, and transfers of energy between adjacent habitats (Orth et al. 2006). Dumbauld and McCoy (2015) identified the following ecological functions performed by seagrasses: enhanced biodiversity, structured habitat for fish and invertebrates (nurseries, refuge from predation), sediment accretion and erosion control by dampening water currents, carbon sequestration, and foraging areas for waterfowl and shorebirds.

Dumbauld and McCoy (2015) found that while oyster mariculture has a negative effect on eelgrass populations in an estuary in Washington State, that negative effect is small when considered in light of the large areas occupied by eelgrass and oysters within that estuary. They observed that disturbances on eelgrass caused by oyster mariculture activities were fairly small, both spatially and temporally, and eelgrass was present within the oyster mariculture beds. Tallis et al. (2009) concluded that eelgrass populations in estuaries were affected by biological and physical factors caused by shellfish mariculture activities, and eelgrass co-exists with oyster mariculture in vigorous populations. The abundance and distribution of seagrasses may be affected by suspended or floating mussel mariculture activities through a variety of mechanisms, such as shading from floating or suspended mariculture structures, altered nutrient levels, changes in water turbidity, changes in sediment biogeochemistry, physical disturbances caused by harvesting activities

and operational activities, and changes in sediment stability (McKindsey et al. 2011).

General condition 23 requires avoidance and minimization of impacts to waters of the United States, including wetlands, at the project site. Division engineers can regionally condition this NWP to restrict or prohibit the use of this NWP in high value tidal wetlands. District engineers will also exercise discretionary authority to require an individual permit if the wetlands to be filled are high value and the activity will result in more than minimal adverse environmental effects. District engineers can also add case-specific special conditions to the NWP authorization to provide protection to wetlands.

(f) Historic properties. General condition 20 states that in cases where the district engineer determines that the activity may affect properties listed, or eligible for listing, in the National Register of Historic Places, the activity is not authorized, until the requirements of Section 106 of the National Historic Preservation Act have been satisfied. There may be situations where commercial shellfish mariculture activities are proposed in waters next to historic districts on the National Register, and if those proposed activities might have the potential to affect historic properties then pre-construction notification to the district engineer is required (see paragraph (c) of NWP general condition 20), so that the district engineer can determine whether section 106 consultation is required before the activity can be authorized by NWP.

(g) Fish and wildlife values. This NWP authorizes activities in tidal waters of the United States, which provide habitat to many species of fish and wildlife. Some fish and wildlife may be attracted to structures used for commercial shellfish mariculture activities, which can provide structural habitat that supports epibiotic organisms that are food for fish and wildlife (NRC 2010). Birds, marine turtles, and marine mammals may be entangled in gear used for commercial shellfish mariculture activities, such as long lines and netting (NRC 2010). Activities authorized by this NWP may alter the habitat characteristics of tidal waters. Some species of aquatic organisms will benefit from those changes, while other species will be adversely affected (Dumbauld et al. 2009). Tidal waters, including tidal wetlands and vegetated shallows, provides food and habitat for many species, including foraging areas, resting areas, corridors for fish movement, and nesting and breeding grounds. Open waters provide habitat for fish and other aquatic organisms. Equipment used for commercial shellfish mariculture activities, such as canopy nets, may impede bird feeding activity and trap birds. On the other hand, structures used for commercial shellfish activities may also become encrusted with fouling organisms, which may be a food source for some bird species.

Shellfish seeding activities associated with commercial shellfish mariculture activities may enhance local populations of bivalve molluscs, which can provide ecological functions and services along with naturally occurring bivalve molluscs. Commercial shellfish mariculture activities may adversely affect benthic invertebrate communities, and the type and severity of those adverse effects may be dependent

on the scale of the mariculture activities, the bivalve species cultivated, the cultivation techniques used, and the physical characteristics of the site used for those operations (NRC 2010). On the other hand, the structures used for commercial shellfish mariculture activities, and the bivalve molluscs themselves, can provide positive effects such as increases in structured habitat for benthic organisms, including epibiotic organisms that may serve as food for other benthic organisms (NRC 2010). For example, in a study of utilization of structured habitat provided by mesh used for clam mariculture activities, Powers et al. (2007) found that clam mariculture structures (which were occupied by epibiotic organisms) and seagrass beds supported higher abundances of juvenile fish and motile invertebrates than unstructured to sand flat habitat.

The faunal and floral communities that attach to, or are attracted to, the structural habitat provided by mussel mariculture equipment are functionally similar to the benthic communities that are found in other hard structural habitats in coastal waters (McKindsey et al. 2011). The structural habitat provided by mussel mariculture equipment can provide substrate for epibenthic organisms that (e.g., invertebrates and algae) are food sources for fish and other invertebrates, and provide refuge areas for aquatic animals to hide from predators. Benthic habitat used by fish and invertebrates may also be enhanced on the bottom of the waterbody below suspended bivalve mariculture structures by cultivated molluscs dropping off of the mariculture structures and aggregating on the substrate (McKindsey et al. 2011).

D’Amours et al. (2008) examined abundances of epibenthic macroinvertebrates and fish in the vicinity of mussel mariculture activities using suspended cultivation techniques and they found greater abundances of these organisms near these activities compared to benthic habitats more than 50 meters from the mussel mariculture activities. They concluded that these organisms were attracted to increased food supply attached to the mussel cultivation structures. Mariculture structures can provide habitat for organisms in a manner similar to artificial reefs (e.g., Dealteris et al. 2004, D’Amours et al. 2008, Forrest et al. 2009), by attracting epibiotic organisms as well as mobile invertebrates, such as crabs, and fish to areas that previously had no structural habitat (e.g., sand flats without submersed aquatic vegetation). Mariculture structures can also provide refuge from predators, by giving aquatic organisms places to hide (D’Amours et al. 2008, Powers et al. 2007)

The hard habitat provided by bivalve mollusc mariculture structures can serve as substitute nursery habitat for numerous species and help sustain populations of these species while losses of natural structural habitat occur (Powers et al. 2007). Compared to mudflats, areas with oyster bottom culture generally support more diverse communities of benthic and epibenthic organisms through the complex habitat provided by oyster shells (Simenstad and Fresh 1995), and these more diverse benthic and epibenthic communities can support fish and wildlife. Bivalve shellfish mariculture activities may indirectly cause decreases in fish biomass if the mariculture structures attract fish and those fish become easier to capture by

humans or other predators (Alleway et al. 2019). Organisms growing on commercial shellfish mariculture structures can act as a food source for birds and other organisms, and provide other habitat functions such as shelter, roosting, and haul-out sites for birds and some marine mammals (NRC 2010). Off-bottom bivalve mariculture activities can support larger numbers of individuals and species because they provide more substrate for epibiotic organisms that attract fish, crustaceans, and other aquatic organisms (NRC 2010). However, these structures may also increase the risk of entanglement of marine animals.

In a review of the effects of off-bottom and suspended mussel culture on benthic communities, McKindsey et al. (2011) found that long line and bouchot mussel cultivation methods added substantial amounts of structural habitat that was used by a variety of benthic organisms. Structural habitat can be provided by rafts, bouchots, and long lines, including the anchors that hold long lines in place and the floats that suspend the long line in the water column. The lines or socks that mussels attach to and grow may also provide structural habitat for a variety of aquatic organism, including fouling organisms. The mussels themselves can provide some structural habitat for other organisms. They cite numerous studies that found larger abundances of fish in the vicinity of bivalve shellfish mariculture structures compared to unstructured estuarine and marine habitat.

Dumbauld et al. (2015) found no significant differences in the use of intertidal unstructured benthic habitat (e.g., mudflats), seagrass beds, and oyster mariculture sites for foraging by juvenile salmon and other finfish. Hosack et al. (2006) compared fish and invertebrate communities in three types of estuarine habitat: seagrass beds, areas occupied by non-native cultured oysters, and unvegetated mudflats. They found that invertebrates that serve as prey for decapod crustaceans and fish occurred at significantly greater densities in seagrass beds and cultivated oyster beds compared to unvegetated mudflats. They also found that species richness and size for fish and decapod crustaceans was not significantly different in seagrass beds, cultivated oyster beds, or unvegetated mudflats. Dumbauld et al. (2015) concluded that the temporary disturbances to benthic habitats, such as those caused by bivalve shellfish mariculture activities, do not have significant adverse effects on utilization of those habitats by salmon.

Bivalve shellfish mariculture activities can have positive and negative effects on large marine vertebrates, such as birds, turtles, and mammals; most of these effects have been inferred from studies that did not directly evaluate mariculture activities (NRC 2010). For example, there is potential for larger marine vertebrates to become entangled in lines and netting used for commercial shellfish mariculture activities (Price et al. 2016). Commercial shellfish mariculture activities may also produce litter that may be ingested birds, marine mammals, and marine turtles (NRC 2010), and may increase the susceptibility of these marine vertebrates to mortality. Anti-predator nets used for some forms of commercial bivalve mollusc mariculture activities may also affect feeding behaviors by fish and wildlife (Ferriss et al. 2015).

Human activities in and around commercial shellfish mariculture activities may cause some fish and wildlife species to avoid areas where those activities are occurring, but avoidance might not occur or may be at a lesser degree if there are not suitable alternative habitats available to those vertebrate species (NRC 2010), especially in coastal areas with substantial human presence. Predator exclusion nets used for commercial shellfish mariculture activities can help enhance populations of other epibenthic organisms (Simenstad and Fresh 1995), by providing substrate that they can attach to and grow. These nets may pose an entanglement risk or affect bottom habitat, depending on the types of anchors used to secure the nets.

Mussel mariculture activities may alter benthic infaunal communities, especially through nutrient enhancement caused by increased biodeposits from suspended or floating culture (McKindsey et al. 2011), with filter feeders potentially being replaced to some degree by deposit-feeding organisms and the effects varying by characteristics of the mariculture activity and the site in which the operation is located. The impacts to benthic infaunal communities are generally limited to the footprint of the mussel mariculture operation.

General condition 2 will reduce adverse effects to fish and other aquatic species by prohibiting activities that substantially disrupt the movement of indigenous aquatic species, unless the primary purpose of the activity is to impound water. Compliance with general conditions 3 and 5 will ensure that the authorized activity has no more than minimal adverse effects on spawning areas and shellfish beds, respectively. The authorized activity cannot have more than minimal adverse effects on breeding areas for migratory birds, due to the requirements of general condition 4.

For an NWP activity, compliance with the Bald and Golden Eagle Protection Act (16 U.S.C. 668(a)-(d)), the Migratory Bird Treaty Act (16 U.S.C. 703; 16 U.S.C. 712), and the Marine Mammal Protection Act (16 U.S.C. 1361 et seq.) is the responsibility of the project proponent. General condition 19 states that the permittee is responsible for contacting appropriate local office of the U.S. Fish and Wildlife Service to determine applicable measures to reduce impacts to migratory birds or eagles, including whether “incidental take” permits are necessary and available under the Migratory Bird Treaty Act or Bald and Golden Eagle Protection Act for a particular activity.

Consultation pursuant to the essential fish habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act will occur as necessary for proposed NWP activities that may adversely affect essential fish habitat. Consultation may occur on a case-by-case or programmatic basis. Division and district engineers can impose regional and special conditions to ensure that activities authorized by this NWP will result in only minimal adverse effects on essential fish habitat.

(h) Flood hazards. The activities authorized by this NWP will have little or no adverse effects on the flood-holding capacity of 100-year floodplains, since these

activities occur in either open navigable waters or intertidal waters. Compliance with general condition 9 will reduce flood hazards. This general condition requires the permittee to maintain, to the maximum extent practicable, the pre-construction course, condition, capacity, and location of open waters, except under certain circumstances.

(i) Floodplain values. Activities authorized by this NWP will have negligible adverse effects on the flood-holding capacity of the floodplain, as well as other floodplain values, since it authorizes only commercial shellfish mariculture activities, which occur in open waters. For those activities that require pre-construction notification, district engineers will review the proposed activities to ensure that those activities result in no more than minimal adverse effects on floodplain values. General condition 23 requires avoidance and minimization of impacts to waters of the United States to the maximum extent practicable at the project site, which will reduce losses of floodplain values.

(j) Land use. Activities authorized by this NWP will have little or no adverse effect on terrestrial land use, since it is limited to commercial shellfish mariculture activities, and those activities usually occur in navigable waters identified through a lease or permit issued by an appropriate state or local government agency, a treaty, or any other easement, lease, deed, or contract which establishes an enforceable property interest for the grower. Since the primary responsibility for land use decisions is held by state, local, and tribal governments, the Corps' control and responsibility is limited to significant issues of overriding national importance, such as navigation and water quality (see 33 CFR 320.4(j)(2)). Bivalve shellfish mariculture activities may utilize fairly large areas of subtidal lands (e.g., 25 to 50 acres) (Robinson et al. 2016), which may result in conflicts about use of submerged lands, which are often held in the public trust by state governments.

Regulations regarding the use of coastal areas for commercial shellfish mariculture activities vary from state to state and may also vary among local governments within a particular state (NRC 2010). Most commercial shellfish mariculture activities occur in submerged lands that are owned by state governments, although some tidelands may be under private ownership (NRC 2010). Leases from state or local governments may be required to conduct commercial shellfish mariculture activities in publicly held lands. To be financially viable, bottom culture for large-scale scallop production may require the ability to lease large areas of submerged lands (Robinson et al. 2016) because scallops are capable of swimming and may swim away from the cultivation site if it is too small. Commercial shellfish mariculture activities may impair some public uses of portions of coastal waters (NRC 2010), such as boating, beachcombing, and fishing. Shafer et al. (2010) found that people who live closest to nearshore mariculture facilities tended to have negative perceptions about those facilities, while acknowledging the economic benefits mariculture operations can have for local communities. Commercial shellfish mariculture operators usually must have leases or other instruments that grant them the rights to use submerged or intertidal lands for bivalve shellfish mariculture

activities. In some states, shellfish growers may have ownership rights over submerged lands and therefore do not need leases or other instruments to cultivate shellfish on those submerged lands. Corps permits, including NWP authorizations, do not convey any property rights.

(k) Navigation. Activities authorized by this NWP may adversely affect navigation, by creating obstructions impede vessel traffic or require vessels to navigate around the floating or suspended mariculture structures, or long lines. These activities may also occur in navigable waters that are too shallow for most vessels, or in intertidal waters. For some bivalve mariculture activities, fencing may be used to keep motile predators, such as starfish, from consuming bottom cultured scallops (Robinson et al. 2016), which may have adverse effects on navigation. Netting may be another anti-predation tool that could have adverse effects on navigation. Activities authorized by this NWP must comply with general condition 1. If commercial shellfish mariculture activity has more than minimal adverse effects on navigation, the district engineer can exercise discretionary authority to require the project proponent to obtain an individual permit for the proposed activity. General condition 1 also allows the district engineer to require the project proponent to remove, relocate, or alter the structures or work to prevent any unreasonable obstruction to the free navigation of the navigable waters. For those activities that require pre-construction notification, the district engineer will need to review those activities on a case-by-case basis and determine if there will be any adverse effects on navigation.

(l) Shore erosion and accretion. The activities authorized by this NWP will have minor direct effects on shore erosion and accretion processes, since the NWP is limited to commercial shellfish mariculture activities that occur in open waters. These activities generally occur in tidal waters. However, NWP 13, regional general permits, or individual permits may be used to authorize bank stabilization projects associated with commercial shellfish mariculture activities. The effects of those bank stabilization projects on shore erosion and accretion will be evaluated through that authorization process.

Commercial shellfish mariculture activities in nearshore waters, especially those that involve suspended and floating culture methods, may in some cases contribute to dissipation of wave energy that reduces shore erosion and accretion (Alleway et al. 2019, NRC 2010). Therefore, the activities authorized by this NWP are unlikely to have adverse effects on shore erosion and accretion.

(m) Recreation. Activities authorized by this NWP may alter recreational uses of the waterbody, by occupying waters that can be used for recreational activities, including boating and fishing. However, since the NWP authorizes only commercial shellfish mariculture activities in areas that have already been identified through leases or permits issued by state or local government agencies, a treaty, or any other easement, lease, deed, or contract that establishes an enforceable property interest for the operator, the operator may have a stronger right to the use of the

leased or permitted area. Certain recreational activities, such as fishing, would likely still be available in the area. Those recreational activities may be enhanced by fish that are attracted to the structures used for commercial shellfish mariculture activities, for feeding and other activities. Some bird species may be attracted to areas where commercial shellfish mariculture activities are occurring, while other bird species may avoid those areas because of the presence of humans and disturbances. Therefore, potential effects on recreation activities such as bird watching and observing other types of wildlife may vary depending on the species and site-specific circumstances. People who live near coastal areas where mariculture activities may occur and who directly use those waters for recreation purposes tend to have more concerns about these activities (Shafer et al. 2010) than people who live farther away and are less likely to use these waters for recreation.

Other types of recreational activities, such as boating, kayaking, and swimming, may be adversely affected by shellfish mariculture operations in coastal waters (NRC 2010). Commercial shellfish mariculture activities may affect other recreational activities, such as bird watching and observing other types of wildlife, since some species may be attracted to the structures used for these activities if they serve as food sources by providing habitat for epibiotic organisms. Other wildlife species may avoid areas used for commercial shellfish mariculture activities because of the presence of humans conducting these operations or the presence of the mariculture structures in the waterbody reducing the amount of area available for foraging and other behaviors.

(n) Water supply and conservation. Activities authorized by this NWP are not likely to adversely affect surface water and groundwater supplies. This NWP authorizes commercial shellfish mariculture activities, which occur in tidal waters of various salinities. These activities will not increase demand for potable water in the region. Activities authorized by this NWP will not adversely affect the quality of water supplies, since these activities do not occur in freshwater ecosystems that may be a source of potable water.

(o) Water quality. Some commercial shellfish mariculture activities may have minor adverse effects on water quality, but other commercial shellfish mariculture activities may have beneficial effects on water qualify when the bivalve molluscs filter-feed (e.g., NRC 2010, Gentry et al. 2020). Filter-feeding removes phytoplankton, organic detritus, and inorganic particles from the water column (NRC 2010, Powers et al. 2007, Jackson et al. 2001), which can reduce turbidity. Bivalve molluscs may also remove suspended sediment from the water column. The production of large numbers of bivalve molluscs through mariculture activities has the potential to overload coastal waters with waste materials if there is not sufficient flushing to disperse those waters (NRC 2010), which can adversely affect water quality in those coastal waters. Mussel mariculture activities may modify nutrient fluxes and nutrient dynamics in coastal waters in the vicinity of these operations (McKindsey et al. 2011) and there is uncertainty regarding how far those effects would extend

beyond the footprint of the mariculture activity.

Bivalve molluscs also excrete waste materials and biodeposits, which can have positive or negative effects on water quality, depending on the quality and quantity of substances excreted by those organisms (NRC 2010, McKindsey et al. 2011). At lower levels, the nutrients in excreted substances and biodeposits (i.e., feces and pseudofeces) can be used by seagrasses for growth and reproduction, but at higher levels those materials they can create conditions that adversely affect benthic communities (NRC 2010). Large populations of the species raised through commercial shellfish mariculture activities can increase in nutrients and other substances in the water column, and for very large numbers of cultivated individuals the effects of those nutrients and other substances, including feces and pseudofeces, can be adverse. For example, feces and pseudofeces from cultivated bivalve molluscs can cause oxygen depletion in the water column if the amount of cultivated bivalves exceeds the waterbody's capacity for effectively processing and flushing those materials (NRC 2010, Powers et al. 2007). On the other hand, biodeposits produced by bivalve molluscs, including cultivated individuals, may also play a role in denitrification, and help reduce eutrophication (NRC 2010). It should also be noted that many estuaries have historically supported large populations of naturally occurring bivalve molluscs and those estuarine systems supported productive ecosystems that were overexploited by human communities (e.g., Zu Ermgassen et al. 2012; Wilberg et al. 2011).

The term "pollutant" does not include the placement of shellfish seed or bivalves at various stages of growth into jurisdictional waters, or the waste products (e.g., feces or pseudofeces, ammonium) excreted by bivalves. In *Association to Protect Hammersley, Eld, and Totten Inlets v. Taylor Res., Inc.*, 299 F.3d 1007 (9th Cir. 2002), the court concluded that Congress did not intend that living bivalves and the natural chemicals and particulate biological matter they release through normal physiological processes, or the shells that might be separated from living bivalves from time to time, be considered pollutants under the Clean Water Act. In other words, bivalve shells and natural waste products excreted by living bivalves are not "biological materials" under the Clean Water Act's definition of "pollutant" because these shells and natural waste products come from the natural growth and development of bivalves and not from a transformative human process.

Under Sections 305(b) and 303(d) of the Clean Water Act, the U.S. EPA compiles information from states on the causes and sources of impairment of broad categories of the Nation's waters, including bays and estuaries, coastal shorelines, and ocean and near coastal waters where commercial shellfish mariculture activities may occur. According to U.S. EPA's current national summary of water quality data (https://iaspub.epa.gov/waters10/attains_nation_cy.control accessed 11/27/2020), states identified 28 causes of impairment and 23 probable sources of impairment for 56,141 square miles of assessed bay and estuaries. Aquaculture activities were not included in the 28 causes of impairment for assessed bays and estuaries. For bays and estuaries, states identified only one square mile of the assessed 56,141 square

miles where aquaculture activities were a probable source of impairment. States assessed 4,627 miles of coastal shoreline and identified 16 causes of impairment and 17 probable sources of impairment. Aquaculture was not identified as a cause of impairment or a probable source of impairment for the 4,627 miles of assessed coastal shoreline. For ocean and near coastal waters, states identified 16 causes of impairment and 14 probable sources of impairment. Aquaculture was not identified as a cause of impairment or a probable source of impairment for the 4,627 miles of 6,944 square miles of coastal shoreline assessed by states. From the state data summarized by the U.S. EPA demonstrates that commercial shellfish mariculture activities has a very small contribution to the impairment of bays and estuaries and does not provide an identifiable contribution to the impairment of coastal shoreline or ocean and near coastal waters. In other words, the designated uses of these waters are rarely affected by commercial shellfish mariculture activities.

In-water physical removal of fouling organisms from bivalve mariculture gear may result in deposits of organic material on the bottom of the waterbody (NRC 2010) and adversely affect water quality as that organic matter decomposes. Chemicals, such as acetic acid brine, may be used to control fouling organisms on bivalve mariculture gear (NRC 2010), and those chemicals may reach the waterbody and alter water quality either directly or indirectly.

Some commercial bivalve shellfish mariculture activities may use pesticides to try to control predators and nuisance species (NRC 2010), such as burrowing shrimp. However, the Corps does not have the legal authority to regulate or control the application of pesticides under its permitting authorities under Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act of 1899. Discharges of pesticides into navigable waters may be regulated under Section 402 of the Clean Water Act by EPA or approved states. Burrowing shrimp can bury oysters under sediment by moving sediment that covers oysters or by destabilizing the sediment so that oysters sink into the sediment (Simenstad and Fresh 1995). When considering the effects of pesticides used for commercial shellfish mariculture activities on estuarine ecosystems, those effects cannot be separated from the other effects these activities have on these ecosystems, such as the structural habitat provided by bivalve shellfish and structures used for their production, the effects bivalve filter feeding has on water quality, and the effects of pseudofeces on water quality and productivity (Simenstad and Fresh 1995). When evaluating the effects of commercial shellfish mariculture activities on the environment, all of the reasonably foreseeable benefits and detriments of those activities should be considered, to determine whether net environmental effects are positive, negative, or neutral. This evaluation should be conducted by evaluating those reasonably foreseeable environmental effects (positive, negative, or neutral) against the current environmental setting, which includes the present effects of past and present human activities that affect coastal waters, including point and non-point pollution from coastal watersheds and other human activities that occur, and have occurred, in these coastal waters.

During commercial shellfish mariculture operations, small amounts of oil and grease from production or harvesting equipment may be discharged into the waterway. Because most production or harvesting activities will occur during a relatively short period of time, the frequency and concentration of these discharges are not expected to have more than minimal adverse effects on overall water quality.

Activities authorized by this NWP, such as deposition of gravel and other materials for bed preparation for on-bottom commercial shellfish mariculture activities and certain harvesting activities, that may result in a discharge into waters of the United States will require water quality certification from the appropriate certifying authority (e.g., a state or approved tribe). Water quality certification may be issued (with or without conditions), waived, or denied. Most water quality concerns are addressed by the state or tribal water quality certification agency. In accordance with general condition 25, the permittee may be required to develop and implement water quality management measures that minimizes the degradation of the aquatic environment, including water quality. The district engineer may require water quality management measures to ensure that adverse effects to water quality are no more than minimal.

(p) Energy needs. The activities authorized by this NWP will result in negligible changes in energy consumption in the area, because the NWP authorizes only certain aspects of commercial shellfish mariculture activities, specifically structures or work in navigable waters and discharges of dredged or fill material into those waters. Therefore, consumption of electricity, natural gas, and petroleum products is likely to be minor, and limited to the operation of dredge harvesting equipment, boats, and other mechanized equipment. A portion of commercial shellfish mariculture activities are conducted by hand. Energy consumption may increase for the transportation of cultivated bivalve molluscs to seafood markets and restaurants, both locally and across the country.

(q) Safety. The activities authorized by this NWP will be subject to Federal, state, and local safety laws and regulations. Therefore, this NWP will not adversely affect the safety of the project area.

(r) Food and fiber production. Activities authorized by this NWP will normally increase food production, through the production of commercial shellfish species. The activities authorized by this NWP will not adversely affect fiber production. These activities will not change the amount of available agricultural land in the nation. The loss of farmland will be negligible, because the activities authorized by this NWP occur in coastal waters. Commercial shellfish mariculture activities may interfere with commercial and recreational fishing activities by excluding fishers from the waters where those mariculture activities occur (NRC 2010). Commercial bivalve shellfish mariculture activities can provide food for human populations (Alleway et al. 2019), and thus increase local and national food production. Bivalve shellfish mariculture activities can help support indigenous and traditional communities in their efforts to continue customary ways of life (Alleway et al. 2019),

and support traditional diets.

The activities authorized by this NWP, including the structures used for commercial shellfish mariculture activities, can provide structural habitat for a variety of pelagic and benthic organisms, such as fish, crustaceans, other molluscs, algae, and fouling organisms, which may indirectly enhance food production by supporting other commercially important aquatic species that are consumed by people.

(s) Mineral needs. Activities authorized by this NWP will have little or no adverse effects on demand for aggregates and stone, since these materials are usually not used for commercial shellfish mariculture activities. Activities authorized by this NWP may increase the demand for other materials, such as steel, aluminum, and copper, which are made from mineral ores.

(t) Considerations of property ownership. The NWP complies with 33 CFR 320.4(g), which states that an inherent aspect of property ownership is a right to reasonable private use. In many areas of the country, commercial shellfish mariculture operators are required to have leases from a state authority to use a portion of the waterbody for these activities (NRC 2010). Operators of commercial shellfish mariculture activities are usually required to obtain leases from state or local governments to secure the rights to cultivate bivalve molluscs in submerged lands or intertidal lands. In some areas of the country, the commercial shellfish mariculture operator may have ownership rights or similar rights over those submerged lands that give him or her exclusive rights to use those submerged lands for these activities. The nationwide permits do not NWPs do not grant any property rights or exclusive privileges (see 33 CFR 330.4(b)(3)). Nearby landowners may object to the activities authorized by this NWP because they may believe those activities have adverse effects on aesthetics and may potentially reduce the value of their property or the enjoyment of their property. The NWP provides expedited DA authorization for commercial shellfish mariculture activities, provided those activities comply with the terms and conditions of the NWP and result in no more than minimal individual and adverse environmental effects.

6.2 Additional Public Interest Review Factors (33 CFR 320.4(a)(2))

6.2.1 Relative extent of the public and private need for the proposed structure or work

This NWP authorizes activities in waters of the United States, especially navigable waters, for commercial shellfish mariculture activities as long as those activities have no more than minimal individual and cumulative adverse environmental effects. These activities satisfy public and private needs for food and other products. The need for this NWP is based upon the number of these activities that occur annually with only minimal individual and cumulative adverse environmental effects.

6.2.2 Where there are unresolved conflicts as to resource use, the practicability of using reasonable alternative locations and methods to accomplish the objective of the proposed structure or work

Most situations in which there are unresolved conflicts concerning resource use arise when environmentally sensitive areas are involved (e.g., special aquatic sites, including wetlands) or where there are competing uses of a resource. The nature and scope of the activity, when planned and constructed in accordance with the terms and conditions of this NWP, reduce the likelihood of such conflict. In the event that there is a conflict, the NWP contains provisions that are capable of resolving the matter (see Section 1.2 of this document).

Similar to most human activities in coastal waters, the alteration of natural ecosystems to increase food production can affect coastal habitats and the species that live in them (NRC 2010, Tallis et al. 2009), so there are trade-offs that need to be considered when making permit decisions for commercial shellfish mariculture activities. Commercial shellfish mariculture activities need to occur in coastal waters that provide the energy, materials, and environmental conditions that support the reproduction and growth of bivalve mollusc species. Therefore, there is unlikely to be no alternative locations where these activities can occur. General condition 23 requires permittees to avoid and minimize adverse effects to waters of the United States to the maximum extent practicable on the project site. Consideration of off-site alternative locations is not required for activities that are authorized by general permits. General permits authorize activities that have no more than minimal individual and cumulative adverse effects on the environment and the overall public interest. The district engineer will exercise discretionary authority and require an individual permit if the proposed activity will result in more than minimal adverse environmental effects on the project site. The consideration of off-site alternatives can be required during the individual permit process.

6.2.3 The extent and permanence of the beneficial and/or detrimental effects which the proposed structure or work is likely to have on the public and private uses to which the area is suited

The nature and scope of the activities authorized by the NWP will most likely restrict the extent of the beneficial and detrimental effects to the area immediately surrounding the commercial shellfish mariculture activity. Activities authorized by this NWP will have no more than minimal individual and cumulative adverse environmental effects.

The terms, conditions, and provisions of the NWP were developed to ensure that individual and cumulative adverse environmental effects are no more than minimal. Specifically, NWPs do not obviate the need for the permittee to obtain other Federal, state, or local authorizations required by law. The NWPs do not grant any property rights or exclusive privileges (see 33 CFR 330.4(b) for further information).

Additional conditions, limitations, restrictions, and provisions for discretionary authority, as well as the ability to add activity-specific or regional conditions to this NWP, will provide further safeguards to the aquatic environment and the overall public interest. There are also provisions to allow suspension, modification, or revocation of the NWP.

7.0 Endangered and Threatened Species

No activity is authorized by any NWP if that activity is likely to jeopardize the continued existence of a threatened or endangered species as listed or proposed for listing under the Federal Endangered Species Act (ESA), or to destroy or adversely modify the critical habitat of such species (33 CFR 330.4(f)). If the district engineer determines a proposed NWP activity may affect listed species or designated critical habitat, he or she will conduct ESA section 7 consultation with the U.S. Fish and Wildlife Service (USFWS) and/or National Marine Fisheries Service (NMFS) as appropriate. The proposed NWP activity is not authorized until the ESA section 7 consultation process is completed or the district engineer determines the proposed NWP activity will have no effect on listed species or designated critical habitat. Current local procedures in Corps districts are effective in ensuring compliance with ESA. Those local procedures include regional programmatic consultations and the development of Standard Local Operating Procedures for Endangered Species (SLOPES). The issuance or reissuance of an NWP, as governed by NWP general condition 18 (which applies to every NWP and which relates to endangered and threatened species and critical habitat) and 33 CFR 330.4(f), results in “no effect” to listed species or critical habitat, because no activity that “may affect” listed species or critical habitat is authorized by NWP unless ESA Section 7 consultation with the USFWS and/or NMFS has been completed. If the non-federal project proponent does not comply with 33 CFR 330.4(f)(2) and general condition 18, and does not submit the required PCN, then the activity is not authorized by NWP. In such situations, it is an unauthorized activity and the Corps district will determine an appropriate course of action under its regulations at 33 CFR part 326 to respond to the unauthorized activity. Unauthorized activities may also be subject to the prohibitions of Section 9 of the ESA.

Each activity authorized by an NWP is subject to general condition 18, which states that “[n]o activity is authorized under any NWP which is likely to directly or indirectly jeopardize the continued existence of a threatened or endangered species or a species proposed for such designation, as identified under the Federal Endangered Species Act (ESA), or which will directly or indirectly destroy or adversely modify designated critical habitat or critical habitat proposed for such designation.” In addition, general condition 18 explicitly states that the NWP does not authorize “take” of threatened or endangered species, which will ensure that permittees do not mistake the NWP authorization as a Federal authorization to take threatened or endangered species. General condition 18 also requires a non-federal permittee to

submit a pre-construction notification to the district engineer if any listed species or designated critical habitat (or proposed species or proposed critical habitat) might be affected or is in the vicinity of the project, or if the project is located in designated or proposed critical habitat. The Corps established the “might affect” threshold in 33 CFR 330.4(f)(2) and paragraph (c) of general condition 18 because it is more stringent than the “may affect” threshold for section 7 consultation in the USFWS’s and NMFS’s ESA section 7 consultation regulations at 50 CFR part 402. The word “might” is defined as having “less probability or possibility” than the word “may” (Merriam-Webster’s Collegiate Dictionary, 10th edition). Since “might” has a lower probability of occurring, it is below the threshold (i.e., “may affect”) that triggers the requirement for ESA section 7 consultation for a proposed Federal action This general condition also states that, in such cases, non-federal permittees shall not begin work on the activity until notified by the district engineer that the requirements of the ESA have been satisfied and that the activity is authorized.

Under the current Corps regulations (33 CFR 325.2(b)(5)), the district engineer must review all permit applications for potential impacts on threatened and endangered species or critical habitat. For the NWP program, this review occurs when the district engineer evaluates the pre-construction notification or request for verification. Nationwide permit general condition 18 requires a non-federal applicant to submit a pre-construction notification to the Corps if any listed species (or species proposed for listing) or designated critical habitat (or critical habitat proposed for such designation) might be affected or is in the vicinity of the project, or if the project is located in designated critical habitat (or critical habitat proposed for such designation). Based on the evaluation of all available information, the district engineer will initiate consultation with the USFWS or NMFS, as appropriate, if he or she determines that the proposed activity may affect any threatened and endangered species or designated critical habitat. Consultation may occur during the NWP authorization process or the district engineer may exercise discretionary authority to require an individual permit for the proposed activity and initiate section 7 consultation during the individual permit process. If the district engineer determines a proposed NWP activity is likely to jeopardize the continued existence of any proposed species or result in the destruction or adverse modification of proposed critical habitat, he or she will initiate a conference with the USFWS or NMFS. If ESA Section 7 consultation or conference is conducted during the NWP authorization process, then the applicant will be notified that he or she cannot proceed with the proposed NWP activity until section 7 consultation is completed.

If the district engineer determines that the proposed NWP activity will have no effect on any threatened or endangered species or critical habitat, then the district engineer will notify the applicant that he or she may proceed under the NWP authorization as long as the activity complies with all other applicable terms and conditions of the NWP, including applicable regional conditions. When the Corps makes a “no effect” determination, that determination is documented in the record for the NWP verification.

In cases where the Corps makes a “may affect” determination, formal or informal section 7 consultation is conducted before the activity is authorized by NWP. A non-federal permit applicant cannot begin work until notified by the Corps that the proposed NWP activity will have “no effect” on listed species or critical habitat, or until ESA Section 7 consultation has been completed (see also 33 CFR 330.4(f)). Federal permittees are responsible for complying with ESA Section 7(a)(2) and should follow their own procedures for complying with those requirements (see 33 CFR 330.4(f)(1)). Therefore, permittees cannot rely on complying with the terms of an NWP without considering ESA-listed species and critical habitat, and they must comply with the NWP conditions to ensure that they do not violate the ESA. General condition 18 also states that district engineers may add activity-specific conditions to the NWPs to address ESA issues as a result of formal or informal consultation with the USFWS or NMFS.

Each year, the Corps conducts thousands of ESA section 7 consultations with the USFWS and NMFS for activities authorized by NWPs. These section 7 consultations are tracked in ORM. During the period of March 19, 2017, to October 20, 2020, Corps districts conducted 1,294 formal consultations and 8,233 informal consultations under NWP PCNs where the Corps verified that the proposed activities were authorized by NWP. During that time period, the Corps also used regional programmatic consultations for 21,677 NWP verifications to comply with ESA section 7. Therefore, each year an average of 8,700 formal, informal, and programmatic ESA section 7 consultations are conducted with the USFWS and/or NMFS in response to NWP PCNs, including those activities that required PCNs under paragraph (c) of general condition 18. In a study on ESA section 7 consultations tracked by the USFWS, Malcom and Li (2015) found that during the period of 2008 to 2015, the Corps conducted the most formal and informal section 7 consultations, far exceeding the numbers of section 7 consultations conducted by other federal agencies.

Section 7 consultations are often conducted on a case-by-case basis for activities proposed to be authorized by NWP that may affect listed species or critical habitat, in accordance with the USFWS’s and NMFS’s interagency regulations at 50 CFR part 402. Instead of activity-specific section 7 consultations, compliance with ESA may also be achieved through formal or informal regional programmatic consultations. Compliance with ESA Section 7 may also be facilitated through the adoption of NWP regional conditions. In some Corps districts SLOPES have been developed through consultation with the appropriate regional offices of the USFWS and NMFS to make the process of complying with section 7 more efficient.

Corps districts have, in most cases, established informal or formal procedures with local offices of the USFWS and NMFS, through which the agencies share information regarding threatened and endangered species and their critical habitat. This information helps district engineers determine if a proposed NWP activity may affect listed species or their critical habitat and, when a “may affect” determination is made, initiate ESA section 7 consultation. Corps districts may utilize maps or

databases that identify locations of populations of threatened and endangered species and their critical habitat. Where necessary, regional conditions are added to one or more NWPs to require pre-construction notification for NWP activities that occur in known locations of threatened and endangered species or critical habitat. Any information provided by local maps and databases and any comments received during the pre-construction notification review process will be used by the district engineer to make a “no effect” or “may affect” determination for the pre-construction notification.

Based on the safeguards discussed in this section, especially general condition 18 and the NWP regulations at 33 CFR 330.4(f), the Corps believes that the activities authorized by this NWP comply with the ESA. Although the Corps continues to believe that these procedures ensure compliance with the ESA, the Corps has taken some steps to provide further assurance. Corps district offices meet with local representatives of the USFWS and NMFS to establish or modify existing procedures such as regional conditions, where necessary, to ensure that the Corps has the latest information regarding the existence and location of any threatened or endangered species or their critical habitat. Corps districts can also establish, through SLOPES or other tools, additional safeguards that ensure compliance with the ESA. Through ESA Section 7 formal or informal consultations, the Corps ensures that no activity is authorized by any NWP if that activity is likely to jeopardize the continued existence of a threatened or endangered species as listed or proposed for listing under the ESA, or to destroy or adversely modify the critical habitat of such species. Other tools such as ESA section 7 conferences, SLOPES, the development of regional conditions added to the NWP by the division engineer, and conditions added to a specific NWP authorization by the district engineer help ensure compliance with the ESA.

If informal section 7 consultation is conducted, and the USFWS and/or NMFS issues a written concurrence that the proposed activity may affect, but is not likely to adversely affect, listed species or designated critical habitat based on conservation measures incorporated in the project to avoid or minimize potential effects to ESA resources, the district engineer will add conditions (e.g., conservation measures) to the NWP authorization. If the USFWS and/or NMFS does not issue a written concurrence that the proposed NWP activity “may affect, but is not likely to adversely affect” listed species or critical habitat, the Corps will initiate formal section 7 consultation if it changes its determination to “may affect, likely to adversely affect.”

If formal section 7 consultation is conducted and a biological opinion is issued, the district engineer will add conditions to the NWP authorization to incorporate appropriate elements of the incidental take statement of the biological opinion into the NWP authorization, if the biological opinion concludes that the proposed NWP activity is not likely to jeopardize the continued existence of listed species or adversely modify or destroy critical habitat. If the biological opinion concludes that the proposed NWP activity is likely to jeopardize the continued existence of listed

species or adversely modify or destroy critical habitat, the proposed activity cannot be authorized by NWP and the district engineer will instruct the applicant to apply for an individual permit. The incidental take statement includes reasonable and prudent measures and terms and conditions such as mitigation, monitoring, and reporting requirements that minimize incidental take. To fulfill its obligations under Section 7(a)(2) of the ESA, the Corps will determine which elements of an incidental take statement are appropriate to be added as permit conditions to the NWP authorization (see 33 CFR 325.4(a)). The appropriate elements of the incidental take statement are those reasonable and prudent measures and terms and conditions that: (1) apply to the activities over which the Corps has control and responsibility (i.e., structures or work in navigable waters and/or the discharges of dredged or fill material into waters of the United States), and (2) the Corps has the authority to enforce under its permitting authorities. Incorporation of the appropriate elements of the incidental take statement into the NWP authorization through binding, enforceable permit conditions may provide the project proponent an exemption from the "take" prohibitions in ESA Section 9 (see Section 7(o)(2) of the ESA).

The Corps can modify this NWP at any time that it is deemed necessary to protect listed species or their critical habitat, either through: 1) national general conditions or national-level modifications, suspensions, or revocations of the NWPs; 2) regional conditions or regional modifications, suspensions, or revocations of NWPs; or 3) activity-specific permit conditions (modifications) or activity-specific suspensions or revocations of NWP authorizations. Therefore, although the Corps has issued the NWPs, the Corps can address any ESA issue, if one should arise. The NWP regulations also allow the Corps to suspend the use of some or all of the NWPs immediately, if necessary, while considering the need for permit conditions, modifications, or revocations. These procedures are provided at 33 CFR 330.5.

8.0 Clean Water Act Section 404(b)(1) Guidelines Analysis

The 404(b)(1) Guidelines are provided at 40 CFR part 230, and compliance criteria specific to general permits are provided at 40 CFR 230.7. This 404(b)(1) Guidelines compliance analysis includes analyses of the direct, secondary, and cumulative effects on the aquatic environment caused by discharges of dredged or fill material authorized by this NWP. The level of documentation for the 404(b)(1) Guidelines analysis should reflect the significance and complexity of the discharge activity, and be commensurate with the proposed impacts (40 CFR 230.6(b)). The Guidelines do not require extensive testing, evaluation or analysis will be needed to make findings of compliance for minor, routine activities that have little, if any, potential for significant degradation of the aquatic environment (40 CFR 230.6(a)). In general, the 404(b)(1) Guidelines do not require quantitative analyses. The only quantitative analysis required for general permits is a prediction of the number of individual discharge activities likely to be regulated under a general permit until its expiration, including repetitions of individual discharge activities at a single location (40 CFR

230.7(b)(3)).

This NWP authorizes discharges of dredged or fill materials into waters of the United States under Section 404 of the Clean Water Act and structures and work in navigable waters of the United States under Section 10 of the Rivers and Harbors Act of 1899. The 404(b)(1) Guidelines only apply to discharges of dredged or fill material into waters of the United States; they do not apply to structures and work regulated under Section 10 of the Rivers and Harbors Act of 1899, including dredging or disposal of dredged material, excavation activities, and filling activities in navigable waters of the United States that is considered “work” under 33 CFR 322.2(c).

For discharges of dredged or fill material into waters of the United States authorized by general permits, the analysis and documentation required by the 404(b)(1) Guidelines are to be performed at the time of issuance of a general permit, such as an NWP. The analysis and documentation under the 404(b)(1) Guidelines is not repeated for specific discharges of dredged or fill material into waters of the United States conducted under the NWP. The 404(b)(1) Guidelines do not require reporting or formal written communication at the time individual discharges of dredged or fill material into waters of the United States are conducted under the authorization provided by an NWP, but a particular NWP may require appropriate reporting. [40 CFR 230.6(d) and 230.7(b)]

8.1 Evaluation Process (40 CFR 230.7(b))

8.1.1 Alternatives (40 CFR 230.10(a))

General condition 23 requires permittees to avoid and minimize discharges of dredged or fill material into waters of the United States to the maximum extent practicable on the project site. The consideration of off-site alternatives is not directly applicable to general permits (see 40 CFR 230.7(b)(1)).

8.1.2 Prohibitions (40 CFR 230.10(b))

This NWP authorizes discharges of dredged or fill material into waters of the United States, which may require water quality certification. Water quality certification requirements will be met in accordance with the procedures at 33 CFR 330.4(c).

No toxic discharges are authorized by this NWP. General condition 6 states that the material must be free from toxic pollutants in toxic amounts.

This NWP does not authorize discharges of dredged or fill material into waters of the United States that are likely to jeopardize the continued existence of any listed threatened or endangered species or result in the destruction or adverse modification of critical habitat. Reviews of preconstruction notifications, regional

conditions, and local operating procedures for endangered species will ensure compliance with the Endangered Species Act. Refer to general condition 18 and to 33 CFR 330.4(f) for information and procedures.

This NWP will not authorize discharges of dredged or fill material into waters of the United States that violate any requirement to protect any marine sanctuary. Refer to section 8.2.3(j)(1) of this document for further information.

8.1.3 Findings of Significant Degradation (40 CFR 230.10(c))

Potential impact analysis (Subparts C through F): The potential impact analysis specified in Subparts C through F is discussed in section 8.2.3 of this document. Mitigation required by the district engineer will ensure that the adverse effects on the aquatic environment are no more than minimal.

Evaluation and testing (Subpart G): Because the terms and conditions of the NWP specify the types of discharges that are authorized, as well as those that are prohibited, individual evaluation and testing for the presence of contaminants will normally not be required. If a situation warrants, provisions of the NWP allow division or district engineers to further specify authorized or prohibited discharges and/or require testing. General condition 6 requires that materials used for construction be free from toxic pollutants in toxic amounts.

Based upon Subparts B and G, after consideration of Subparts C through F, and because NWPs can authorize only those discharges of dredged or fill material into waters of the United States that result in no more than minimal individual and cumulative adverse environmental effects, the discharges authorized by this NWP will not cause or contribute to significant degradation of waters of the United States.

8.1.4 Factual determinations (40 CFR 230.11)

The factual determinations required in 40 CFR 230.11 are discussed in section 8.2.3 of this document.

8.1.5 Appropriate and practicable steps to minimize potential adverse impacts (40 CFR 230.10(d))

As demonstrated by the information in this document, as well as the terms, conditions, and provisions of this NWP, actions to minimize adverse effects (Subpart H) have been thoroughly considered and incorporated into the NWP. General condition 23 requires permittees to avoid and minimize discharges of dredged or fill material into waters of the United States to the maximum extent practicable on the project site. Compensatory mitigation may be required by the district engineer to ensure that the net adverse effects on the aquatic environment are no more than minimal.

8.2 Evaluation Process (40 CFR 230.7(b))

8.2.1 Description of permitted activities (40 CFR 230.7(b)(2))

As indicated by the text of this NWP in section 1.0 of this document, and the discussion of potential impacts in section 5.0, the activities authorized by this NWP are sufficiently similar in nature and environmental impact to warrant authorization under a single general permit. Specifically, the purpose of the NWP is to authorize discharges of dredged or fill material into waters of the United States for commercial shellfish mariculture activities. The nature and scope of the impacts are controlled by the terms and conditions of the NWP.

Under section 404(e) of the Clean Water Act, the Corps may, after notice and opportunity for public hearing, issue general permits on a state, regional, or nationwide basis for any category of activities involving discharges of dredged or fill material if it determines that the activities in such category are similar in nature, will cause only minimal adverse environmental effects when performed separately, and will have only minimal cumulative adverse effect on the environment. The statute does not provide direction on how broad or narrow that a category of activities authorized by an NWP or other general permit must be, so it is left to the discretion of the Corps to determine an appropriate category of activities for an NWP.

This NWP authorizes discharges of dredged or fill material into waters of the United States for commercial shellfish mariculture activities. For the purposes of Section 404 of the Clean Water Act the terms “dredged material,” “discharges of dredged material,” “fill material,” and “discharges of fill material” are defined in 33 CFR 323.2. The use of structures for commercial shellfish mariculture activities, such as long lines, cages, racks, bags, tubes, and netting are not regulated under Section 404 of the Clean Water Act because they do not constitute “dredged material” or “fill material” or result in discharges of dredged or fill material.

Discharges of dredged material into waters of the United States for commercial shellfish mariculture activities may occur during bivalve shellfish harvesting activities, as well as harrowing, raking, and levelling activities to smooth out the substrate for bivalve shellfish production. These activities may adversely affect water quality by releasing sediments into the water column. These activities may adversely affect benthic organisms such as seagrasses, algae, epibenthic invertebrates, benthic invertebrates that live in the substrate, and fish. These activities may also cause disturbances that cause fish, invertebrates, and other organisms to avoid the site of the NWP activity. Most of the impacts to benthic organisms may be temporary, as these organisms can recover after various natural and anthropogenic disturbances that occur in these dynamic coastal ecosystems. For example, certain seagrass species in certain locations have in some cases exhibited capacity to recover and reproduce after dredge harvesting activities for commercial shellfish mariculture activities (e.g., Tallis et al. 2009).

Discharges of fill material into waters of the United States for commercial shellfish mariculture activities may involve discharging fill material such as shell or gravel into waters of the United States to create or enhance substrate suitable for the production of bivalve molluscs, including suitable substrate for shellfish seeding activities. The term “discharge of fill material” does not include plowing, cultivating, seeding and harvesting for the production of food, fiber, and forest products (see 33 CFR 323.2(f)), and this NWP authorizes discharges of fill material to produce bivalve molluscs as food for human consumption. Therefore, shellfish seeding activities by themselves are not considered to be discharges of fill material regulated under section 404. Discharges of dredged material may also occur during harvesting activities, which may involve the use of mechanical or hydraulic dredging equipment. Commercial shellfish mariculture activities that involve only the use of structures in navigable waters, such as racks, cages, bags, tubes, netting, rafts, stakes, bouchots, and long lines, for bivalve shellfish cultivation activities are not regulated under Section 404 of the Clean Water Act because they do not involve discharges of dredged or fill material into waters of the United States. If the placement of these structures in navigable waters causes changes in water circulation patterns and velocities, and causes suspended sediment to drop out of suspension because of slower water velocities, the accumulation of sediment on the bottom of the waterbody is not a discharge of dredged or fill material because there is no discharge from a point source (e.g., a person deliberately placing dredged or fill material into a waterbody). Structures used for on-bottom, suspended, or floating commercial shellfish mariculture activities do not constitute fill material under the Corps’ regulations (see 33 CFR 323.2).

The activities authorized by this NWP are sufficiently similar in nature and environmental impact to warrant authorization by a general permit. The terms of the NWP authorize a specific category of activity (i.e., discharges of dredged or fill material for commercial shellfish mariculture activities) in a specific category of waters (i.e., waters of the United States). The restrictions imposed by the terms and conditions of this NWP will result in the authorization of activities that have similar impacts on the aquatic environment, namely the modification of aquatic habitats, such as estuarine and marine waters, through commercial shellfish mariculture activities.

If a situation arises in which the discharge of dredged or fill material into waters of the United States requires further review, or is more appropriately reviewed under the individual permit process, provisions of the NWPs allow division and/or district engineers to take such action.

8.2.2 Cumulative effects (40 CFR 230.7(b)(3))

The 404(b)(1) Guidelines at 40 CFR 230.11(a) define cumulative effects as “…the changes in an aquatic ecosystem that are attributable to the collective effect of a number of individual discharges of dredged or fill material.” For the issuance of general permits, such as this NWP, the 404(b)(1) Guidelines require the permitting

authority to “set forth in writing an evaluation of the potential individual and cumulative impacts of the categories of activities to be regulated under the general permit.” [40 CFR 230.7(b)] More specifically, the 404(b)(1) Guidelines cumulative effects assessment for the issuance or reissuance of a general permit is to include an evaluation of “the number of individual discharge activities likely to be regulated under a general permit until its expiration, including repetitions of individual discharge activities at a single location.” [40 CFR 230.7(b)(3)] If a situation arises in which cumulative effects are likely to be more than minimal and the proposed activity requires further review, or is more appropriately reviewed under the individual permit process, provisions of the NWPs allow division and/or district engineers to take such action.

Based on reported use of this NWP during the period of March 19, 2017, to March 18, 2019, the Corps estimates that this NWP will be used approximately 331 times per year on a national basis, resulting in impacts to approximately 13,684 acres of waters of the United States. The reported use includes pre-construction notifications submitted to Corps districts, as required by the terms and conditions of the NWP, including NWP general condition 18 when any listed species or designated critical habitat might be affected or is in the vicinity of the proposed activity, or if the proposed activity is located in designated critical habitat. Regional conditions imposed by division engineers may also require pre-construction notification for proposed activities. The reported use also includes voluntary notifications to submitted to Corps districts where the applicants request written verification in cases when pre-construction notification is not required. The reported use does not include activities that do not require pre-construction notification and were not voluntarily reported to Corps districts. The Corps estimates that 50 NWP 48 activities will occur each year that do not require pre-construction notification, and that these activities will impact 200 acres of jurisdictional waters each year.

Based on reported use of this NWP during that time period, the Corps estimates that no NWP 48 verifications will require compensatory mitigation to offset the authorized impacts to waters of the United States and ensure that the authorized activities resulted in only minimal adverse effects on the aquatic environment. The verified activities that do not require compensatory mitigation will have been determined by Corps district engineers to result in no more than minimal individual and cumulative adverse effects on the aquatic environment without compensatory mitigation. During 2021-2026, the Corps expects little change to the percentage of NWP 48 verifications requiring compensatory mitigation, because there have been no substantial changes in the mitigation general condition or the NWP regulations for determining when compensatory mitigation is to be required for NWP activities. The Corps estimates that no compensatory mitigation will be required to offset these impacts. The demand for these types of activities could increase or decrease over the five-year duration of this NWP.

Based on these annual estimates, the Corps estimates that approximately 1,805 activities could be authorized over a five year period until this NWP expires,

resulting in impacts to approximately 69,420 acres of waters of the United States, including jurisdictional wetlands. No compensatory mitigation is anticipated to be required to offset those impacts. Many commercial shellfish mariculture operations are ongoing and recurring activities in the same locations as they have been operating, often for many years. There is a relatively small number of new commercial shellfish mariculture activities that are likely to be authorized by this NWP after it goes into effect. In some areas of the United States, commercial shellfish mariculture activities have been occurring for over 100 years (NRC 2010). In Washington State, commercial shellfish mariculture activities have been conducted for more than 160 years (Washington Sea Grant 2015). The commercial shellfish mariculture activities that have been recurring for years are part of the current environmental setting, and the impacts of the activities authorized by this NWP during the five years it is anticipated to be in effect are evaluated against the affected environment/current environmental setting that includes those on-going activities. The authorized impacts are expected to result in only minor changes to the affected environment (i.e., the current environmental setting), which is described in section 4.0 of this document.

Compensatory mitigation is the restoration (re-establishment or rehabilitation), establishment (creation), enhancement, and/or in certain circumstances preservation of aquatic resources for the purposes of offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved (33 CFR 332.2). For activities authorized by NWPs, compensatory mitigation and other forms of mitigation may be used to ensure that the adverse environmental effects are no more than minimal, individually and cumulatively (33 CFR 330.1(e)(3); NWP general condition 23). Restoration is usually the first compensatory mitigation option considered because the likelihood of ecological success is greater (33 CFR 332.3(a)(2)). As discussed below, restoration of wetlands and streams can increase the ecological functions and services provided by those aquatic resources. However, restoration typically cannot return a degraded wetland or stream to a prior historic condition because of changes in environmental conditions at various scales over time (e.g., Higgs et al. 2014, Jackson and Hobbs 2009, Zedler and Kercher 2005; Palmer et al. 2014), and many of those environmental changes are beyond the control of the mitigation provider. Therefore, it is important to establish realistic goals and objectives for wetland and stream restoration projects (e.g., Hobbs 2007, Ehrenfeld 2000).

Rey Banayas et al. (2009) concluded that restoration activities can increase biodiversity and the level of ecosystem services provided. However, such increases do not approach the amounts of biodiversity and ecosystem services performed by undisturbed reference sites. The ability to restore ecosystems to provide levels of ecological functions and services similar to historic conditions or reference standard conditions is affected by human impacts (e.g., urbanization, agriculture) to watersheds or other landscape or seascape units and to the processes that sustain those ecosystems (Zedler et al. 2012, Hobbs et al. 2014). Those changes need to be taken into account when establishing goals and objectives for restoration

projects (Zedler et al. 2012), including compensatory mitigation projects. The ability to reverse ecosystem degradation to restore ecological functions and services is dependent on the degree of degradation of that ecosystem and the surrounding landscape or seascape, and whether that degradation is reversible (Hobbs et al. 2014). Most studies of the ecological performance of compensatory mitigation projects have focused solely on the ecological attributes of the compensatory mitigation projects, and few studies have also evaluated the aquatic resources impacted by permitted activities (Kettlewell et al. 2008), so it is difficult to assess whether compensatory mitigation projects have fully or partially offset the lost functions provided by the aquatic resources that are impacted by permitted activities.

Wetland restoration, enhancement, and establishment projects can provide wetland functions, as long as the wetland compensatory mitigation project is placed in an appropriate landscape position, has appropriate hydrology for the desired wetland type, and the watershed condition will support the desired wetland type (NRC 2001). Site selection is critical to find a site with appropriate hydrologic conditions and soils to support a replacement wetland that will provide the desired wetland functions and services (Mitsch and Gosselink 2015). In a meta-analysis of 70 wetland restoration studies, Meli et al. (2014) concluded that wetland restoration activities increase biodiversity and ecosystem service provision in degraded wetlands, but the degree of recovery is context dependent. They identified the following factors as influencing wetland restoration outcomes: wetland type, the main cause of degradation, the type of restoration action conducted, and the assessment protocol used to evaluate restoration outcomes. Moreno-Mateos et al. (2015) reviewed the recovery trajectories of 628 wetland restoration and creation projects and concluded that restoring or establishing wetland hydrology is of primary importance, and is more likely to be ecologically successful if wetland hydrology can be achieved by re-establishing water flows instead of extensive earthwork. In addition, they determined that, with respect to the plant community, natural revegetation is sufficient for recovery and development of most wetland types after wetland hydrology is restored or established.

The ecological performance of wetland restoration, enhancement, and establishment is dependent on practitioner's understanding of wetland functions, allowing sufficient time for wetland functions to develop, and allowing natural processes of ecosystem development (self-design or self-organization) to take place, instead of over-designing and over-engineering the replacement wetland (Mitsch and Gosselink 2015). The likelihood of ecological success in wetland restoration varies by wetland type, with the higher rates of success for coastal, estuarine, and freshwater marshes, and lower rates of success for forested wetlands and seagrass beds (Lewis et al. 1995). In its review, the NRC (2001) concluded that some wetland types can be restored or established (e.g., non-tidal emergent wetlands, some forested and scrub-shrub wetlands, seagrasses, and coastal marshes), while other wetland types (e.g., vernal pools, bogs, and fens) are difficult to restore and should be avoided where possible. Restored riverine and tidal

wetlands achieved wetland structure and function more rapidly than depressional wetlands (Moreno-Mateos et al. 2012). Because of its greater potential to provide wetland functions, restoration is the preferred compensatory mitigation mechanism (33 CFR 332.3(a)(2)). Bogs, fens, and springs are considered to be difficult-to-replace resources and compensatory mitigation should be provided through in-kind rehabilitation, enhancement, or preservation of these wetlands types (33 CFR 332.3(e)(3)).

In its review of outcomes of wetland compensatory mitigation activities, the NRC (2001) stated that wetland functions can be replaced by wetland restoration and establishment activities. They discussed five categories of wetland functions: hydrology, water quality, maintenance of plant communities, maintenance of animal communities, and soil functions. It is difficult to restore or establish natural wetland hydrology, and water quality functions are likely to be different than the functions provided at wetland impact sites (NRC 2001). Reestablishing or establishing the desired plant community may be difficult because of invasive species colonizing the mitigation project site (NRC 2001). The committee also found that establishing and maintaining animal communities depends on the surrounding landscape. Soil functions can take a substantial amount of time to develop, because they are dependent on soil organic matter and other soil properties (NRC 2001). The NRC (2001) concluded that the ecological performance in replacing wetland functions depends on the particular function of interest, the restoration or establishment techniques used, and the extent of degradation of the compensatory mitigation project site and its watershed.

The ecological performance of wetland restoration and enhancement activities is affected by the amount of changes to hydrology and inputs of pollutants, nutrients, and sediments within the watershed or contributing drainage area (Wright et al. 2006). Wetland restoration is becoming more effective at replacing or improving wetland functions, especially in cases where monitoring and adaptive management are used to correct deficiencies in these efforts (Zedler and Kercher 2005). Wetland functions take time to develop after the restoration or enhancement activity takes place (Mitsch and Gosselink 2015, Gebo and Brooks 2012), and different functions develop at different rates (Moreno-Mateos 2012, NRC 2001). Irreversible changes to landscapes, especially those that affect hydrology within contributing drainage areas or watersheds, cause wetland degradation and impede the ecological performance of wetland restoration efforts (Zedler and Kercher 2005). Gebo and Brooks (2012) evaluated wetland compensatory mitigation projects in Pennsylvania and compared them to reference standards (i.e., the highest functioning wetlands in the study area) and natural reference wetlands that showed the range of variation due to human disturbances. They concluded that most of the wetland mitigation sites were functioning at levels within with the range of functionality of the reference wetlands in the region, and therefore were functioning at levels similar to some naturally occurring wetlands. The ecological performance of mitigation wetlands is affected by on the landscape context (e.g., urbanization) of the replacement wetland and varies with wetland type (e.g., riverine or depressional) (Gebo and Brooks

2012). Moreno-Mateos et al. (2012) conducted a meta-analysis of wetland restoration studies and concluded that while wetland structure and function can be restored to a large degree, the ecological performance of wetland restoration projects is dependent on wetland size and local environmental setting. They found that wetland restoration projects that are larger in size and in less disturbed landscape settings achieve structure and function more quickly.

Under the Corps' regulations, streams considered to be are difficult-to-replace resources and compensatory mitigation should be provided through stream rehabilitation, enhancement, and preservation since those techniques are most likely to be ecologically successful (see 33 CFR 332.3(e)(3)). For the purposes of this section, the term "stream restoration" is used to cover river and stream rehabilitation and enhancement activities. Restoration can be done on large rivers and small streams, and sometimes entire stream networks (Wohl et al. 2015), in a variety of watershed land use settings, including urban and agricultural areas.

River and stream restoration activities can improve the functions performed by these aquatic ecosystems, and the ecosystem services they provide (Wohl et al. 2015, Beechie et al. 2010). Because of changes in land use and other changes in the watershed that have occurred over time, stream restoration can improve stream functions but cannot return a stream to a historic state (Wohl et al. 2015, Roni et al. 2008). Improvements in ecological performance of stream restoration projects is dependent on the restoration method and how outcomes are assessed (Palmer et al. 2014). The ability to restore the ecological functions of streams is dependent on the condition of the watershed draining to the stream being restored because human land uses and other activities in the watershed affect how that stream functions (Palmer et al. 2014). Ecologically successful stream restoration activities depend on addressing the factors that most strongly affect stream functions, such as water quality, water flow, and riparian area quality, rather than focusing solely on restoring the physical habitat of streams (Palmer et al. 2010, Roni et al. 2008), especially the stream channel.

To be effective, stream restoration activities need to address the causes of stream degradation, which are often within the watershed and outside of the stream channel (Palmer et al. 2014). Actions that focus on restoring processes and connectivity are more likely to be successful that channel reconfiguration efforts (Hawley 2018). Stream rehabilitation and enhancement projects, including the restoration and preservation of riparian areas, provide riverine functions (e.g., Allan and Castillo (2007) for rivers and streams, NRC (2002) for riparian areas). Ecologically effective stream restoration can be conducted by enhancing riparian areas, removing dams, reforestation, and implementing watershed best management practices that reduce storm water and agricultural runoff to streams (Palmer et al. 2014). Process-based stream restoration is intended to address the causes of stream degradation, and should be conducted at the appropriate scale for the cause of stream degradation, such as the watershed or stream reach (Beechie et al. 2010). Process-based stream restoration has substantial potential to re-

establish the physical, chemical, and biological processes that sustain riverine ecosystems, including their floodplains (Beechie et al. 2010). Process-based stream restoration can also reduce long-term restoration costs (Beechie et al. 2013, Hawley 2018).

Restoration of incised streams can be accomplished allowing beavers to construct dams in these streams, or by placing structures in the stream channel that mimic the effects that beaver dams have on these steams (DeVries et al. 2012). Examples of stream restoration and enhancement techniques include: dam removal and modification, culvert replacement or modification, fish passage structures when connectivity cannot be restored or improved by dam removal or culvert replacement, levee removal or setbacks, reconnecting floodplains and other riparian habitats, road removal, road modifications, reducing sediment and pollution inputs to streams, replacing impervious surfaces with pervious surfaces, restoring adequate in-stream or base flows, restoring riparian areas, fencing streams and their riparian areas to exclude livestock, improving in-stream habitat, recreating meanders, and replacing hard bank stabilization structures with bioengineering bank stabilization measures (Roni et al. 2013). Miller and Kochel (2010) recommend that stream restoration projects allow the stream channel to self-adjust in response to changing hydrologic and sediment regimes in the watershed, and include other restoration actions such as re-establishing riparian areas next to the stream channel and excluding livestock from the riparian area and stream channel. Large and medium sized rivers can be restored through various approaches, including levee setbacks, levee removal, or creating openings in levees, to restore or improve connectivity between the river and the floodplain, as well as other ecological and geomorphic processes (Wohl et al. 2015). Dam removal, as well as changes in dam operations that provide environmentally-beneficial flows of water and sediment, can also restore functions of rivers and larger streams (Wohl et al. 2015).

Hydrologic restoration can be more effective than in-stream habitat restoration projects (Hawley 2018) because they can help address alterations in watershed hydrology through land use and other watershed changes. Examples of hydrologic restoration approaches include reforestation, floodplain restoration, bankfull wetlands, detention basins, beaver reintroduction, and placement of large woody debris into the stream channel. Restoration actions outside of the stream channel, such as constructed wetlands, storm water management ponds, and revegetating riparian areas, can result in significant improvements in the biodiversity, community structure, and nutrient cycling processes of downstream waters (Smucker and Detenbeck 2014). Non-structural and structural techniques can be used to rehabilitate and enhance streams, and restore riparian areas (NRC 1992). Examples of non-structural stream restoration practices include removing disturbances to allow recovery of stream and riparian area structure and function, restoring natural stream flows by reducing or eliminating activities that have altered stream flows, preserving or restoring floodplains, and restoring and protecting riparian areas, including fencing to exclude livestock and people that can degrade

riparian areas (NRC 1992).

Form based restoration efforts, such as channel reconfiguration, can cause substantial adverse impacts to riverine systems through earthmoving activities (which can cause substantial increases in sediment loads) and the removal of riparian trees and other vegetation, with little demonstrable improvements in stream functions (Palmer et al. 2014). In-stream habitat enhancement activities, such as channel reconfiguration and adding in-stream structures, have resulted in limited effectiveness in improving biodiversity in streams (Palmer et al. 2010). In an evaluation of 644 stream restoration projects, Palmer et al. (2014) concluded that stream channel reconfiguration does not promote ecological recovery of degraded streams, but actions taken within the watershed and in riparian areas to restore hydrological processes and reduce pollutant inputs to streams can improve stream functions and ecological integrity. Stream restoration activities should also include consideration of social factors, especially the people that live in the floodplain or near the river or stream (Wohl et al. 2015). These social factors may also impose constraints on what restoration actions can be taken.

Seagrass beds are dynamic ecosystems that can persist for long periods of time or change from season to season (Fonseca et al. 1998). Seagrass beds can be restored, but these restoration activities generally have lower rates of ecological success than the restoration of other wetland types, such as estuarine and freshwater marshes (Lewis et al. 1995). The restoration and natural recovery of seagrasses requires consideration of addressing impediments that occur at various scales, including larger scale problems such as water quality and land use practices (Orth et al. 2006). The ecological success of seagrass restoration can be influenced by the dynamics of coastal environments and various stressors (e.g., reduced water quality/eutrophication, construction activities, dredging, other direct impact, natural disturbances) that affect seagrasses (van Katwijk et al. 2016). Realistic expectations should be established for seagrass restoration activities because of our limited understanding of seagrasses and the challenges of controlling conditions in open coastal waters (Fonseca 2011).

Site selection is critical for successful restoration of seagrasses (Fonseca 2011, Fonseca et al. 1998). Ecologically successful seagrass restoration is dependent on finding sites where seagrass beds recently existed (Fonseca et al. 1998). The ecological outcomes of seagrass restoration activities is also affected by the size of the restoration project, with larger restoration efforts more likely to be ecologically successful and sustainable because larger projects can produce positive feedbacks that facilitate the establishment and persistence of seagrasses (van Katwijk et al. 2016). At some proposed seagrass restoration sites, it may be infeasible to change the site from a stable unvegetated state to a stable vegetated state through seagrass planting efforts (Fonseca 2011). Small scale restoration activities may be overwhelmed by natural processes that prevent seagrasses from becoming reestablished (Fonseca 2011). Another impediment to ecologically successful seagrass restoration is bioturbation, which can impede natural seagrass recruitment

(Fonseca 2011) or disturb plantings. Bioturbation can be caused by animals such as shrimp, crabs, ducks, fish, and urchins, and result in stable, unvegetated benthic habitats (Fonseca 2011).

Fonseca (2011) recommends locating seagrass restoration activities in areas with water depths similar to nearby natural seagrass beds, at a sufficient size to achieve restoration goals, with characteristics that are similar to those at other ecologically successful seagrass restoration projects, and where anthropogenic disturbances can be reduced or removed. Restoration of submersed aquatic vegetation beds requires taking actions to reduce inputs of sediment, nutrients, and organic matter into estuarine waters and avoiding physical damage from boating activities and fishing gear (Waycott et al. 2009). Controlling these stressors has been more effective at restoring seagrass beds than seagrass transplantation efforts (Waycott et al. 2009). Potential restoration sites need to have sufficient light, moderate nutrient loads, suitable salinity and water temperatures, available seeds and other propagules, and an absence of mechanical disturbances that will destroy or degrade plants (Fonseca et al. 1998). Seagrass recovery is affected by numerous factors, such as the characteristics of the target seagrass species, disturbance intensity, disturbance characteristic(s), environmental conditions, disturbance history, the condition of existing seagrass beds, population structure, reproductive capacity, timing, and feedbacks between biotic and abiotic components at the site (O'Brien et al. 2018).

As discussed in section 4.0, the status of waters and wetlands in the United States as reported under the provisions of Sections 303(d) and 305(b) of the Clean Water Act exhibits considerable variation, ranging from "good" to "threatened" to "impaired." One of the criteria that district engineers consider when they evaluate proposed NWP activities is the "degree or magnitude to which the aquatic resources perform these functions" (see paragraph 2 of Section D, "District Engineer's Decision." The quality of the affected waters is considered by district engineers when making decisions on whether to require compensatory mitigation for proposed NWP activities to ensure no more than minimal adverse environmental effects (see 33 CFR 330.1(e)(3)), and amount of compensatory mitigation required (see 33 CFR 332.3(f)). The quality of the affected waters also factors into the determination of whether the required compensatory mitigation offsets the losses of aquatic functions caused by the NWP activity.

The compensatory mitigation required by district engineers in accordance with general condition 23 and through activity-specific conditions added to the NWP authorization is expected to provide aquatic resource functions and services to offset some or all of the losses of aquatic resource functions caused by the activities authorized by this NWP, and reduce the incremental contribution of those activities to the cumulative effects on the Nation's wetlands, streams, and other aquatic resources. The required compensatory mitigation must be conducted in accordance with the applicable provisions of 33 CFR part 332, which requires development and implementation of approved mitigation plans, as well as monitoring to assess

ecological success in accordance with ecological performance standards established for the compensatory mitigation project. The district engineer will evaluate monitoring reports to determine if the compensatory mitigation project has fulfilled its objectives, is ecological successful, and offsets the permitted impacts. If the monitoring efforts indicate that the compensatory mitigation project is failing to meet its objectives, the district engineer may require additional measures, such as adaptive management or alternative compensatory mitigation, to address the compensatory mitigation project's deficiencies. [33 CFR 332.7(c)]

According to Dahl (2011), during the period of 2004 to 2009 approximately 489,620 acres of former upland were converted to wetlands as a result of wetland reestablishment and establishment activities. Efforts to reestablish or establish wetlands have increased wetland acreage in the United States.

The individual and cumulative adverse effects on the aquatic environment resulting from the activities authorized by this NWP, including compliance with all applicable NWP general conditions as well as regional conditions imposed by division engineers and activity-specific conditions imposed by district engineers, are expected to be no more than minimal. The Corps expects that the convenience and time savings associated with the use of this NWP will encourage applicants to design their projects within the scope of the NWP, including its limits, rather than request individual permits for projects that could result in greater adverse impacts to the aquatic environment. Division and district engineers will restrict or prohibit this NWP on a regional or case-specific basis if they determine that these activities will result in more than minimal individual and cumulative adverse effects on the aquatic environment.

8.2.3 Section 404(b)(1) Guidelines Impact Analysis, Subparts C through F

(a) Substrate: Discharges of dredged or fill material into waters of the United States will alter the substrate of those waters, usually by altering the composition of the substrate to make it more suitable for shellfish reproduction and growth. Some commercial shellfish mariculture activities involve bed preparation by depositing gravel or shell on the bottom of the waterbody to provide substrate for larval shellfish to attach and grow (NRC 2010). The increase in habitat complexity due to the deposition of shell on the bottom of the waterbody can support a variety of plants and animals, including benthic and epibenthic organisms (Simenstad and Fresh 1995). Impacts to substrate caused by dredged harvesting of commercially grown bivalve shellfish can vary, and the severity of those impacts can depend on the duration and intensity of the dredging (NRC 2010). The discharges of dredged or fill material authorized by this NWP will not replace aquatic areas with dry land. There may be changes to the physical, chemical, and biological characteristics of the substrate. The original substrate may be removed or covered by other material, such as sand or gravel.

Shell, gravel, or other appropriate material deposited on the bottom of the

waterbody for commercial shellfish mariculture activities can provide suitable substrate for larval bivalve molluscs to attach to and grow. The bivalve molluscs that are produced through these activities are likely to contribute to the ecological functions and services performed by the waterbody. The shell, gravel, or other appropriate material, plus the bivalve shellfish grow on that substrate, may be colonized by epibiotic organisms such as macroalgae, barnacles, other bivalve mollusc species, bryozoans, sponges, and tunicates (NRC 2010) that may provide additional ecological functions and services, including food that supports the production of fish, large crustaceans, and aquatic organisms. The structured habitat provided by commercial shellfish mariculture activities can be higher in habitat value than unstructured habitat provided by mudflats (e.g., Hosack et al. 2006) and sandflats (e.g., Powers et al. 2007). Discharges of shell or gravel into estuarine water to enhance substrate for bivalve mollusc establishment and growth can also help increase sizes of local populations of other epibenthic organisms (Simenstad and Fresh 1995).

(b) Suspended particulates/turbidity: Depending on the method of operation, including harvesting techniques, sediment control measures, equipment, composition of the bottom substrate, and wind and current conditions during these shellfish mariculture activities involving discharges of dredged or fill material into waters of the United States, there may be temporary increases in water turbidity. Pre-construction notification is required for discharges of dredged or fill material into waters of the United States that directly affect more than 1/2-acre of submerged aquatic vegetation, which will allow the district engineer to review those activities and ensure that adverse effects on the aquatic environment are no more than minimal. Particulates will likely be temporarily resuspended in the water column during harvesting activities. There may also be temporary increases in turbidity during bed preparation for on-bottom bivalve shellfish mariculture activities, as shell, gravel, or other material is discharged into the waterbody to enhance the substrate for cultivation activities. The turbidity plume will normally be limited to the immediate vicinity of the disturbance and should dissipate shortly after each phase of operation. Nationwide permit activities cannot create turbidity plumes that smother important spawning areas downstream (see general condition 3).

(c) Water: Commercial shellfish mariculture activities involving discharges of dredged or fill material into waters of the United States can affect some characteristics of water, such as water clarity, chemical content, dissolved gas concentrations, pH, and temperature. Filter feeding by commercially grown bivalve molluscs removes plankton, organic matter, and inorganic particles from the water column, which enhances water clarity (NRC 2010, McKindsey et al. 2011). In some waters, suspension feeding by bivalve molluscs can also help reduce eutrophication and associated adverse effects (NRC 2010). Bivalve molluscs excrete wastes into the water column, which can alter the chemicals dissolved in the surrounding water (NRC 2010). The wastes excreted by bivalve molluscs may also help fertilize benthic habitats (NRC 2010). Changes in water quality can affect the species and quantities of organisms inhabiting the aquatic area, and the activities authorized by

this NWP will usually have beneficial effects on water quality. Water quality certification is required for activities authorized by this NWP that involve discharges of dredged or fill material into waters of the United States, which will ensure that the discharges comply with applicable water quality requirements. Permittees may be required to implement water quality management measures, including best management practices, to ensure that the authorized discharges do not result in more than minimal degradation of water quality.

(d) Current patterns and water circulation: Discharges of dredged or fill material into waters of the United States authorized by this NWP are likely to have minor adverse effects on the movement of water in the aquatic environment. On-bottom cultivation techniques may alter water flows and hydrodynamics when shell, gravel, and other material is placed on the bottom of the waterbody to create mounds for cultivating bivalve molluscs and reduce the risk of sedimentation smothering the cultivated bivalve molluscs. Certain discharges of dredged or fill material into waters of the United States authorized by this NWP require pre-construction notification to the district engineer, which will help ensure that adverse effects to current patterns and water circulation are no more than minimal. General condition 9 requires the authorized activity to be designed to withstand expected high flows and to maintain the course, condition, capacity, and location of open waters to the maximum extent practicable.

(e) Normal water level fluctuations: The discharges of dredged or fill material into waters of the United States authorized by this NWP are not likely to adversely affect normal patterns of water level fluctuations due to tides and flooding, since they likely only occupy a small proportion of the volume of the waterbody. Commercial shellfish mariculture activities occur in open waters and do not replace aquatic areas with dry land. General condition 9 requires the permittee to maintain the pre-construction course, condition, capacity, and location of open waters, to the maximum extent practicable.

(f) Salinity gradients: The discharges of dredged or fill material into waters of the United States authorized by this NWP are likely to have no adverse effects on salinity gradients, since commercial shellfish mariculture activities utilize existing waters and do not discharge freshwater that could change salinity.

(g) Threatened and endangered species: The NWPs do not authorize activities that will jeopardize the continued existence of species listed as endangered or threatened under the Endangered Species Act of 1973, as amended. In addition, the NWPs do not authorize activities that will destroy or adversely modify critical habitat of those species. See 33 CFR 330.4(f) and paragraph (a) of general condition 18. For activities authorized by NWP, compliance with the Endangered Species Act is discussed in more detail in section 7.0 of this document.

(h) Fish, crustaceans, molluscs, and other aquatic organisms in the food web. Discharges of shell, gravel and other materials used for on-bottom commercial

shellfish mariculture activities may provide structural habitat that attracts fish, crustaceans, and other aquatic organisms by providing substrate upon which epibiotic (fouling) organisms can become established and grow (e.g., Dumbauld et al. 2015, D'Amour et al. 2008, Powers et al. 2007, Hosack et al. 2006, NRC 2010), and those epibiotic organisms may serve as a food source for aquatic organisms. For those NWP activities that require pre-construction notification, the district engineer review those activities to ensure that adverse effects to fish and other aquatic organisms in the food web are no more than minimal. Fish and other motile animals may avoid the project site while commercial shellfish mariculture activities such as site preparation, transplantation, and harvesting are conducted. Sessile or slow-moving animals in the path of discharges of dredged or fill material and mariculture equipment may be destroyed. On the other hand, the increase in habitat complexity that typically results from bivalve shellfish mariculture activities can support a greater diversity of benthic and epibenthic animals and plants (Simenstad and Fresh 1995) compared to unstructured subtidal and intertidal habitats. Some aquatic animals may be smothered by discharges of dredged or fill material into waters of the United States. Motile animals may return to those areas that are temporarily impacted by discharges of dredged or fill material into waters of the United States, when the affected area is restored to pre-construction conditions or the dredged or fill material becomes assimilated into benthic habitats. Bivalve shellfish production is likely to increase as a result of the discharges of dredged or fill material into waters of the United States authorized by this NWP, and the associated increases in the number of bivalve molluscs in the waterbody may provide a variety of ecological functions and services.

Commercial shellfish mariculture activities may cause changes in prey availability for fish, birds, marine mammals, and sea turtles (NRC 2010), and those changes may be positive, negative, or neutral. Bivalve shellfish mariculture activities in intertidal areas can affect the shoreline feeding behaviors of shorebirds, and the effects vary by species, with some species avoiding mariculture areas and other species foraging in areas between structures (Kelly et al. 1996). In other words, some bird species may benefit from the commercial shellfish mariculture activities (e.g., through increased prey availability) and other species may be adversely affected by the commercial shellfish mariculture activities (e.g., by becoming entangled in anti-predator netting or disturbed by the presence of humans conducting these activities).

Division and district engineers can place conditions on this NWP to prohibit discharges of dredged or fill material into waters of the United States during important stages of the life cycles of certain aquatic organisms. Such time of year restrictions can prevent adverse effects to these aquatic organisms during reproduction and development periods. General conditions 3 and 5 address protection of spawning areas and shellfish beds, respectively. General condition 3 states that activities in spawning areas during spawning seasons must be avoided to the maximum extent practicable. In addition, general condition 3 also prohibits activities that result in the physical destruction of important spawning areas.

General condition 5 prohibits activities in areas of concentrated shellfish populations, except for activities authorized by NWPs 4 and 48.

(i) Other wildlife: Discharges of dredged or fill material into waters of the United States authorized by this NWP are likely to result in negligible adverse effects on other wildlife associated with aquatic ecosystems, such as resident and transient fish. Some wildlife species may be adversely affected by discharges of dredged or fill material into waters of the United States associated with commercial shellfish activities while other wildlife species may benefit from these discharges. Commercial shellfish mariculture activities may also disturb marine mammals, marine turtles, and birds and can cause declines in habitat quality and disrupt their feeding and reproductive behaviors (NRC 2010). Commercial shellfish mariculture activities may increase the spread of non-native species (NRC 2010). This NWP does not authorize discharges of dredged or fill material into waters of the United States that are likely to jeopardize the continued existence of federally-listed endangered and threatened species or result in the destruction or adverse modification of critical habitat. General condition 4 states that activities in breeding areas for migratory birds must be avoided to the maximum extent practicable.

(j) Special aquatic sites: The potential impacts to specific special aquatic sites are discussed below:

(1) Sanctuaries and refuges: The discharges of dredged or fill material into waters of the United States authorized by this NWP are likely to have only minimal adverse effects on waters of the United States within sanctuaries or refuges designated by federal or state laws or local ordinances. To cultivate bivalve molluscs in coastal waters in sanctuaries and refuges, the operator may need to obtain permission from the federal, state, or local government authority responsible for managing the sanctuary or refuge. District engineers will exercise discretionary authority and require individual permits for discharges of dredged or fill material into waters of the United States in sanctuaries and refuges if those discharges will result in more than minimal individual and cumulative adverse effects on the aquatic environment.

(2) Wetlands: The discharges of dredged or fill material into waters of the United States authorized by this NWP are likely to have only minor impacts on wetlands, since most commercial shellfish mariculture activities occur primarily in open waters, seaward of any tidal fringe wetlands that may be present in the vicinity of the operation. Some discharges of dredged or fill material into waters of the United States associated with commercial shellfish mariculture activities may directly or indirectly affect intertidal wetlands. There may be other activities associated with the commercial shellfish mariculture activity that may affect wetlands and may require separate Department of the Army authorization. This NWP does not authorize attendant features that may require discharges of dredged or fill material to construct, such as boat ramps, stockpiles, or staging areas, or the deposition of shell material back into waters of the United States as waste. District

engineers will review those NWP activities that require pre-construction notification to ensure that the adverse effects on the aquatic environment caused by NWP activities are no more than minimal. Division engineers can add regional conditions to this NWP to restrict or prohibit its use in certain high value wetlands. See paragraph (e) of section 6.1 for a more detailed discussion of impacts to wetlands.

(3) Mud flats: The discharges of dredged or fill material into waters of the United States authorized by this NWP are likely to have minor impacts on mud flats because most commercial shellfish mariculture activities are conducted in subtidal waters. In some areas of the country, commercial shellfish mariculture activities may occur in intertidal areas with mud flats. Some on-bottom bivalve molluscan mariculture activities may involve discharges of shell, gravel, or other materials into mud flats to enhance the suitability of the substrate for shellfish growth. These discharges may have long-term effects on the mud flat and change the physical characteristics of the mud flat. If these fills are permanent, they may permanently alter the structure and functions of the mud flat. Harvesting activities involving discharges of dredged material into mud flats, such as hydraulic dredging to remove molluscs that are benthic infauna (e.g., clams) may disturb mud flats. Many of the discharges authorized by this NWP will only have temporary impacts on mud flats, and the mud flats will likely recover from disturbance shortly after harvesting activities are completed. Mud flats occur in highly dynamic coastal environments and are affected by a variety of natural and anthropogenic disturbances. Mud flats may also be disturbed by dredging, harrowing, and levelling activities for bivalve shellfish production and harvesting.

(4) Vegetated shallows: The discharges of dredged or fill material into waters of the United States authorized by this NWP are likely to have minor adverse effects on vegetated shallows because impacts to submersed aquatic vegetation that may be caused by those discharges (e.g., through dredge harvesting) are generally temporary and the submersed aquatic vegetation may recover after those temporary disturbances, depending on local environmental conditions and other factors. Commercial shellfish mariculture activities can have positive and negative effects on submerged aquatic vegetation (NRC 2010). The filter feeding by bivalve shellfish can improve water clarity by removing particulates and plankton from the water column to increase light availability for submerged aquatic vegetation (NRC 2010, McKindsey et al. 2011). The improved water clarity can increase populations of submerged aquatic vegetation in the waterbody because they can establish and grow in deeper waters (NRC 2010). The biodeposits excreted by bivalve molluscs can act as fertilizer for plants in vegetated shallows (NRC 2010). Floating and on-bottom bivalve mariculture equipment, such as racks, bags, and cages can shade submerged aquatic vegetation and compete for space (NRC 2010). Dredging to harvest commercially produced bivalve shellfish can disturb submerged aquatic vegetation and remove individual shoots (NRC 2010, Tallis 2009). While bivalve molluscs may compete with seagrasses for space in coastal waters, bivalve shellfish can in some cases benefit seagrasses by providing nutrients to sediments and the water column and by making the water clearer (Dumbauld and McCoy

2015, NRC 2010). Appropriate siting of shellfish aquaculture operations can minimize interactions with submerged aquatic vegetation (Wickliffe et al. 2019).

The presence of suspension feeding bivalve shellfish in estuarine and marine waters has been shown to help improve the productivity of species of submerged aquatic vegetation in those waters (e.g., Peterson and Heck 2001). Filter feeding bivalves remove suspended particles and plankton from the water column and often release nutrients to sediments, which may help increase seagrass production (Dumbauld et al. 2009). Dumbauld and McCoy (2015) evaluated interactions between oyster mariculture and the seagrass *Zostera marina* in Willapa Bay, Washington and found that oyster mariculture impacts on seagrasses are temporary when examined at a landscape scale and that seagrasses recover fairly rapidly after mechanical disturbances by mariculture activities. There are trade-offs between oyster mariculture and eelgrass populations, and the effects of oyster mariculture on eelgrass vary depending on the oyster cultivation techniques used (Tallis et al. 2009). Those trade-offs should be examined at a landscape or seascape scale, rather than a site scale because of the variability that occurs over time (Tallis et al. 2009). In some west coast estuaries, seagrasses coexist with commercial oyster mariculture activities (Dumbauld et al. 2015).

Pre-construction notification is required for commercial shellfish mariculture activities that directly affect more than 1/2-acre of submerged aquatic vegetation. The pre-construction notification requirement provides the district engineer with an opportunity to review those activities on a case-by-case basis and assess potential impacts on submerged aquatic vegetation and ensure that the authorized activity results in no more than minimal adverse environmental effects. If the vegetated shallows are high value and the proposed activity will result in more than minimal adverse effects on the aquatic environment, the district engineer will exercise discretionary authority to require the project proponent to obtain an individual permit.

Some harvesting activities associated with commercial shellfish mariculture activities may require Clean Water Act section 404 authorization. Hydraulic dredging used to harvest cultivated bivalve molluscs may result in a regulated discharge of dredged material, depending on whether there is any addition of dredged material into, including redeposit of dredged material other than incidental fallback within, the waters of the United States (see 33 CFR 323.3(d)(1)). Mechanical harvesting may or may not require section 404 authorization, depending on how it is done and whether it results in a discharge of dredged material, as that term is defined at 33 CFR 323.2(d). Hand harvesting and mixed harvesting techniques can have less severe impacts on seagrasses than dredge harvesting (Dumbauld and McCoy 2015).

Bed preparation activities for commercial shellfish mariculture activities, such as harrowing, raking, and levelling, may require section 404 authorization because they may result in a discharge of dredged material (see definition at 33 CFR

323.2(d)). The impacts of these activities are likely to be temporary because the substrate in intertidal areas where these activities may occur is moved around by water flows, including tidal water flows. Other types of bed preparation activities, such as the placement of shell, gravel, or other materials suitable for bivalve shellfish to attached to or grow are likely to require Clean Water Act Section 404 authorization as a “discharge of fill material” as that term is defined in the Corps’ regulations at 33 CFR 323.2(f). Bed preparation through the placement of shell, gravel, or other materials on the bottom of the waterbody are likely to be temporary because those materials will be moved around by the ebb and flow of the tide and by currents.

Disturbances to seagrasses caused by bivalve shellfish harvesting activities and their ability to recover from such disturbances vary by seagrass species, the geographic scope of disturbance, disturbance intensity, the season in which the harvesting activities occur, and substrate characteristics (NRC 2010). While commercial shellfish mariculture activities may have direct and indirect effects on seagrasses, these adverse effects are usually observed at relatively small spatial and temporal scales, and those adverse effects may in some cases be temporary (Dumbauld and McCoy 2015). They also observed that seagrasses can co-exist and intermingle with cultivated bivalve molluscs. At a seascape or landscape scale, bivalve shellfish mariculture activities might not substantially reduce seagrasses because the mariculture activities typically occur within a small proportion of the waterbody and the ecological functions performed by bivalve molluscs can create conditions that support the growth and persistence of seagrasses (Dumbauld and McCoy 2015). Habitat patches within coastal waters usually change over time in these highly dynamic environments. Some species may compete for space and replace other species in that location, and those other species may occupy space in another area of coastal waters.

Neither the Clean Water Act nor the Clean Water Act Section 404(b)(1) Guidelines prohibit discharges of dredged or fill material or other types of impacts to vegetated shallows. Under the 404(b)(1) Guidelines, discharges of dredged or fill material into special aquatic sites can be authorized by general permits and individual permits. The Clean Water Act recognizes the protection and propagation of fish and shellfish as one of its objectives (see 33 USC 1251(a)(2)). As discussed elsewhere in this document, seagrasses and cultivated bivalve shellfish can coexist in waterbodies, as they coexisted historically before overfishing depleted natural stocks of bivalve molluscs (e.g., Lotze et al. 2009). Commercial shellfish mariculture activities have occurred in the United States for more than 100 years (NRC 2010), often in areas inhabited by submerged aquatic vegetation. Under the 404(b)(1) Guidelines, discharges and dredged or fill material into special aquatic sites and other waters of the United States can be authorized to fulfill a specific project purpose. For NWP 48, that project purpose is the production of bivalve molluscs for human consumption, to fulfill a fundamental human need for energy and nutrients for life-supporting metabolic processes. A secondary benefit of commercial shellfish mariculture activities is the variety of ecological functions and services that the

cultivated bivalve molluscs can provide to coastal ecosystems, such as improved water quality, habitat for a variety of fish and invertebrates, shore erosion control, and nutrient cycling. While commercial shellfish mariculture activities, including harvesting activities, may directly and indirectly affect seagrasses, many of those activities have temporary impacts and seagrasses possess the ability to recover after those disturbances occur.

Activities authorized by NWPs must have no more than minimal individual and cumulative adverse environmental effects (see 33 USC 1344(e)(1)). Activities authorized by this NWP are likely to have some degree of adverse environmental effects to specific components of the aquatic environment, such as vegetated shallows, and those activities can be authorized by NWP as long as the individual and cumulative adverse environmental effects are no more than minimal. Under various provisions of 33 CFR part 330, division and district engineers have discretionary authority to modify, suspend, or revoke NWP authorizations. This discretionary authority may be used by division and district engineers only to further condition or restrict the applicability of an NWP for cases where they have concerns for the aquatic environment under the Clean Water Act Section 404(b)(1) Guidelines or for any factor of the public interest (see 33 CFR 330.1(d)).

(5) Coral reefs: The discharges of dredged or fill material into waters of the United States authorized by this NWP may have adverse effects on coral reefs, but commercial shellfish mariculture activities are typically not conducted in areas inhabited by coral reefs. Division engineers may add regional conditions to this NWP if there is potential for the discharges authorized by this NWP to have direct or indirect impacts on coral reefs, and those impacts could be more than minimal.

(6) Riffle and pool complexes: The discharges of dredged or fill material into waters of the United States authorized by this NWP are unlikely to have any adverse effects on riffle and pool complexes, since it is limited to commercial shellfish mariculture activities that are conducted in navigable marine and estuarine waters. Riffle and pool complexes are found only in certain types of streams (Montgomery and Buffington 1997), and these streams are freshwater streams and are not used for commercial shellfish mariculture activities.

(k) Municipal and private water supplies: See paragraph (n) of section 6.1 for a discussion of potential impacts to water supplies.

(l) Recreational and commercial fisheries, including essential fish habitat: The discharges of dredged or fill material into waters of the United States authorized by this NWP are likely to have minor adverse effects on waters of the United States that act as habitat for populations of economically important fish and shellfish species, since it authorizes commercial shellfish mariculture activities. The activities authorized by this NWP will increase populations of shellfish in navigable waters, which will provide ecological functions and services associated with those organisms. The bivalve shellfish and associated features in shellfish beds can

provide structural habitat for a variety of organisms that serve as food for fish species that are used in recreational and commercial fisheries. Both eelgrass and oysters provide habitat for invertebrates that are important food sources for populations of fish and decapod crustaceans (Hosack et al. 2006). When dredging is used to harvest commercially grown bivalve molluscs, the impacts of those activities on benthic communities can be greater than the impacts associated with dredge harvesting of naturally-occurring bivalve shellfish (NRC 2010). Division and district engineers can add conditions to this NWP to prohibit discharges during important life cycle stages, such as spawning or development periods, of economically valuable fish and shellfish. Compliance with general conditions 3 and 5 will ensure that the authorized discharges do not adversely affect important spawning areas or concentrated shellfish populations. As discussed in paragraph (g) of section 6.1, there are procedures to help ensure that individual and cumulative impacts to essential fish habitat are no more than minimal. For example, division and district engineers can impose regional and special conditions to ensure that activities authorized by this NWP will result in only minimal adverse effects on essential fish habitat.

(m) Water-related recreation: See paragraph (m) of section 6.1 above.

(n) Aesthetics: See paragraph (c) of section 6.1 above.

(o) Parks, national and historical monuments, national seashores, wilderness areas, research sites, and similar areas: This NWP can be used to authorize discharges of dredged or fill material into waters of the United States in parks, national and historical monuments, national seashores, wilderness areas, and research sites if there are commercial shellfish mariculture activities are authorized in those areas through leases, permits, treaties, or other legal instruments that establish enforceable property interests for growers, and those discharges result in no more than minimal adverse effects on the aquatic environment. Division engineers can regionally condition the NWP to prohibit its use in designated areas, such as national wildlife refuges or wilderness areas.

9.0 Determinations

9.1 Finding of No Significant Impact

Based on the information in this document, the Corps has determined that the structures and work in navigable waters of the United States and the discharges of dredged or fill material into waters of the United States authorized by the issuance of this NWP will not have a significant impact on the quality of the human environment. During the five-year period this NWP will be in effect, the activities authorized by this NWP will result in only minor changes to the affected environment described in section 4.0 of this environmental assessment. Therefore,

the preparation of an environmental impact statement is not required for the issuance of this NWP.

9.2 Public Interest Determination

In accordance with the requirements of 33 CFR 320.4, the Corps has determined, based on the information in this document, that the issuance of this NWP to authorize structures and work in navigable waters of the United States and discharges of dredged or fill material into waters of the United States for commercial shellfish mariculture activities is not contrary to the public interest.

9.3 Section 404(b)(1) Guidelines Compliance

This NWP has been evaluated for compliance with the 404(b)(1) Guidelines, including Subparts C through G. Based on the information in this document, the Corps has determined that the discharges authorized by this NWP comply with the 404(b)(1) Guidelines, with the inclusion of appropriate and practicable conditions, including mitigation measures required by the NWP general conditions, that minimize adverse effects on affected aquatic ecosystems. The discharges of dredged or fill material into waters of the United States authorized by this NWP will result in only minor changes to the current environmental setting described in section 4.0 of this document, and will have no more than minimal individual and cumulative adverse effects on the aquatic environment during the 5-year period this NWP is in effect.

9.4 Section 176(c) of the Clean Air Act General Conformity Rule Review

This issuance of this NWP has been analyzed for conformity applicability pursuant to regulations implementing Section 176(c) of the Clean Air Act. It has been determined that the activities authorized by this permit will not exceed de minimis levels of direct emissions of a criteria pollutant or its precursors and are exempted by 40 CFR 93.153. Any later indirect emissions are generally not within the Corps

continuing program responsibility and generally cannot be practicably controlled by the Corps. For these reasons, a conformity determination is not required for this NWP.

FOR THE COMMANDER

Dated: 4 January 2021

William H. Graham Jr.
Major General, U.S. Army
Deputy Commanding General for Civil and Emergency Operations

10.0 References

Allan, J.D. 2004. Landscapes and Riverscapes: The Influence of Land Use on Stream Ecosystems. Annual Review of Ecology, Evolution, and Systematics. 35:257–284.

Allan, J.D. and M.M. Castillo. 2007. Stream Ecology: Structure and Function of Running Waters, 2nd edition. Springer (The Netherlands). 436 pp.

Alleway, H.K, C.L. Gillies, M.J. Bishop, R.R. Gentry, S.J. Theuerkauf, and R. Jones. 2019. The ecosystem services of marine aquaculture: Valuing benefits to people and nature. Bioscience 69:59-68.

Backstrom, A.C, G.E. Garrard, R.J. Hobbs, and S.A. Bekessy. 2018. Grappling with the social dimensions of novel ecosystems. Frontiers in Ecology and the Environment 16:109-117, doi: 10.1002/fee.1769

Beck, M.W., and 14 others. 2011. Oyster reefs at risk and recommendations for conservation, restoration, and management. Bioscience 61:107-16.
Beechie, T. J.S. Richardson, A.M. Gurnell, and J. Negishi. 2013. Watershed processes, human impacts, and process-based restoration. In, Stream and Watershed Restoration: A Guide to Restoring Riverine Processes and Habitats. Edited by P. Roni and T. Beechie. Wiley and Sons, Inc. (West Sussex, UK), pp. 11-49.

Beechie, T.J., D.A. Sear, J.D. Olden, G.R. Pess, J.M. Buffington, H. Moir, P. Roni, and M.M. Pollock. 2010. Process-based principles for restoring river ecosystems. Bioscience 60:209-222.

Benstead, J.P. and D.S. Leigh. 2012. An expanded role for river networks. Nature Geoscience 5:678-679.

Bigelow, D.P. and A. Borchers. 2017. Major Uses of Land in the United States, 2012. EIB-178. U.S. Department of Agriculture, Economic Research Service. 62 pp.

Bodkin, D.B. 2012. The Moon in the Nautilus Shell: Discordant Harmonies Reconsidered from Climate Change to Species Extinction, How Life Persists in an Ever-Changing World. Oxford University Press (New York, New York). 424 pp.

Booth, D.B., J.R. Karr, S. Schauman, C.P. Konrad, S.A. Morley, M.G. Larson, and S.J. Burges. 2004. Reviving urban streams: Land use, hydrology, biology, and human behavior. Journal of the American Water Resources Association. 40:1351-1364.

Borum, J., R.K. Gruber, and W.M. Kemp. 2013. Seagrass and related submersed vascular plants. In Estuarine Ecology, 2nd edition. Edited by J.W. Day, Jr., B.C.

Crump, W.M. Kemp, and A. Yáñez-Arancibia. Wiley-Blackwell. Chapter 5, pp. 111-127.

Brinson, M.M. and A.I. Malvárez. 2002. Temperate freshwater wetlands: type, status and threats. Environmental Conservation 29:115-133.

Brooks, R.T. and E.A. Colburn. 2011. Extent and channel morphology of unmapped headwater stream segments of the Quabbin watershed, Massachusetts. Journal of the American Water Resources Association 47:158-168.

Brown, T.C. and P. Froemke. 2012. Nationwide assessment of non-point source threats to water quality. Bioscience 62:136-146.

Butman, D. and P.A. Raymond. 2011. Significant efflux of carbon dioxide from streams and rivers in the United States. Nature Geoscience 4:839–842.

Canter, L.W. 1996. Environmental Impact Analysis. 2nd edition. McGraw-Hill (Chapter 4).

Carpenter, S.R., E.H. Stanley, and J.M. Vander Zanden. 2011. State of the world's freshwater ecosystems: Physical, chemical, and biological changes. Annu. Rev. Environ. Resources. 36:75-99.

Chapin, S.F, and 16 others. 2010. Ecosystem stewardship: sustainability strategies for a rapidly changing planet. Trends in Ecology and Evolution 25:241-249.

Clarke Murray, C., M.E. Mach, and R.G. Martone, R.G. 2014. Cumulative effects in marine ecosystems: scientific perspectives on its challenges and solutions. WWF-Canada and Center for Ocean Solutions. 60 pp.

Clewell, A.F. and J. Aronson. 2013. Ecological Restoration: Principles, Values, and Structrue of an Emerging Profession. 2nd edition. Island Press (Washington, DC). Chapter 3, pages 35-36.

Costanza, R., R. de Groot, P. Sutton, S. van der Ploeg, S.J. Anderson, I. Kubiszewski, and R.K. Turner. 2014. Changes in the global value of ecosystem services. Global Environmental Change 26:152-148.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service. FWS/OBS-79-31. 131 pp.

D'Anna, L.M. and G.D. Murray. 2015. Perceptions of shellfish aquaculture in British Columbia and implications for well-being in marine social-ecological systems. Ecology and Society 20(1): 57. http://dx.doi.org/10.5751/ES-07319-200157

Dahl, T.E. 2011. Status and trends of wetlands in the conterminous United States 2004 to 2009. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC. 108 pp.

Dahl, T.E. 1990. Wetlands losses in the United States 1780s to 1980s. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. 21 pp.

Dahl, T.E. and C.E. Johnson. 1991. Status and Trends of Wetlands in the Conterminous United States, Mid-1970s to Mid-1980s. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC. 28 pp.

D'Amours, O., P. Archambault, C.W. McKindsey, and L.E. Johnson. 2008. Local enhancement of epibenthic macrofauna by aquaculture activities. Marine Ecology Progress Series 371: 73–84.

Davis, M.A. and 18 others. 2011. Don't judge species on their origins. Nature 474:153-154.

Day, J.W., Jr., A. Yáñez-Arancibia, and W.M. Kemp. 2013. Human impact and management of coastal and estuarine ecosystems. In Estuarine Ecology, 2nd edition. Edited by J.W. Day, Jr., B.C. Crump, W.M. Kemp, and A. Yáñez-Arancibia. Wiley-Blackwell. Chapter 19, pp. 483-495.

Dealteris, J.T., B.D. Kilpatrick, and R.B. Rheault. 2004. A comparative evaluation of the habitat value of shellfish aquaculture gear, submerged aquatic vegetation and a non-vegetated seabed. Journal of Shellfish Research 23:867-874.
Deegan, L.A., D.S. Johnson, R.S. Warren, B.J. Peterson, J.W. Fleeger, S. Fagherazzi, and W.M. Wollheim. 2012. Coastal eutrophication as a driver of salt marsh loss. Nature 490:388-392.

DeVries, P., K.L. Fetherston, A. Vitale, and S. Madsen. 2012. Emulating riverine landscape controls of beaver in stream restoration. Fisheries 37:246-255.

Dumbauld, B.R. and L.M. McCoy. 2015. Effect of oyster aquaculture on seagrass Zostera marina at the estuarine landscape scale in Willapa Bay, Washington (USA). Aquaculture Environment Interactions 7:29-47.

Dumbauld, B.R., G.R. Hosack, and K.M. Bosley. 2015. Association of juvenile salmon and estuarine fish with intertidal seagrass and oyster aquaculture habitats in a northeast Pacific estuary. Transactions of the American Fisheries Society 144:1091-1110.

Dumbauld, B.R., J.L. Ruesink, and S.S. Rumrill. 2009. The ecological role of bivalve shellfish aquaculture in the estuarine environment: A review with application to oyster and clam culture in west coast (USA) estuaries. Aquaculture 290:196-223.

Dudgeon, D. A.H. Arthington, M.O. Gessner, Z.-I. Kawabata, D.J. Knowler, C. Lévêque, R.J. Naiman, A.-H. Prieur-Richard, D. Soto, M.L.J. Stiassny, and C.A. Sullivan. 2005. Freshwater biodiversity: importance, threats, status and conservation challenges. Biological Reviews 81:163-182.

Ehrenfeld, J.G. 2000. Defining the Limits of Restoration: The Need for Realistic Goals. Restoration Ecology 8:2-9.

Ellis, E.C. 2015. Ecology in an anthropogenic biosphere. Ecological Monographs 85:287–331.

Ellis, E.C., K.K. Goldewijk, S. Siebert, D. Lightman, and N. Ramankutty. 2010. Anthropogenic transformation of the biomes, 1700 to 2000. Global Ecology and Biogeography 19:589-606.

Ellis, E.C. and N. Ramankutty. 2008. Putting people in the map: Anthropogenic biomes of the world. Frontiers in Ecology and the Environment 6:439-447.

Elmore, A.J., J.P. Julian, S.M. Guinn, and M.C. Fitzpatrick. 2013. Potential stream density in mid-Atlantic watersheds. PLOS ONE 8:e74819

Evans, N.M. and M.A. Davis. 2018. What about cultural ecosystems? Opportunities for cultural considerations in the “International Standards for the Practice of Ecological Restoration.” Restoration Ecology 26:612-617.

Ewel, J.J. and F.E. Putz. 2004. A place for alien species in ecosystem restoration. Frontiers in Ecology and the Environment 2:354–360.

Federal Geographic Data Committee. 2013. Classification of wetlands and deepwater habitats of the United States. FGDC-STD-004-2013. Second Edition. Wetlands Subcommittee, Federal Geographic Data Committee and U.S. Fish and Wildlife Service, Washington, DC.

Fennessy, M.S., A.D. Jacobs, and M.E. Kentula. 2007. An evaluation of rapid methods for assessing the ecological condition of wetlands. Wetlands 27:543-560.

Ferriss, B.E., L.L. Conway-Cranos, B.L. Sanderson, L. Hoberechtd. 2019. Bivalve aquaculture and eelgrass: A global meta-analysis. Aquaculture 498:254-262.

Ferriss, B.E., J.C.P. Reum, P.S. McDonald, D.M. Farrell, and C.J. Harvey. 2016. Evaluating trophic and non-trophic effects of shellfish aquaculture in a coastal estuarine foodweb. ICES Journal of Marine Science 73:429–440. doi:10.1093/icesjms/fsv173

Fischenich, J.C. 2006. Functional objectives for stream restoration. EMRRP Technical Notes Collection (ERDC TN-EMRRP-SR-52). Vicksburg, MS: U.S. Army

Engineer Research and Development Center. 18 pp.

Foley, J.A., and 18 others. 2005. Global consequences of land use. Science 309:570-574.

Folke, C., S.R. Carpenter, B. Walker, M. Scheffer, T. Chapin, and J. Rockstrom. 2010. Resilience thinking: Integrating resilience, adaptability, and transformability. Ecology and Society, volume 15, article 20.

Folke, C. S. Carpenter, B. Walker, M. Scheffer, T. Elmqvist, L. Gunderson, and C.S. Holling. 2004. Regime shifts, resilience, and biodiversity in ecosystem management. Annual Review of Ecology, Evolution, and Systematics. 35:557–81.

Folke, C. and 21 others. 2011. Reconnecting to the biosphere. AMBIO 40:719-738.

Fonseca, M.S. 2011. Addy Revisited: What Has Changed with Seagrass Restoration in 64 Years? Ecological Restoration 29:73-81.

Fonseca, M.S., J.W. Kenworthy, and G.W. Thayer. 1998. Guidelines for the conservation and restoration of seagrasses in the United States and adjacent waters. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Coastal Ocean Office. Decision Analysis Series Report Number 12. 230 pp.

Forrest, B.M., N.B. Keeley, G.A. Hopkins, S.C. Webb, D.M. Clement. 2009. Bivalve aquaculture in estuaries: Review and synthesis of oyster cultivation effects. Aquaculture 298:1-15.

Frayer, W.E., T.J. Monahan, D.C. Bowden, F.A. Graybill. 1983. Status and Trends of Wetlands and Deepwater Habitats in the Conterminous United States: 1950s to 1970s. Department of the Interior, U.S. Fish and Wildlife Service. Washington, DC. 32 pp.

Froehlich, H.E., R.R. Gentry, and B.S. Halpern. 2017. Conservation aquaculture: Shifting the narrative and paradigm of aquaculture's role in resource management. Biological Conservation 215:162-168.

Gebo, N.A. and R.P. Brooks. 2012. Hydrogeomorphic (HGM) assessments of mitigation sites compared to natural reference wetlands in Pennsylvania. Wetlands 32:321-331.

Gentry, R.R., H.K. Alleway, M.J. Bishop, C.L. Gillies, T. Waters, and R. Jones. 2020. Exploring the potential for marine aquaculture to contribute to ecosystem services. Reviews in Aquaculture 12:499-512.

Gergel, S.E., M.G. Turner, J.R. Miller, J.M. Melack, and E.H. Stanley. 2002. Landscape indicators of human impacts to riverine systems. Aquatic Sciences

64:118-128.

Gittman, R.K, F.J. Fodrie, A.M. Popowich, D.A. Keller, J.F. Bruno, C.A. Currin, C.H. Peterson, and M.F. Piehler. 2015. Engineering away our natural defenses: an analysis of shoreline hardening in the United States. Frontiers in Ecology and the Environment 13:301-307.

Glasoe, S. and A. Christy. 2004. Coastal urbanization and microbial contamination of shellfish growing areas. Office of the Governor, Puget Sound Action Team. Publication #: PSA T04-09.

Gosselink, J.G. and L.C. Lee. 1989. Cumulative impact assessment in bottomland hardwood forests. Wetlands 9:83-174.

Gunderson, L.H. 2000. Ecological resilience – in theory and application. Annual Review of Ecology and Systematics. 31:425–39.

Hall, J.V., W.E. Frayer, and B.O. Wilen. 1994. Status of Alaska Wetlands. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC. 33 pp.

Halpern, B.S. and 10 others. 2015. Spatial and temporal changes in cumulative human impacts on the world's ocean. Nature Communications. 6:7615, doi: 10.1038/ncomms8615

Halpern, B.S., and 18 others. 2008. A global map of human impact on marine ecosystems. Science 319:948-952.

Hansen, W.F. 2001. Identifying stream types and management implications. Forest Ecology and Management 143:39-46.

Harris, L.D. and J.G. Gosselink. 1990. Cumulative impacts of bottomland hardwood forest conversion on hydrology, water quality, and terrestrial wildlife. In: Ecological Processes and Cumulative Impacts: Illustrated by Bottomland Hardwood Wetland Ecosystems. Ed. by J.G. Gosselink, L.C. Lee, and T.A. Muir. Lewis Publishers, Inc. (Chelsea, MI). pp. 260-322.

Hawley, R.J. 2018. Making stream restoration more sustainable: A geomorphically, ecologically, and socioeconomically principled approach to bridge the practice with science. Bioscience 68:517-528.

Heck, Jr., K.L., G. Hays, and R.J. Orth. 2003. Critical evaluation of the nursery role hypothesis for seagrass meadows. Marine Ecology Progress Series 253:123–136.

Higgs, E., D.A. Falk, A. Guerrini, M. Hall, J. Harris, R.J. Hobbs, S.T. Jackson, J.M. Rhemtulla, and W. Throop. 2014. The changing role of history in restoration ecology. Frontiers in Ecology and the Environment 12:499-506.

Hobbs, R.J. 2016. Degraded or just different? Perceptions and value judgments in restoration decisions. Restoration Ecology 24:153–158.

Hobbs, R.J. 2007. Setting effective and realistic restoration goals: Key directions for research. Restoration Ecology 15:354-357.

Hobbs, R.J., and 27 others. 2014. Managing the whole landscape: historical, hybrid, and novel ecosystems. Frontiers in Ecology and the Environment 12:557-564.

Hosack, G.R., B.R. Dumbauld, J.L. Ruesink, and D.A. Armstrong. 2006. Habitat associations of estuarine species: Comparisons of intertidal mudflat, seagrass (Zostera marina), and oyster (Crassostrea gigas) habitats. Estuaries and Coasts 29:1150-1160.

Hughes, T.P., and 16 others. 2003. Climate change, human impacts, and the resilience of coral reefs. Science 301:929-933.

Jackson, J.B.C., and 18 others. 2001. Historical overfishing and the recent collapse of coastal ecosystems. Science 293:629-638.

Julius, S.H., J.M. West, D. Nover, R. Hauser, D.S. Schimel, A.C. Janetos, M.K. Walsh, and P. Backlund. 2013. Climate change and U.S. natural resources: Advancing the nation's capacity to adapt. Ecological Society of America. Issues in Ecology, Report Number 18. 17 pp.

Karieva, P. S. Watts, R. McDonald, and T. Boucher. 2007. Domesticated nature: Shaping landscapes and ecosystems for human welfare. Science 316:1866-1869.

Kelly, J.P., J.G. Evens, R.W. Stallcup, and D. Wimpfhimer. Effects of oyster culture on habitat use by wintering shorebirds in Tomales Bay, California. California Fish and Game 82:160-174.

Kettlewell, C.I., V. Bouchard, D. Porej, M. Micacchion, J.J. Mack, D. White, and L. Fay. 2008. An assessment of wetland impacts and compensatory mitigation in the Cuyahoga River watershed, Ohio, USA. Wetlands 28:57-67.

Kopf, R.K., C.M. Finlayson, P. Humphries, N.C. Sims, and S. Hladyz. 2015. Anthropocene baselines: Assessing change and managing biodiversity in human-dominated aquatic ecosystems. Bioscience 65:798-811.

Korpinen, S. and J.H. Andersen. 2016. A global review of cumulative pressure and impact assessment in marine environments. Frontiers in Marine Science. Volume 3, Number 153. doi: 10.3389/fmars.2016.00153

Leopold, L.B., M.G. Wolman, and J.P. Miller. 1964. Fluvial Processes in

Geomorphology. Dover Publications, Inc. (New York). 522 pp.

Leopold, L.B. 1994. A View of the River. Harvard University Press (Cambridge). 298 pp.

Leopold. L.B. 1968. Hydrology for urban land planning – A guidebook on the hydrologic effects of urban land use. Department of the Interior. U.S. Geological Survey. Geological Survey Circular 554. 18 pp.

Lewis, R.R., J.A. Kusler, and K.L. Erwin. 1995. Lessons learned from five decades or wetland restoration and creation in North America. In: Bases Ecológicas para la Restaruación de Humedales en la Cuenca Mediterránea. Edited by C. Montes, G. Oliver, F. Monila, and J. Cobos. pp. 107-122.

Lotze, H.K. and 9 others. 2006. Depletion, degradation, and recovery potential of estuaries and coastal seas. Science 312:1806-1809.

MacDonald, L.H. 2000. Evaluating and Managing Cumulative Effects: Process and Constraints. Environmental Management 26:299–315.

Malcom, J.W. and Y.-W. Li. 2015. Data contradict common perceptions about a controversial provision of the US Endangered Species Act. Proceedings of the National Academy of Sciences. 112:15844–15849.

McKindsey, C.W., P. Archambault, M.D. Callier, and F. Olivier. 2011. Influence of suspended and off-bottom mussel culture on the sea bottom and benthic habitats: a review. Canadian Journal of. Zoology 89: 622–646.

Meli, P., J.M. Rey Benayas, P. Balvanera, and M.M. Ramos. 2014. Restoration enhances wetland biodiversity and ecosystem service supply, but results are context-dependent: A meta-analysis. PLoS One 9:e93507.

Meyer, J.L. and J.B. Wallace. 2001. Lost linkages and lotic ecology: rediscovering small streams. In Ecology: Achievement and Challenge. Ed. by M.C. Press, N.J. Huntly, and S. Levin. Blackwell Science (Cornwall, Great Britain). pp. 295-317.

Millar, C.I. and L.B. Brubaker. 2006. Climate change and paleoecology: New contexts for restoration ecology. In: Foundations of Restoration Ecology, edited by D.A. Falk, M.A. Palmer, and J.B. Zedler. Island Press (Washington, DC). Chapter 15, pages 315-340.

Millennium Ecosystem Assessment (MEA). 2005a. Ecosystems and Human Well-Being: Wetlands and Water Synthesis. World Resources Institute, Washington, DC. 68 pp.

Millennium Ecosystem Assessment (MEA). 2005b. Ecosystems and Human Well-

being: Current State and Trends, Chapter 19 – Coastal Ecosystems. World Resources Institute, Washington, DC. 37 pp.

Millennium Ecosystem Assessment (MEA). 2005c. Ecosystems and human well-being: Biodiversity synthesis. World Resources Institute, Washington, DC. 86 pp.

Miller, J.R. and R.C. Kochel. 2010. Assessment of channel dynamics, in-stream structures, and post-project channel adjustments in North Carolina and is implications to effective stream restoration. Environment and Earth Science 59:1681-1692.

Mitsch, W.J. and J.G. Gosselink. 2015. Wetlands. 5th edition. John Wiley and Sons, Inc. (Hoboken, New Jersey) 736 pp.

Mitsch, W.J. and M.E. Hernandez. 2013. Landscape and climate change threats to wetlands of North and Central America. Aquatic Sciences 75:133-149.

Montgomery, D.R. and J.M. Buffington. 1997. Channel-reach morphology in mountain drainage basins. Geological Society of America Bulletin 109:596-611.

Moreno-Mateos, D., P. Meli, M.I. Vara-Rodríguez, and J. Aronson. 2015. Ecosystem response to interventions: lessons from restored and created wetland ecosystems. Journal of Applied Ecology. 52:1528-1537.

Moreno-Mateos, D., M.E. Power, F.A. Comìn, R. Yockteng. 2012. Structural and functional loss in restored wetland ecosystems. PLoS Biol 10(1): e1001247. doi:10.1371/journal.pbio.1001247

National Academy of Sciences and the Royal Society (NAS and RS). 2019. Climate change and ecosystems. Washington, DC: The National Academies Press. https://doi.org/10.17226/25504

National Oceanic and Atmospheric Administration (NOAA). 2013. National Coastal Population Report: Population Trends from 1970 to 2020. NOAA State of the Coast Report Series. 22 pp.

National Oceanic and Atmospheric Administration (NOAA). 1975. The Coastline of the United States. http://shoreline.noaa.gov/_pdf/Coastline_of_the_US_1975.pdf (accessed October 23, 2014).

National Research Council (NRC). 1986. Ecological Knowledge and Environmental Problem-Solving: Concepts and Case-Studies. National Academy Press (Washington, DC). 388 pp.

National Research Council (NRC). 1992. Restoration of Aquatic Ecosystems. National Academy Press (Washington, DC). 552 pp.

National Research Council (NRC). 1994. Priorities for Coastal Ecosystem Science. National Academy Press (Washington, DC). 118 pp.

National Research Council (NRC). 1995. Wetlands: Characteristics and Boundaries. National Academy Press (Washington, DC). 306 pp.

National Research Council (NRC). 2001. Compensating for Wetland Losses Under the Clean Water Act. National Academy Press (Washington, DC). 322 pp.

National Research Council (NRC). 2002. Riparian Areas: Functions and Strategies for Management National Academy Press (Washington, DC). 444 pp.

National Research Council (NRC). 2010. Ecosystem Concepts for Sustainable Bivalve Mariculture. National Academy Press (Washington, DC). 190 pp.

Naylor, R.L., S.L. Williams, and D.R. Strong. 2001. Aquaculture—A Gateway for Exotic Species. Science 294:1655-1656.

O'Brien, K.R. and 17 others. 2018. Seagrass ecosystem trajectory depends on the relative timescales of resistance, recovery and disturbance. Marine Pollution Bulletin 134:166–176.

Odum, E.P. and G.W. Barrett. 2005. Fundamentals of Ecology (5th edition). Thompson Brooks/Cole (Canada). (Chapter 7)

Orth, R.J., and others. 2006. A global crisis for seagrass ecosystems. Bioscience 56:987-996.

Orth, R.J., and others. 2017. Submersed aquatic vegetation in Chesapeake Bay: Sentinel species in a changing world. Bioscience 67:698-712.

Palmer, M.A., K.L. Hondula, and B.J. Koch. 2014. Ecological restoration of streams and rivers: Shifting strategies and shifting goals. Annual Review of Ecology, Evolution, and Systematics. 45:247-269.

Palmer, M.A., H.L. Menninger, and E. Bernhardt. 2010. River restoration, habitat heterogeneity, and biodiversity: a failure of theory or practice? Freshwater Biology 55:205-222.

Patten, K. 2014. The Impacts of Nonnative Japanese Eelgrass (*Zostera japonica*) on Commercial Shellfish Production in Willapa Bay, WA. Agricultural Sciences 5:625-633.

Paul, M.J. and J.L. Meyer. 2001. Streams in the urban landscape. Annual Review of Ecology and Systematics. 32:333-365.

Perring, M.P. and E.C. Ellis. 2013. The extent of novel ecosystems: long in time and broad in space. (Chapter 8) In: *Novel Ecosystems: Intervening in the New Ecological World Order*, by R.J. Hobbs, E.S. Higgs, and C.M. Hall. Wiley-Blackwell (West Sussex, UK). 368 pp.

Peterson, C.H. and J. Lubchenco. 1997. Marine ecosystem services, in Nature's Services: Societal Dependence on Natural Ecosystems. Edited by G.C. Daily. Island Press (Washington, DC). pp. 177-194.

Postel, S. and S. Carpenter. 1997. Freshwater ecosystem services, in Nature's Services: Societal Dependence on Natural Ecosystems. Edited by G.C. Daily. Island Press (Washington, DC). pp. 195-214.

Powers, M.J., C.H. Peterson, H.C. Summerson, and S.P. Powers. 2007. Macroalgal growth on bivalve aquaculture netting enhances nursery habitat for mobile invertebrates and juvenile fishes. Marine Ecology Progress Series 339: 109–122.

Price, C.S., E. Keane, D. Morin, C. Vaccaro, D. Bean, and J.A. Morris, Jr. 2016. Protected species and longline mussel aquaculture interactions. NOAA Technical Memorandum NOS NCCOS 211. 85 pp.
Radeloff, V.C., and 19 others. 2015. The rise of novelty in ecosystems. Ecological Applications 25:2015-2068.

Reid, L.M. 1993. Research and cumulative watershed effects. U.S. Department of Agriculture, U.S. Forest Service General Technical Report PSW-GTR-141. 118 pp.

Rey Benayas, J.M., A.C. Newton, A. Diaz, and J.M. Bullock. 2009. Enhancement of biodiversity and ecosystems by ecological restoration: a meta-analysis. Science 325:1121-1124.

Rick, T.C. and 14 others. 2016. Millennial-scale sustainability of the Chesapeake Bay Native American oyster fishery. Proceedings of the National Academy of Sciences 113:6568–6573.

Robb, C.K. 2014. Assessing the impact of human activities on British Columbia's estuaries. PLOS ONE, Volume 9, Issue 6, e99578.

Robinson, S.M.C., G.J. Parsons, L.-A. Davidson, S.E. Shumway, and N.J. Blake. 2016. Scallop Aquaculture and Fisheries in Eastern North America. (Chapter 18) In: Scallops: Biology, Ecology, Aquaculture, and Fisheries. Ed. By S.E. Shumway and G.J. Parsons. Elsevier Science (Oxford).

Roni, P., K. Hanson, and T. Beechie. 2008. Global review of the physical and biological effectiveness of stream habitat rehabilitation techniques. North American

Journal of Fisheries Management 28:856-890.

Roni, P., G. Pess, K. Hanson, and M. Pearsons. 2013. Selecting appropriate stream and watershed restoration techniques. *In*: Stream and Watershed Restoration: A Guide to Restoring Riverine Processes and Habitats. Edited by P. Roni and T. Beechie. Wiley and Sons, Inc. (West Sussex, UK), pp. 144-188.

Royal Society (RS) and the National Academy of Sciences (NAS). 2014. Climate change evidence and causes: An overview from the Royal Society and the U.S. National Academy of Sciences. 34 pp.

Ruesink, J.L., B.E. Feist, C.J. Harvey, J.S. Hong, A.C. Trimble, and L.M. Wisehart. 2006. Changes in productivity associated with four introduced species: ecosystem transformation of a “pristine” estuary. Marine Ecology Progress Series 311:203-215.

Ruesink, J.L., H.S. Lenihan, A.C. Trimble, K.W. Heiman, F. Micheli, J.E. Byers, and M.C. Kay. 2005. Introduction of non-native oysters: Ecological effects and restoration implications. Annual Review of Ecology, Evolution, and Systematics 36:643-689.

Scheffer, M. and 9 others. 2009. Early-warning signals for critical transitions. Nature 461:53-59.

Scheffer, M., S. Carpenter, J.A. Foley, C. Folke, and B. Walker. 2001. Catastrophic shifts in ecosystems. Nature 413:591-596.

Shackelford, N., R.J. Hobbs, N.E. Heller, L.M. Hallett, and T.R. Seastedt. 2013. Finding a middle-ground: The native/non-native debate. Biological Conservation 158:55-62.

Shafer, C.S., G.J. Inglis, and V. Martin. 2010. Examining Residents’ Proximity, Recreational Use, and Perceptions Regarding Proposed Aquaculture Development. Coastal Management 38:559-574.

Sharma, S., J. Goff, R.M. Moody, D. Byron, K.L. Heck, Jr., S.P. Powers, C. Ferraro, and J. Cebrian. 2016. Do restored oyster reefs benefit seagrasses? An experimental study in the Northern Gulf of Mexico. Restoration Ecology 24:306-313.

Sheppard, C. 2014. Coral Reefs: A Very Short Introduction. Oxford University Press (New York). 152 pp.

Simenstad, C.A. and K.L. Fresh. 1995. Influence of intertidal aquaculture on benthic communities in Pacific Northwest estuaries: Scales of disturbance. Estuaries 18:43-70.

Skinner, M.A., S.C. Courtenay, C.W. McKindsey, C.E. Carver, and A.L. Mallet.

2014. Experimental determination of the effects of light limitation from suspended bag oyster (Crassostrea virginica) aquaculture on the structure and photosynthesis of eelgrass (Zostera marina) Journal of Experimental Marine Biology and Ecology 459:169–180.

Smith, R.D., Ammann, A., Bartoldus, C., and Brinson, M.M. 1995. An approach for assessing wetland functions using hydrogeomorphic classification, reference wetlands, and functional indices. Technical Report WRP-DE-9, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Smucker, N.J. and N.E. Detenbeck. 2014. Meta-analysis of lost ecosystem attributes in urban streams and the effectiveness of out-of-channel management practices. Restoration Ecology 22:741-748.

Staudt, A. A.K. Leidner, J. Howard, K.A. Brauman, J.S. Dukes, L.J. Hansen, C. Paukert, J. Sabo, and L.A. Solórzano. 2013. The added complications of climate change: understanding biodiversity and ecosystems. Frontiers in Ecology and Environment 11:494-501.

Steffen, W., P.J. Crutzen, and J.R. McNeill. 2007. The Anthropocene: Are humans overwhelming the forces of nature? Ambio 36:614-621

Tallis, H.M. J. Ruesink, B. Dumbauld, S. Hacker, and L.M. Wisehart. 2009. Oysters and aquaculture practices affect eelgrass density and productivity in a Pacific Northwest estuary. Journal of Shellfish Research 28:251-261.

Tiner, R.W. 2017. Wetland Indicators: A Guide to Wetland Formation, Identification, Delineation, Classification, and Mapping. 2nd edition. CRC Press (Boca Raton, FL) 606 pp.

U.S. Department of Agriculture (USDA). 2018. Summary Report: 2015 National Resources Inventory, Natural Resources Conservation Service, Washington, DC, and Center for Survey Statistics and Methodology, Iowa State University, Ames, Iowa. http://www.nrcs.usda.gov/technical/nri/15summary (accessed January 6, 2020)

U.S. Department of Agriculture. 2015. Summary Report: 2012 National Resources Inventory, Natural Resources Conservation Service, Washington, DC, and Center for Survey Statistics and Methodology, Iowa State University, Ames, Iowa. http://www.nrcs.usda.gov/technical/nri/12summary (accessed January 21, 2016)

U.S. Environmental Protection Agency (U.S. EPA). 2015. National Summary of State Information. http://ofmpub.epa.gov/waters10/attains_index.control (accessed May 27, 2015).

U.S. Environmental Protection Agency (U.S. EPA). 2016. National Wetland

Condition Assessment 2011: A Collaborative Survey of the Nation's Wetlands. EPA-843-R-15-005. Office of Wetlands, Oceans, and Watersheds, Office of Research and Development (Washington, DC). 105 pp.

Van Andel, J. and J. Aronson. 2012. Getting Started. Chapter 1 in: Restoration Ecology: The New Frontier. 2nd edition. Edited by J. van Andel and J. Aronson. (Blackwell Publishing, Ltd.)

Van Andel, J. A.P. Grootjans, and J. Aronson. 2012. Unifying Concepts. Chapter 2 in: Restoration Ecology: The New Frontier. 2nd edition. Edited by J. van Andel and J. Aronson. (Blackwell Publishing, Ltd.)

van der Schatte Olivier, A., L. Jones, L. LeVay, M. Christie, J. Wilson, and S. K. Malham. 2018. A global review of the ecosystem services provided by bivalve aquaculture. Reviews in Aquaculture 12:3-25.
van Katwijk, M.M. and 25 others. 2016. Global analysis of seagrass restoration: the importance of large-scale planting. Journal of Applied Ecology 53:567–578.

Vitousek, P.M., H.A. Mooney, J. Lubchenco, and J.M. Melillo. 1997. Human domination of the Earth's ecosystems. Science 277:494-499.

Walker, B., C.S. Holling, S.R. Carpenter, and A. Kinzig. 2004. Resilience, adaptability and transformability in social–ecological systems. Ecology and Society 9(2): 5. http://www.ecologyandsociety.org/vol9/iss2/art5

Walter, R.C. and D.J. Merritts. 2008. Natural streams and the legacy of water-powered mills. Science 319:299-304.

Washington Sea Grant. 2015. Shellfish aquaculture in Washington State. Final report to the Washington State Legislature, 84 pp.

Waycott, M. and 13 others. 2009. Accelerating loss of seagrasses across the globe threatens coastal ecosystems. Proceedings of the National Academy of Sciences 106:12377–12381.

Weins, J.A. and R.J. Hobbs. 2015. Integrating conservation and restoration in a changing world. Bioscience 65:302-312.

Wilberg, M.J., M.E. Livings, J.S. Barkman, B.T. Morris, and J.M. Robinson. 2011. Overfishing, disease, habitat loss, and potential extirpation of oysters in upper Chesapeake Bay. Marine Ecology Progress Series 436:131-144.

Wickliffe, L.C., V.C. Crothers, S.J. Theuerkauf, K.L. Riley, and J.A. Morris, Jr. 2019. Shellfish aquaculture map viewers: An assessment of design, data, and functions to inform planning and siting in the United States. Journal of Shellfish Research 38:209-221.

Williams, J.W., K.D. Burke, M.S. Crosley, D.A. Grant, and V.C. Radeloff. 2019. Land-use and climatic causes of environmental novelty in Wisconsin since 1890. Ecological Applications 29(7), e01955.

Wisehart, L.M., B.R. Dumbauld, J.L. Ruesink, and S.D. Hacker. 2007. Importance of eelgrass early life history stages in response to oyster aquaculture disturbance. Marine Ecology Progress Series 344:71-80.

Wohl, E. S.N. Lane, and A.C. Wilcox. 2015. The science and practice of river restoration. Water Resources Research 51:5974-5997.

Wright, T., J. Tomlinson, T. Schueler, K. Cappiella, A. Kitchell, and D. Hirschman. 2006. Direct and indirect impacts of urbanization on wetland quality. Wetlands and Watersheds Article #1. Center for Watershed Protection (Ellicott City, Maryland). 81 pp.

Zedler, J.B., J.M. Doherty, and N.A. Miller. 2012. Shifting restoration policy to address landscape change, novel ecosystems, and monitoring. Ecology and Society 17:36.

Zedler, J.B. and S. Kercher. 2005. Wetland resources: Status, trends, ecosystem services, and restorability. Annual Review Environmental Resources. 30:39-74.

Zu Ermgassen, P.S.E., and 14 others. 2012. Historical ecology with real numbers: past and present extent and biomass of an imperiled estuarine habitat. Proceedings of the Royal Society B 279:3393–3400., doi:10.1098/rspb.2012.0313