

## Scallop FMP Amendment 15 - amendment text for updating EFH description and non-fishing impacts to EFH, changing HAPC timeline, and updating EFH research objectives (EFH Omnibus Amendment)

- 1. In Section 1.1, Amendments to the Fishery Management Plan, insert the following descriptions of EFH amendments in sequential order, and include the effective date and FR reference of the approved Amendment 15.***

### *Amendment 12: Aleutian Islands Habitat Conservation Area Revision*

Amendment 12 revised the Aleutian Islands Habitat Conservation Area boundaries near Agattu and Buldir Islands. The amendment was approved on February 4, 2008 (73 FR 9035).

### *Amendment 15: Revisions to EFH*

Amendment 15, approved on \_\_\_\_\_, revised Amendments 7 and 9 based on the outcome of the 2010 EFH 5-year review. The amendment revised EFH descriptions and identifications by species, and updated life history, distribution, and habitat association information; updated descriptions of EFH impacts from non-fishing activities, and EFH conservation recommendations for non-fishing activities; revised the timeline associated with the HAPC process to a 5-year timeline; and updated EFH research priority objectives.

- 1. In Section 3.1.3.2, Description of Habitat Areas of Particular Concern, insert the following two new paragraphs before the paragraph beginning "In 2005...":***

Proposed HAPCs, identified on a map, must meet at least two of the four considerations established in 50 CFR 600.815(a)(8), and rarity of the habitat is a mandatory criterion. HAPCs may be developed to address identified problems for FMP species, and they must meet clear, specific, adaptive management objectives.

The Council will initiate the HAPC process by setting priorities and issuing a request for HAPC proposals. Any member of the public may submit a HAPC proposal. HAPC proposals may be solicited every 5 years, to coincide with the EFH 5-year review, or may be initiated at any time by the Council. The Council will establish a process to review the proposals. The Council may periodically review existing HAPCs for efficacy and considerations based on new scientific research.

- 2. In Section 3.1.3.4, Review of EFH, revise the second paragraph as follows (note, delete text indicated with ~~strikeout~~, insert text that is underlined):***

Additionally, the Council may ~~use the FMP amendment cycle every three years to solicit proposals for HAPCs and/or conservation and enhancement measures to minimize the potential adverse effects of fishing. Any proposal endorsed by the Council would be implemented by FMP amendment.~~ HAPC proposals may be solicited every 5 years, coinciding with the EFH 5-year review, or may be initiated at any time by the Council.

- 3. In Appendix D, Section 1.0, insert the following new paragraph at the end of the section:***

In 2009 and 2010, the Council undertook a five-year review of EFH for the Council's managed species, which was documented in the Final EFH 5-year Review for 2010 Summary Report published in April 2010 (NPFMC and NMFS 2010). The review evaluated new information on EFH, including EFH

descriptions and identification, and fishing and non-fishing activities that may adversely affect EFH. The review also assessed information gaps and research needs, and identified whether any revisions to EFH are needed or suggested. The Council identified various elements of the EFH descriptions meriting revision, and approved omnibus amendments 98/90/40/15/11 to the BSAI Groundfish FMP, the GOA Groundfish FMP, the BSAI King and Tanner Crab FMP, the Scallop FMP, and the Salmon FMP, respectively, in 2011. Amendment 15 to the Scallop FMP revised the EFH description for weathervane scallop; updated the description of EFH impacts from non-fishing activities, and EFH conservation recommendations for non-fishing activities; revised the timeline associated with the HAPC process to a 5-year timeline coinciding with the EFH 5-year review; and updated EFH research objectives in the FMP.

**2. In Appendix D, Section 2.0, revise the table references in the first paragraph as follows (note, delete text indicated with ~~strikeout~~, insert text that is underlined), and insert new Tables 1-3 directly afterward.**

This section describes habitat requirements and life histories of the scallops managed by this FMP. Information contained in this appendix details life history information for federally managed scallop species. Each species or species group is described individually; however, summary tables that denote habitat associations (Table ~~12~~), biological associations ~~reproductive traits~~ (Table ~~23~~), and predator and prey associations (Table ~~34~~) are also provided. In each section, a species-specific table summarizes habitat requirements.



3. *In Appendix D, Section 2.1, following the caption for Figure 2, delete the sentence “The following abbreviations are used in the habitat tables to specify location, position in the water column, bottom type, and other oceanographic features.”, and the two following textboxes that list abbreviations.*
4. *In Appendix D, Section 2.1, delete existing Tables 2, 3, and 4.*
5. *In Appendix D, Section 2.2, revise the text in the subsections entitled “Relevant Trophic Information”, “Approximate Upper Size Limit of Juvenile Scallops (in cm)”, and “Habitat and Biological Associations” as follows, where deletions are marked with ~~strikeout~~, and insertions are underlined:*

#### **Relevant Trophic Information**

Scallop predators have not been well studied. Scallops are likely prey to various fish and invertebrates during the early part of their life cycle. Flounders are known to prey on juvenile weathervane scallops, and octopus and seastars ~~sea stars~~ ~~may~~ are also ~~be~~ important predators.

**Approximate Upper Size Limit of Juvenile Scallops (in cm):** Weathervane scallops begin to mature by age 2~~3~~ at about 7.6 cm (3 inches) in shell height (SH), and virtually all scallops are mature by age 4. Growth, maximum size, and size at maturity vary significantly within and between beds and geographic areas. Weathervane scallops are long-lived; individuals may live 28 years or more. The natural mortality rate is thought to be about 15% annually ( $M = 0.16$ ).

#### **Habitat and Biological Associations**

Scallops are found from intertidal waters and to 300 m. Abundance tends to be greatest between ~~45~~40 and 130 m on beds of mud, clay, sand, and gravel (Hennick 1973). Weathervane scallops are associated with other benthic species, such as red king crabs, Tanner crabs, shrimps, octopi, flatfishes, Pacific cod, and other species of benthic invertebrates and fishes.

**6. In Appendix D, Section 2.2, Subsection “Habitat and Biological Associations”, replace the existing table and caption with the following table, caption, and note:**

**SPECIES: Weathervane Scallops off Alaska**

Stage - EFH Level	Duration or Age	Diet/ Prey	Season/ Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	several days	None	May–July	inner and middle continental shelf	demersal		unknown	
Larvae	2–3 weeks		May–August	inner, middle, and outer continental shelf	pelagic		unknown	
Early juveniles	Age 0 to Age 3		August +	inner, middle, and outer continental shelf	demersal	mud, sand, gravel, sandy mud, muddy sand	unknown	
Late Juveniles/ Adults	Age 3 - 28		Spawning May–July	inner, middle, and outer continental shelf	demersal	mud, sand, gravel, sandy mud, muddy sand	unknown	

Note, inner continental shelf = 1–50 m, middle continental shelf = 50–100 m, outer continental shelf = 100–200 m.

**7. In Appendix D, Section 2.2, insert a new subsection at the end of this section entitled “Literature References”, and include the following content:**

**Literature References**

Bechtol, W. R., R. L. Gustafson and T. R. Kerns. 2009. A survey of weathervane scallops in Kamishak Bay, 2003. Alaska Department of Fish and Game, Fishery Data Series No. 09-24, Anchorage.

Lauth, R. R. 2010. Results of the 2009 eastern Bering Sea continental shelf bottom trawl survey of groundfish and invertebrate resources. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC 204, 228 p.

Rosenkranz, G.E., Gallager, S.M., Shepard, R.W., Blakeslee, M. 2008. Development of a high-speed, megapixel benthic imaging system for coastal fisheries research in Alaska. Fisheries Research 92:340–344

Rosenkranz, G. and R. Burt. 2009. Summary of observer data collected during the 2006/07 Alaska weathervane scallop fishery. Alaska Department of Fish and Game, Fishery Data Series No. 09 49, Anchorage.

Rosenkranz, G. E. 2010. Summary of observer data collected during the 2007/08 Alaska weathervane scallop fishery. Alaska Department of Fish and Game, Fishery Data Series No. 10-36, Anchorage.

Spalinger, K. 2009. Bottom trawl survey of crab and groundfish: Kodiak, Chignik, South Peninsula, and Eastern Aleutians Management Districts, 2008. Alaska Department of Fish and Game, Fishery Management Report No. 09-25, Anchorage.

Spalinger, K. 2010. Bottom trawl survey of crab and groundfish: Kodiak, Chignik, South Peninsula, and Eastern Aleutians Management Districts, 2009. Alaska Department of Fish and Game, Fishery Management Report No. 10-23, Anchorage.

**8. In Appendix D, Section 3.0, make the following edits to the existing second and third paragraphs (note, delete text indicated with ~~strikeout~~, insert text that is underlined), and insert a new fourth paragraph:**

EFH for groundfish species is determined to be the general distribution of a species described by life stage. General distribution is a subset of a species’ total population distribution, and is identified as the distribution of 95 percent of the species population, for a particular life stage, if life history data are available for the species. Where information is insufficient and a suitable proxy cannot be inferred, EFH is not described. General distribution is used to describe EFH for all stock conditions whether or not

higher levels of information exist, because the available higher level data are not sufficiently comprehensive to account for changes in stock distribution (and thus habitat use) over time.

EFH is described for FMP-managed species by life stage as general distribution using ~~new~~ guidance from the EFH Final Rule (50 CFR 600.815), ~~such as including the updated~~ EFH Level of Information definitions. New analytical tools are used and recent scientific information is incorporated for each life history stage from updated scientific habitat assessment reports. EFH descriptions include both text (see section 3.1) and maps (see section 3.2), if information is available for a species' particular life stage. ~~These descriptions are risk averse, supported by scientific rationale, and accounts for changing oceanographic conditions. The methodology and data sources for the EFH descriptions are described in Appendix D to the EFH EIS (NMFS 2005).~~

EFH descriptions are interpretations of the best scientific information. In support of this information, a thorough review of FMP species is contained in the Environmental Impact Statement for Essential Fish Habitat Identification and Conservation (NMFS 2005) (EFH EIS) is contained in Section 3.2.1, Biology, Habitat Usage, and Status of Magnuson-Stevens Act Managed Species and detailed by life history stage in Appendix F: EFH Habitat Assessment Reports. This EIS was supplemented in 2010 by a 5-year review, which re-evaluated EFH descriptions and fishing and non-fishing impacts on EFH in light of new information (NPFMC and NMFS 2010). The EFH descriptions are risk averse, supported by scientific rationale, and account for changing oceanographic conditions and regime shifts.

**9. *In Appendix D, Section 3.1, Description of Essential Fish Habitat, revise the text description of EFH for weathervane scallop for the late juvenile and adult stages as follows (note, text to be inserted is indicated with underline):***

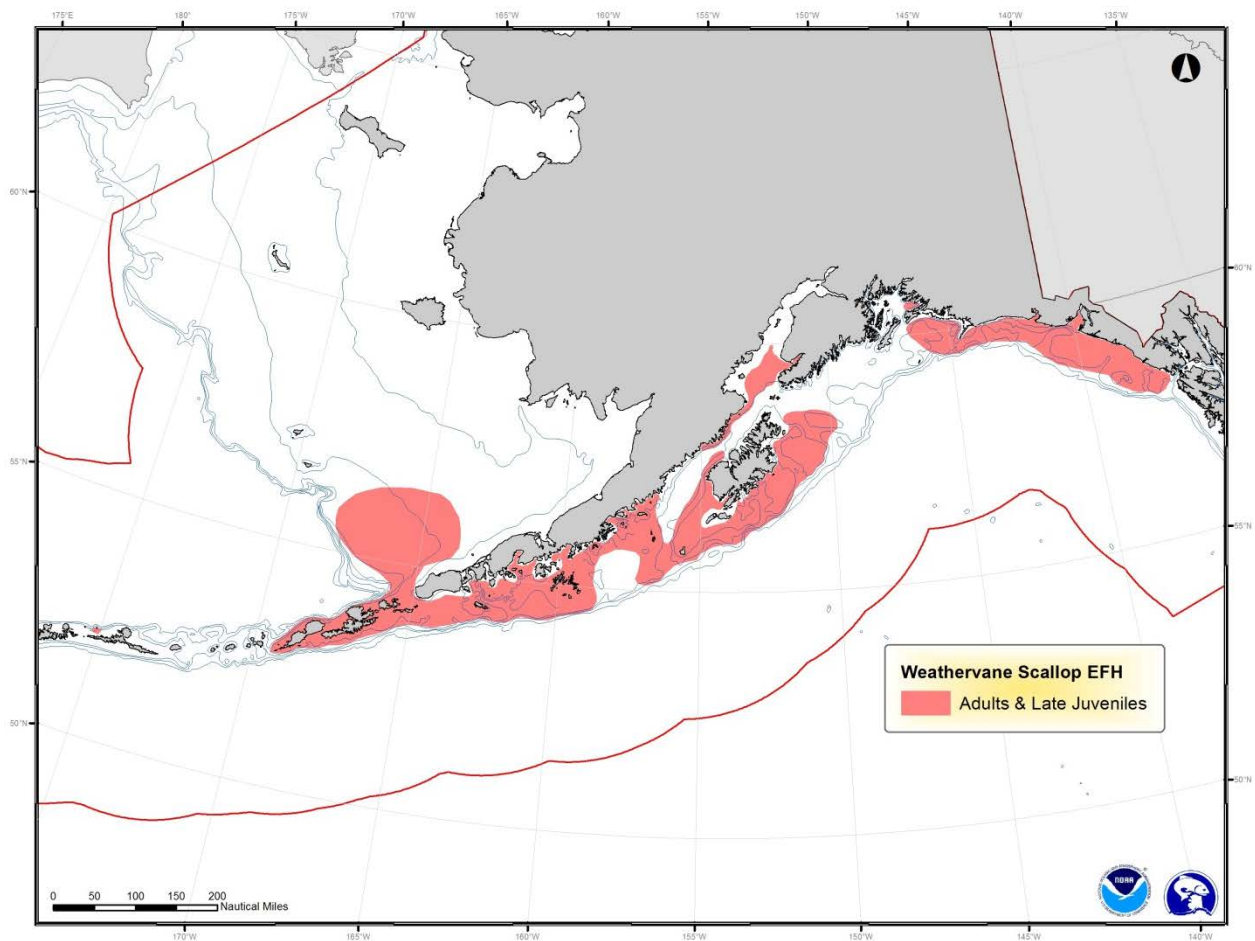
**Late Juveniles**

EFH for late juvenile weathervane scallops is the general distribution area for this life stage, located in the sea floor along the inner (1 to 50 m), middle (50 to 100 m) and outer (100 to 200 m) shelf in concentrated areas of the GOA and BSAI where there are substrates of clay, mud, sand, and gravel that are generally elongated in the direction of current flow, as depicted in Figure 3.

**Adults**

EFH for adult weathervane scallops is the general distribution area for this life stage, located in the sea floor along the inner (1 to 50 m), middle (50 to 100 m) and outer (100 to 200 m) shelf in concentrated areas of the GOA and BSAI where there are substrates of clay, mud, sand, and gravel that are generally elongated in the direction of current flow, as depicted in Figure 3.

**10. In Appendix D, Section 3.2, Maps of Essential Fish Habitat, delete the existing Figure 3 and replace with the revised Figure 3 below (note, the figure caption should be retained unchanged):**



**4. In Appendix D, delete Section 3.3.7 HAPC Process.**

**5. In Appendix D, Section 3.3 Essential Fish Habitat Conservation and Habitat Areas of Particular Concern, delete the second paragraph, beginning “HAPCs are specific sites within EFH...”.**

**6. In Appendix D, retitle Section 3.3 as “EFH Conservation and HAPC Restrictions”. Renumber Section 3.3 as Section 3.4, and renumber all subsections in the new Section 3.4 accordingly.**

**7. In Appendix D, create a new Section 3.3, entitled Habitat Areas of Particular Concern, and insert the following content:**

Habitat Areas of Particular Concern (HAPCs) are specific sites within EFH that are of particular ecological importance to the long-term sustainability of managed species, are of a rare type, or are especially susceptible to degradation or development. HAPCs are meant to provide greater focus to conservation and management efforts, and may require additional protection from adverse effects.

### 3.3.1 HAPC Process

The Council may designate specific sites as HAPCs and may develop management measures to protect habitat features within HAPCs.

50 CFR 600.815(a)(8) provides guidance to the regional fishery management councils in identifying HAPCs. FMPs should identify specific types or areas of habitat within EFH as habitat areas of particular concern based on one or more of the following considerations:

- (i) The importance of the ecological function provided by the habitat.
- (ii) The extent to which the habitat is sensitive to human-induced environmental degradation.
- (iii) Whether, and to what extent, development activities are, or will be, stressing the habitat type.
- (iv) The rarity of the habitat type.

Proposed HAPCs, identified on a map, must meet at least two of the four considerations established in 50 CFR 600.815(a)(8), and rarity of the habitat is a mandatory criterion. HAPCs may be developed to address identified problems for FMP species, and they must meet clear, specific, adaptive management objectives.

The Council will initiate the HAPC process by setting priorities and issuing a request for HAPC proposals. Any member of the public may submit a HAPC proposal. HAPC proposals may be solicited every 5 years, to coincide with the EFH 5-year review, or may be initiated at any time by the Council. The Council will establish a process to review the proposals. The Council may periodically review existing HAPCs for efficacy and considerations based on new scientific research.

### 3.3.2 Designation of HAPCs

In 2005, the Council identified the following areas as HAPCs within EFH:

- Alaska Seamount Habitat Protection Areas
- Bowers Ridge Habitat Conservation Zone
- GOA Coral

Maps of these areas, as well as their coordinates, and any fishing restrictions that apply in these areas, are described in Section 3.4.

#### ***8. In Appendix D, Section 4.0, Effects of Fishing on Essential Fish Habitat, insert the following new paragraph at the end of the section:***

The evaluation of fishing effects on EFH for BSAI groundfish species was reconsidered as part of the Council's EFH 5-year Review for 2010, and is documented in the Final Summary Report for that review (NPFMC and NMFS 2010). The review evaluated new information since the development of the EFH EIS, for individual species and their habitat needs, as well as the distribution of fishing intensity, spatial habitat classifications, classification of habitat features, habitat- and feature-specific recovery rates, and gear- and habitat-specific sensitivity of habitat features. Based on the review, the Council concluded that recent research results are consistent with the habitat sensitivity and recovery parameters and distributions of habitat types used in the analysis of fishing effects documented in the EFH EIS. The review noted that fishing intensity has decreased overall, gear regulations have been designated to reduce habitat damage, and area closures have limited the expansion of effort into areas of concern.



**9. In Appendix D, delete existing text in Section 5.0 Non-fishing Impacts, and replace with the revised Section 5.0 in the attached file.**

**10. In Appendix D, Section 7.0 Research Approach for EFH, revise the first paragraph as follows (note, delete text indicated with ~~strikeout~~, insert text that is underlined):**

The EFH EIS (NMFS 2005) identified ~~a the following~~ research approach for EFH regarding minimizing fishing impacts. The research approach was revised in 2010 following the Council's EFH 5-year Review for 2010, documented in a Final Summary Report (NPFMC and NMFS 2010).

**11. In Appendix D, Section 7.0 Research Approach for EFH, delete existing text under the heading "Objectives" and replace with the following:**

Establish a scientific research and monitoring program to understand the degree to which impacts have been reduced within habitat closure areas, and to understand how benthic habitat recovery of key species is occurring.

**12. In Appendix D, Section 7.0 Research Approach for EFH, delete existing text under the heading "Research Activities" and replace with the following:**

- Fishing effort data from observers and remote sensing would be used to study changes in bottom trawl and other fishing gear activity in the closed (and open) areas. Effects of displaced fishing effort would have to be considered. The basis of comparison would be changes in the structure and function of benthic communities and populations, as well as important physical features of the seabed, after comparable harvests of target species are taken with each gear type.
- Monitor the structure and function of benthic communities and populations in the newly closed areas, as well as important physical features of the seabed, for changes that may indicate recovery of benthic habitat. Whether these changes constitute recovery from fishing or just natural variability/shifts requires comparison with an area that is undisturbed by fishing and otherwise comparable.
- Validate the LEI model and improve estimates of recovery rates, particularly for the more sensitive habitats, including coral and sponge habitats in the Aleutian Islands region, possibly addressed through comparisons of benthic communities in trawled and untrawled areas.
- Obtain high resolution mapping of benthic habitats, particularly in the on-shelf regions of the Aleutian Islands.
- Time series of maturity at age should be collected to facilitate the assessment of whether habitat conditions are suitable for growth to maturity.
- In the case of red king crab spawning habitat in southern Bristol Bay, research the current impacts of trawling on habitat in spawning areas and the relationship of female crab distribution with respect to bottom temperature.

**13. In Appendix D, Section 8.0, insert the following reference alphabetically.**

NPFMC and NMFS. 2010. Essential Fish Habitat (EFH) 5-year Review for 2010 Summary Report: Final. April 2010. <http://www.alaskafisheries.noaa.gov/habitat/efh/review.htm>

**14. Update the Table of Contents for Appendix D.**

## 5.0 Non-fishing Activities that may Adversely Affect Essential Fish Habitat

The waters and substrates that comprise essential fish habitat (EFH) are susceptible to a wide array of human activities unrelated to fishing. Broad categories of such activities include, but are not limited to, mining, dredging, fill, impoundment, discharges, water diversions, thermal additions, actions that contribute to nonpoint source pollution and sedimentation, introduction of potentially hazardous materials, introduction of exotic species, and the conversion of aquatic habitat that may eliminate, diminish, or disrupt the functions of EFH. Non-fishing activities discussed in this document are subject to a variety of regulations and restrictions designed to limit environmental impacts under federal, state, and local laws. Listing all applicable environmental laws and management practices is beyond the scope of the document. Moreover, the coordination and consultation required by section 305(b) of the Magnuson-Stevens Conservation and Management Act (MSA) does not supersede the regulations, rights, interests, or jurisdictions of other federal or state agencies. NMFS may use the information in this document as a source when developing conservation recommendations for specific actions under section 305(b)(4)(A) of the MSA. NMFS will not recommend that state or federal agencies take actions beyond their statutory authority, and NMFS' EFH conservation recommendations are not binding.

Ideally, actions that are not water-dependent should not be located in EFH if such actions may have adverse impacts on EFH. Activities that may result in significant adverse effects on EFH should be avoided where less environmentally harmful alternatives are available. If there are no alternatives, the impacts of these actions should be minimized. Environmentally sound engineering and management practices should be employed for all actions that may adversely affect EFH. If avoidance or minimization is not practicable, or will not adequately protect EFH, compensatory mitigation as defined for section 404 of the Clean Water Act (CWA) should be considered to conserve and enhance EFH.

The potential for effects from larger, less readily managed processes associated with human activity also exists, such as climate change and ocean acidification. Climate change may lead to habitat changes that prompt shifts in the distribution of managed species. Likewise, should ocean conditions warm to allow for new shipping routes, new vectors may emerge for introducing invasive species in cargo and ballast waters. Ocean acidification could also alter species distributions and complicated food web dynamics. These larger ecosystem-level effects are discussed in this document where applicable, within each activity type.

This section of the fishery management plan (FMP) synthesizes a comprehensive review of the "Impacts to Essential Fish Habitat from Non-fishing Activities in Alaska" (NMFS 2011), which is incorporated in the FMP by reference. The general purpose of that document is to identify non-fishing activities that may adversely impact EFH and provide conservation recommendations that can be implemented for specific types of activities to avoid or minimize adverse impacts to EFH. This information must be included in FMPs under section 303(a)(7) of the MSA. It is also useful to NMFS biologists reviewing proposed actions that may adversely

affect EFH, and the comprehensive document (NMFS 2011) will be utilized by federal action agencies undertaking EFH consultations with NMFS, especially in preparing EFH assessments.

The conservation recommendations for each activity category are suggestions the action agency or others can undertake to avoid, offset, or mitigate impacts to EFH. NMFS develops EFH conservation recommendations for specific activities case-by-case based on the circumstances; therefore, the recommendations in this document may or may not apply to any particular project. Because many non-fishing activities have similar adverse effects on living marine resources, some redundancy in the descriptions of impacts and the accompanying conservation recommendations between sections in this report is unavoidable.

The comprehensive non-fishing activities document (NMFS 2011) updates and builds upon a collaborative evaluation of non-fishing effects to EFH completed in 2004 by the NMFS Alaska Region, Northwest Region, and Southwest Region and the respective Fisheries Science Centers. In April 2005, NMFS completed the Final Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska (EFH EIS; NMFS 2005) and the North Pacific Fishery Management Council amended its FMPs to address the EFH requirements of the MSA. The EFH EIS contained an Appendix (Appendix G) that addressed non-fishing impacts to EFH. A 5-year review of the Council's EFH provisions, including those addressing non-fishing impacts to EFH, was completed by the Council in April 2010 (NPFMC and NMFS 2010), on the basis of which this section has been updated.

The remainder of this section addresses non-fishing activities that may adversely affect EFH. These activities are grouped into the four different systems in which they usually occur: upland, river or riverine, estuary or estuarine, and coastal or marine.

## 5.1 Upland Activities

Upland activities can impact EFH through both point source and nonpoint source pollution. Nonpoint source impacts are discussed here. Technically, the term "nonpoint source" means anything that does not meet the legal definition of point source in section 502(14) of the CWA, which refers to discernible, confined, and discrete conveyance from which pollutants are or may be discharged. Land runoff, precipitation, atmospheric deposition, seepage, and hydrologic modification, generally driven by anthropogenic development, are the major contributors to nonpoint source pollution.

Nonpoint source pollution is usually lower in intensity than an acute point source event, but may be more damaging to fish habitat in the long term. It may affect sensitive life stages and processes, is often difficult to detect, and its impacts may go unnoticed for a long time. When population impacts are detected, they may not be tied to any one event or source, and may be difficult to correct, clean up, or mitigate.

The impacts of nonpoint source pollution on EFH may not necessarily represent a serious, widespread threat to all species and life history stages. The severity of the threat of any specific pollutant to aquatic organisms depends upon the type and concentration of the pollutant and the length of exposure for a particular species and its life history stage. For example, species that spawn in areas that are relatively deep with strong currents and well-mixed water may not be as susceptible to pollution as species that inhabit shallow, inshore areas near or within enclosed

bays and estuaries. Similarly, species whose egg, larval, and juvenile life history stages utilize shallow, inshore waters and rivers may be more prone to coastal pollution than are species whose early life history stages develop in offshore, pelagic waters.

### 5.1.1 Silviculture/Timber Harvest

Recent revisions to federal and state timber harvest regulations in Alaska and best management practices (BMPs) have resulted in increased protection of EFH on federal, state, and private timber lands (USDA 2008; <http://www.fs.fed.us/r10/tongass/projects/tlmp/>).

These revised regulations include forest management practices, which when fully implemented and effective, could avoid or minimize adverse effects to EFH. However, if these management practices are ineffective or not fully implemented, timber harvest could have both short and long term impacts on EFH throughout many coastal watersheds and estuaries. Historically, timber harvest in Alaska was not conducted under the current protective standards, and these past practices may have degraded EFH in some watersheds.

#### *Potential Adverse Impacts*

In both small and large watersheds there are many complex and important interactions between fish and forests (Northcote and Hartman 2004). Five major categories of silvicultural activities can adversely affect EFH if appropriate forestry practices are not followed: (1) construction of logging roads, (2) creation of fish migration barriers, (3) removal of streamside vegetation, (4) hydrologic changes and sedimentation, and (5) disturbance associated with log transfer facilities (LTFs). Possible effects to EFH include the following (Northcote and Hartman 2004):

- Removal of the dominant vegetation and conversion of mature and old-growth upland and riparian forests to tree stands or forests of early seral stage;
- Reduction of soil permeability and increase in the area of impervious surfaces;
- Increase in erosion and sedimentation due to surface runoff and mass wasting processes, also potentially affecting riparian areas;
- Impaired fish passage because of inadequate design, construction, and/or maintenance of stream crossings;
- Altered hydrologic regimes resulting in inadequate or excessive surface and stream flows, increased streambank and streambed erosion, loss of complex instream habitats;
- Changes in benthic macroinvertebrate populations,
- Loss of instream and riparian cover;
- Increased surface runoff with associated contaminants (e.g., herbicides, fertilizers, and fine sediments) and higher temperatures;
- Alterations in the supply of large woody debris (LWD) and sediment, which can have negative effects on the formation and persistence of instream habitat features; and
- Excess debris in the form of small pieces of wood and silt, which can cover benthic habitat and reduce dissolved oxygen levels.

## *Recommended Conservation Measures*

The following recommended conservation measures for silviculture/timber harvest should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH. Additionally, management standards, guidelines, and BMPs are available from the Forest Service Region 10, the State of Alaska Division of Forestry, and forest plans for the Tongass and Chugach National Forests.

- **Stream Buffers:** For timber operations in watersheds with EFH, adhere to modern forest management practices and BMPs, including the maintenance of vegetated buffers along all streams to the extent practicable in order to reduce sedimentation and supply large wood.
- **Estuary and Beach Fringe:** For timber operations adjacent to estuaries or beaches, maintain vegetated buffers as needed to protect EFH.
- **Watershed Analysis:** A watershed analysis should be incorporated into timber and silviculture projects whenever practicable.
- **Forest Roads:** Forest roads can be a major cause of sediment into streams and road culverts can block or inhibit upstream fish passage. Roads need to be designed to minimize sediment transport problems and to avoid fish passage problems.

### **5.1.2 Pesticides**

Pesticides are substances intended to prevent, destroy, control, repel, kill, or regulate the growth of undesirable biological organisms. Pesticides include the following: insecticides, herbicides, fungicides, rodenticides, repellents, bactericides, sanitizers, disinfectants, and growth regulators. More than 900 different active pesticide ingredients are currently registered for use in the United States and are formulated with a variety of other inert ingredients that may also be toxic to aquatic life. Legal mandates covering pesticides are the CWA and the Federal Insecticide, Fungicide, and Rodenticide Act. Water quality criteria for the protection of aquatic life have only been developed for a few of the currently used ingredients (EPA, Office of Pesticide Programs). While agricultural run-off is a major source of pesticide pollution in the lower 48 states, in Alaska, other human activities, such as fire suppression on forested lands, forest site preparation, noxious weed control, right-of-way maintenance (e.g., roads, railroads, power lines), algae control in lakes and irrigation canals, riparian habitat restoration, and urban and residential pest control, are the most common sources of these substances.

Pesticides are frequently detected in freshwater and estuarine systems that provide EFH. Pesticides can enter the aquatic environment as single chemicals or as complex mixtures. Direct applications, surface runoff, spray drift, agricultural return flows, and groundwater intrusions are all examples of transport processes that deliver pesticides to aquatic ecosystems. Habitat alteration from pesticides is different from more conventional water quality parameters because, unlike temperature or dissolved oxygen, the presence of pesticides can be difficult to detect due to limitations in proven methodologies. This monitoring may also be expensive. As analytical methodologies have improved in recent years, the number of pesticides documented in fish and their habitats has increased. In addition, pesticides may bioaccumulate in the ecosystem by retention in sediments and detritus, which are then ingested by macroinvertebrates, and which, in

turn, are eaten by larger invertebrates and fish (Atlantic States Marine Fisheries Commission 1992).

### ***Potential Adverse Impacts***

There are three basic ways that pesticides can adversely affect EFH. These are (1) a direct, lethal or sublethal, toxicological impact on the health or performance of exposed fish; (2) an indirect impairment of aquatic ecosystem structure and function; and (3) a loss of aquatic macroinvertebrates that are prey for fish and aquatic vegetation that provides physical shelter for fish.

### ***Recommended Conservation Measures***

The following recommended conservation measures regarding pesticides (including insecticides, herbicides, fungicides, rodenticides, repellents, bactericides, sanitizers, disinfectants, and growth regulators) should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

- Incorporate integrated pest management and BMPs as part of the authorization or permitting process (Scott et al. 1999). If pesticides must be applied, consider area, terrain, weather, droplet size, pesticide characteristics, and other conditions to avoid or reduce effects to EFH.
- Carefully review labels and ensure that application is consistent with the product's directions.
- Avoid the use of pesticides within 500 linear feet and/or 1,000 aerial feet of anadromous fish bearing streams.
- For forestry vegetation management projects, establish a 35-foot pesticide-free buffer area from any surface or marine water body and require that pesticides not be applied within 200 feet of a public water source (Alaska Department of Environmental Conservation guidelines).
- Consider current and recent meteorological conditions. Rain events may increase pesticide runoff into adjacent water bodies. Saturated soils may inhibit pesticide penetration.
- Do not apply pesticides when wind speeds exceed 10 mph.
- Begin application of pesticide products nearest to the aquatic habitat boundary and proceed away from the aquatic habitat; do not apply towards a water body.

### **5.1.3 Urban and Suburban Development**

Urban and suburban development is most likely the greatest non-fishing threat to EFH (NMFS 1998 a, 1998b). Urban and suburban development and the corresponding infrastructure result in four broad categories of impacts to aquatic ecosystems: hydrological, physical, water quality, and biological (CWP 2003).

### ***Potential Adverse Impacts***

Potential impacts to EFH most directly related to general urban and suburban development discussed below are the watershed effects of land development, including stormwater runoff.

Other development-related impacts are discussed in later sections of this document, including dredging, wetland fill, and shoreline construction.

Development activities within watersheds and in coastal marine areas can impact EFH on both long and short timeframes. The Center for Watershed Protection (CWP) made a comprehensive review of the impacts associated with impervious cover and urban development and found a negative relationship between watershed development and 26 stream quality indicators (CWP 2003). The primary impacts include (1) the loss of hyporheic zones (the region beneath and next to streams where surface and groundwater mix), and riparian and shoreline habitat and vegetation; and (2) runoff. Removal of riparian and upland vegetation has been shown to increase stream water temperatures, reduce supplies of LWD, and reduce sources of prey and nutrients to the water system. An increase in impervious surfaces in a watershed, such as the addition of new roads, buildings, bridges, and parking facilities, results in a decreased infiltration to groundwater and increased runoff volumes. This also has the potential to adversely affect water quality and the shape of the hydrograph in downstream water bodies (i.e., estuaries and coastal waters).

### *Recommended Conservation Measures*

The following recommended conservation measures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH where threats of impacts from urban and suburban development exist.

- Implement BMPs for sediment control during construction and maintenance operations (USEPA 1993).
- Avoid using hard engineering structures for shoreline stabilization and channelization when possible.
- Encourage comprehensive planning for watershed protection, and avoid or minimize filling and building in coastal and riparian areas affecting EFH.
- Where feasible, remove obsolete impervious surfaces from riparian and shoreline areas, and reestablish water regime, wetlands, and native vegetation.
- Protect and restore vegetated buffer zones of appropriate width along streams, lakes, and wetlands that include or influence EFH.
- Manage stormwater to replicate the natural hydrologic cycle, maintaining natural infiltration and runoff rates to the maximum extent practicable.
- Where instream flows are insufficient to maintain water quality and quantity needed for EFH, establish conservation guidelines for water use permits, and encourage the purchase or lease of water rights and the use of water to conserve or augment instream flows.
- Use the best available technologies in upgrading wastewater systems to avoid combined sewer overflow problems and chlorinated sewage discharges into rivers, estuaries, and the ocean.
- Design and install proper wastewater treatment systems.
- Where vegetated swales are not feasible, install and maintain oil/water separators to treat runoff from impervious surfaces in areas adjacent to marine or anadromous waters.

#### 5.1.4 Road Building and Maintenance

Roads and trails have always been part of man's impact on his environment (Luce and Crowe 2001). Federal, state, and local transportation departments devote huge budgets to construction and upgrading of roads. As in other places, roads play an important part in access and thus are vital to the economy of Alaska (Connor 2007).

##### *Potential Adverse Impacts*

Today's road design construction and management practices have improved from the past. Roads however, still have a negative effect on the biotic integrity of both terrestrial and aquatic ecosystems (Trombulak and Frissell 2000), and the effects of roads on aquatic habitat can be profound. Potential adverse impacts to aquatic habitats resulting from existence of roads in watersheds include (1) increased surface erosion, including mass wasting events, and deposition of fine sediments; (2) changes in water temperature; (3) elimination or introduction of migration barriers such as culverts; (4) changes in streamflow; (5) introduction of invasive species; and (6) changes in channel configuration, and (7) the concentration and introduction of polycyclic aromatic hydrocarbons, heavy metals and other pollutants.

##### *Recommended Conservation Measures*

The following conservation measures should be viewed as options to avoid and minimize adverse impacts from road building and maintenance and promote the conservation, enhancement, and proper functioning of EFH.

- Roads should be sited to avoid sensitive areas such as streams, wetlands, and steep slopes to the extent practicable.
- Build bridges rather than culverts for stream crossings when possible. If culverts are to be used, they should be sized, constructed, and maintained to match the gradient and width of the stream, so as to accommodate design flood flows; they should be large enough to provide for migratory passage of adult and juvenile fishes.
- Design bridge abutments to minimize disturbances to stream banks, and place abutments outside of the floodplain whenever possible.
- Specify erosion control measures in road construction plans.
- Avoid side casting of road materials on native surfaces and into streams.
- Use only native vegetation in stabilization plantings.
- Use seasonal restrictions to avoid impacts to habitat during species critical life history stages (e.g., spawning and egg development periods).
- Properly maintain roadway and associated stormwater collection systems.
- Limit roadway sanding and the use of deicing chemicals during the winter to minimize sedimentation and introduction of contaminants into nearby aquatic habitats.



## 5.2 Riverine Activities

### 5.2.1 Mining

Mining within riverine habitats may result in direct and indirect chemical, biological, and physical impacts to habitats within the mining site and surrounding areas during all stages of operations. On site mining activities include exploration, site preparation, mining and milling, waste management, decommissioning or reclamation, and abandonment (NMFS 2004, American Fisheries Society 2000). Mining and its associated activities have the potential to cause adverse effects to EFH from exploration through post-closure. The operation of metal, coal, rock quarries, and gravel pit mines in upland and riverine areas has caused varying degrees of environmental damage in urban, suburban, and rural areas. Some of the most severe damage, however, occurs in remote areas, where some of the most productive fish habitat is often located (Sengupta 1993). In Alaska, existing regulations, promulgated and enforced by other federal and state agencies, are designed to control and manage these changes to the landscape to avoid and minimize impacts. However, while environmental regulations may avoid, limit, control, or offset many potential impacts, mining will, to some degree, always alter landscapes and environmental resources (National Research Council 1999). (Additional information on mining impacts in the marine environment is covered later in this synthesis.)

#### 5.2.1.1 Mineral Mining

Mining and mineral extraction activities take many forms, such as commercial and recreational suction dredging, placer, open pit and surface mining, and contour operations. The process for mineral extraction involves exploration, mine development, mining (extraction), processing and reclamation.

#### *Potential Adverse Impacts*

The potential adverse effects of mineral mining on fish populations and EFH are well documented (Farag et al. 2003, Hansen et al. 2002, Brix et al. 2001, Goldstein et al. 1999) and depend on the type, extent, and location of the activities. Impacts associated with the extraction of material from within or near a stream or river bed may include (1) alteration in channel morphology, hydraulics, lateral migration and natural channel meander; (2) increases in channel incision and bed degradation; (3) disruption in pre-existing balance of suspended sediment transport and turbidity; (4) direct impacts to fish spawning and nesting habitats (redds), juveniles, and prey items; (5) simplification of in-channel fluvial processes and LWD deposition; (6) altered surface and ground water regimes and hydro-geomorphic and hyporheic processes; and (7) destruction of the riparian zone during extraction operations. Additional impacts may include mining-related pollution, acid mine drainage, habitat fragmentation and conversion, altered temperature regimes, reduction in oxygen concentration, the release of toxic materials (NMFS 2008), and additional impacts to wetland and riverine habitats. Many of these types of impacts have been previously introduced in the document. The additional discussion that follows is intended to round out the discussion of impacts that have not been previously introduced.

#### *Recommended Conservation Measures*

The following measures are adapted from recommendations in Spence et al. (1996), NMFS (2004), and Washington Department of Fish and Wildlife (2009). These conservation

recommendations for mineral mining should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

- To the extent practicable, avoid mineral mining in waters, water sources and watersheds, riparian areas, hyporheic zones, and floodplains providing habitat for federally managed species.
- Schedule necessary in-water activities when the fewest species/least vulnerable life stages of federally managed species will be present.
- Minimize spillage of dirt, fuel, oil, toxic materials, and other contaminants into EFH. Prepare a spill prevention plan if appropriate.
- Treat and test wastewater (acid neutralization, sulfide precipitation, reverse osmosis, electrochemical, or biological treatments) and recycle on site to minimize discharge to streams.
- Minimize the effects of sedimentation on fish habitat, using methods such as contouring, mulching, construction of settling ponds, and sediment curtains. Monitor turbidity during operations, and cease operations if turbidity exceeds predetermined threshold levels.
- If possible, reclaim, rather than bury, mine waste that contains heavy metals, acid materials, or other toxic compounds to limit the possibility of leachate entering groundwater.
- Restore natural contours and use native vegetation to stabilize and restore habitat function to the extent practicable. Monitor the site to evaluate performance.
- Minimize the aerial extent of ground disturbance and stabilize disturbed lands to reduce erosion.
- For large scale mining operations, stochastic models should be employed to make predictions of ground and surface hydrologic impacts and acid generating potential in mine pits and tailing impoundments.

#### ***5.2.1.2 Sand and Gravel Mining***

In Alaska, riverine sand and gravel mining is extensive and can involve several methods: wet-pit mining (i.e., removal of material from below the water table); dry-pit mining on beaches, exposed bars, and ephemeral streambeds; and subtidal mining.

#### ***Potential Adverse Impacts***

Primary impacts associated with riverine sand and gravel mining activities include (1) turbidity plumes and re-suspension of sediment and nutrients, (2) removal of spawning habitat, and (3) alteration of channel morphology. These often lead to secondary impacts including alteration of migration patterns, physical and thermal barriers to upstream and downstream migration, increased fluctuation in water temperature, decrease in dissolved oxygen, high mortality of early life stages, increased susceptibility to predation, loss of suitable habitat (Packer et al. 2005), decreased nutrients (from loss of floodplain connection and riparian vegetation), and decreased food production (loss of invertebrates) (Spence et al. 1996).

### *Recommended Conservation Measures*

The following recommended conservation measures for sand and gravel mining are adapted from NMFS (2004) and OWRRI (1995). They should be viewed as options to avoid and minimize adverse impacts to EFH due to sand and gravel mining and promote the conservation, enhancement, and proper functioning of EFH.

- To the extent practicable, avoid sand/gravel mining in waters, water sources and watersheds, riparian areas, hyporheic zones and floodplains providing habitat for federally managed species.
- Identify upland or off-channel (where the channel will not be captured) gravel extraction sites as alternatives to gravel mining in or adjacent to EFH, if possible.
- If operations in EFH cannot be avoided, design, manage, and monitor sand and gravel mining operations to minimize potential direct and indirect impacts to living marine resources and habitat. For example, minimize the areal extent and depth of extraction.
- Include restoration, mitigation, and monitoring plans, as appropriate, in sand/gravel extraction plans.
- Implement seasonal restrictions to avoid impacts to habitat during species critical life history stages.

#### 5.2.2 Organic and Inorganic Debris

Organic and inorganic debris, and its impacts to EFH, extend beyond riverine systems into estuarine coastal and marine systems. To reduce duplication, impacts to other systems are also addressed here.

Natural occurring flotsam, such as LWD and macrophyte wrack (i.e., kelp), plays an important role in aquatic ecosystems, including EFH. LWD and wrack promote habitat complexity and provide structure to various aquatic and shoreline habitats.

The natural deposition of LWD creates habitat complexity by altering local hydrologic conditions, nutrient availability, sediment deposition, turbidity, and other structural habitat conditions. In riverine systems, the physical structure of LWD provides cover for managed species, creates habitats and microhabitats (e.g., pools, riffles, undercut banks, and side channels), retains gravels, and helps maintain underlying channel structure (Abbe and Montgomery 1996, Montgomery et al. 1995, Ralph et al. 1994, Spence et al. 1996). LWD also plays similar role in salt marsh habitats (Maser and Sedell 1994). In benthic ocean habitats, LWD enriches local nutrient availability as deep-sea wood borers convert the wood to fecal matter, providing terrestrially-based carbon to the ocean food chain (Maser and Sedell 1994). When deposited on coastal shorelines, macrophyte wrack creates microhabitats and provides a food source for aquatic and terrestrial organisms such as isopods and amphipods, which play an important role in marine food webs.

Conversely, inorganic flotsam and jetsam debris can negatively impact EFH. Inorganic marine debris is a problem along much of the coastal United States, where it litters shorelines, fouls estuaries, entangles fish and wildlife, and creates hazards in the open ocean. Marine debris consists of a wide variety of man-made materials, including general litter, plastics, hazardous

wastes, and discarded or lost fishing gear. The debris enters waterbodies indirectly through rivers and storm water outfalls, as well as directly via ocean dumping and accidental release. Although laws and regulatory programs exist to prevent or control the problem, marine debris continues to affect aquatic resources.

### ***5.2.2.1 Organic Debris Removal***

Natural occurring flotsam, such as LWD and macrophyte wrack (i.e., kelp), is sometimes intentionally removed from streams, estuaries, and coastal shores. This debris is removed for a variety of reasons, including dam operations, aesthetic concerns, and commercial and recreational purposes (e.g., active beach log harvests, garden mulch, and fertilizer). However, the presence of organic debris is important for maintaining aquatic habitat structure and function.

### ***Potential Adverse Impacts***

The removal of organic debris from natural systems can reduce habitat function, adversely impacting habitat quality. Reductions in LWD inputs to estuaries may also affect the ecological balance of estuarine systems by altering rates and patterns of nutrient transport, sediment deposition, and availability of in-water cover for larval and juvenile fish. In rivers and streams of the Pacific Northwest, the historic practice of removing LWD to improve navigability and facilitate log transport has altered channel morphology and reduced habitat complexity, thereby negatively affecting habitat quality for spawning and rearing salmonids (Koski 1992, Sedell and Luchessa 1982).

Beach grooming and wrack removal can substantially alter the macrofaunal community structure of exposed sand beaches (Dugan et al. 2000). Species richness, abundance, and biomass of macrofauna associated with beach wrack (e.g., sand crabs, isopods, amphipods, and polychaetes) are higher on ungroomed beaches than on those that are groomed (Dugan et al. 2000). The input and maintenance of wrack can strongly influence the structure of macrofauna communities, including the abundance of sand crabs (*Emerita analoga*) (Dugan et al. 2000), an important prey species for some managed species of fish.

### ***Recommended Conservation Measures***

The recommended conservation measures for organic debris removal are listed below. They should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

- Encourage the preservation of LWD whenever possible, removing it only when it presents a threat to life or property.
- Encourage appropriate federal, state, and local agencies to aid in the downstream movement of LWD around dams, culverts, and bridges wherever possible, rather than removing it from the system.
- Educate landowners and recreationalists about the benefits of maintaining LWD.
- Localize beach grooming practices, and minimize them whenever possible.
- Advise gardeners to only harvest dislodged, dead kelp and leave live, growing kelp (whether dislodged or not).

### ***5.2.2.2 Inorganic Debris***

Inorganic debris in the marine environment is a chronic problem along much of the U.S. coast, resulting in littered shorelines and estuaries with varying degrees of negative effects to coastal ecosystems. Nationally, land-based sources of marine debris account for about 80 percent of the marine debris on beaches and in U.S. waters. Debris can originate from combined sewer overflows and storm drains, stormwater runoff, landfills, solid waste disposal, poorly maintained garbage bins, floating structures, and general littering of beaches, rivers, and open waters. It generally enters waterways indirectly through rivers and storm drains or by direct ocean dumping. Ocean-based sources of debris also create problems for managed species. These include discarded or lost fishing gear (NMFS 2008), and galley waste and trash from commercial merchant, fishing, military, and other vessels.

#### ***Potential Adverse Impacts***

Land and ocean sourced inorganic marine debris is a very diverse problem, and adverse effects to EFH are likewise varied. Floating or suspended trash can directly affect managed species that consume or are entangled in it. Toxic substances in plastics can kill or impair fish and invertebrates that use habitat polluted by these materials. The chemicals that leach from plastics can persist in the environment and can bioaccumulate through the food web.

Once floatable debris settles to the bottom of estuaries, coastal and open ocean areas, it can continue to cause environmental problems. Plastics and other materials with a large surface area can cover and suffocate immobile animals and plants, creating large spaces devoid of life. Currents can carry suspended debris to underwater reef habitats where the debris can become snagged, damaging these sensitive habitats. The typical floatable debris from combined sewer overflows includes street litter, sewage containing viral and bacterial pathogens, pharmaceutical by-products from human excretion, and pet wastes. Pathogens can also contaminate shellfish beds and reefs.

#### ***Recommended Conservation Measures***

Pollution prevention and improved waste management can occur through regulatory controls and best management practices. The recommended conservation measures for minimizing inorganic debris listed in the section below should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

- Encourage proper trash disposal, particularly in coastal and ocean settings, and participate in coastal cleanup activities.
- Advocate for local, state and national legislation that rewards proper disposal of debris.
- Encourage enforcement of regulations addressing marine debris pollution and proper disposal.
- Provide resources and technical guidance for development of studies and solutions addressing the problem of marine debris.
- Educate the public on the impact of marine debris and provide guidance on how to reduce or eliminate the problem.
- Implement structural controls that collect and remove trash before it enters nearby waterways.

- Consider the use of centrifugal separation to physically separate solids and floatables from water in combined sewer outflows.
- Encourage the development of incentives and funding mechanisms to recover lost fishing gear.
- Require all existing and new commercial construction projects near the coast to develop and implement refuse disposal plans.

### 5.2.3 Dam Operation

Dams provide sources of hydropower, water storage, and flood control. Construction and operation of dams can affect basic hydrologic and geomorphic function including the alteration of physical, biological, and chemical processes that, in turn, can have effects on water quality, timing, quantity, and alter sediment transport.

#### *Potential Adverse Impacts (adapted from NMFS 2008)*

The effects of dam construction and operation on fish and aquatic habitat include (1) complete or partial upstream and downstream migratory impediment; (2) water quality and flow pattern alteration; (3) alteration to distribution and function of ice, sediment and nutrient budgets; (4) alterations to the floodplain, including riparian and coastal wetland systems and associated functions and values; and (5) thermal impacts. Dam construction and operations can impede or block anadromous fish passage and other aquatic species migration in streams and rivers. Unless proper fish passage structures or devices are operational, dams can either prevent access to productive upstream spawning and rearing habitat or can alter downstream juvenile migration. Turbines, spillways, bypass systems, and fish ladders also affect the quality and quantity of EFH available for salmon passage in streams and rivers (Pacific Fishery Management Council 1999). The construction of a dam can fragment habitat, resulting in alterations to both upstream and downstream biogeochemical processes.

#### *Recommended Conservation Measures (adapted from NMFS 2008)*

The following conservation recommendations regarding dams should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

- Avoid construction of new dam facilities, where possible.
- Construct and design facilities with efficient and functional upstream and downstream adult and juvenile fish passage which ensures safe, effective, and timely passage.
- Operate dams within the natural flow fluctuations rates and timing and, when possible, mimic the natural hydrograph, allow for sediment and wood transport, and consider and allow for natural ice function. Monitor water flow and reservoir flow fluctuation.
- Understand longer term climatic and hydrologic patterns and how they affect habitat; plan project design and operation to minimize or mitigate for these changes.
- Use seasonal restrictions for construction, maintenance, and operation of dams to avoid impacts to habitat during species' critical life history stages.
- Develop and implement monitoring protocols for fish passage.
- Retrofit existing dams with efficient and functional upstream and downstream fish

passage structures.

- Construct dam facilities with the lowest hydraulic head practicable for the project purpose. Site the project at a location where dam height can be reduced.
- Downstream passage should prevent adults and juveniles from passing through the turbines and provide sufficient water downstream for safe passage.
- Coordinate maintenance and operations that require drawdown of the impoundment with state and federal resource agencies to minimize impacts to aquatic resources.
- Develop water and energy conservation guidelines for integration into dam operation plans and into regional and watershed-based water resource plans.
- Encourage the preservation of LWD, whenever possible.
- Develop a sediment transport and geomorphic maintenance plan to allow for peak flow mimicking that will result in sediment pulses through the reservoir/dam system and allow high flow geomorphic processes.

#### 5.2.4 Commercial and Domestic Water Use

An increasing demand for potable water, combined with inefficient use of freshwater resources and natural events (e.g., droughts) have led to serious ecological damage worldwide (Deegan and Buchsbaum 2005). Because human populations are expected to continue increasing in Alaska, it is reasonable to assume that water uses, including water impoundments and diversion, will similarly increase (Gregory and Bisson 1997). Groundwater supplies 87 percent of Alaska's 3,500 public drinking water systems. Ninety percent of the private drinking water supplies are groundwater. Each day, roughly 275 million gallons of water derived from aquifers, which directly support riverine systems, are used for domestic, commercial, industrial, and agricultural purposes in Alaska (Groundwater Protection Council 2010). Surface water sources serve a large number of people from a small number of public water systems (e.g., Anchorage and several southeastern communities).

##### *Potential Adverse Impacts*

The diversion of freshwater for domestic and commercial uses can affect EFH by (1) altering natural flows and the process associated with flow rates, (2) altering riparian habitats by removing water or by submersion of riparian areas, (3) removing the amount and altering the distribution of prey bases, (4) affecting water quality, and (5) entrapping fishes. Water diversions can involve either withdrawals (reduced flow) or discharges (increased flow).

##### *Recommended Conservation Measures*

These conservation measures for commercial and domestic water use should be viewed as options to avoid and minimize adverse impacts from commercial and domestic water use and promote the conservation, enhancement, and proper functioning of EFH.

- Design water diversion and impoundment projects to create flow conditions that provide for adequate fish passage, particularly during critical life history stages. Avoid low water levels that strand juveniles and dewater redds. Incorporate juvenile and adult fish passage facilities on all water diversion projects (e.g., fish bypass systems). Install screens at water diversions on fish-bearing streams, as needed.

- Maintain water quality necessary to support fish populations by monitoring and adjusting water temperature, sediment loads, and pollution levels.
- Maintain appropriate flow velocity and water levels to support continued stream functions. Maintain and restore channel, floodplain, riparian, and estuarine conditions.
- Where practicable, ensure that mitigation is provided for unavoidable impacts to fish and their habitat.

### 5.3 Estuarine Activities

A large portion of Alaska’s population resides near the state’s 33,904-mile coastline (NOAA 2010). The dredging and filling of coastal wetlands for commercial and residential development, port, and harbor development directly removes important wetland habitat and alters the habitat surrounding the developed area. Physical changes from shoreline construction can result in secondary impacts such as increased suspended sediment loading, shading from piers and wharves, as well as introduction of chemical contamination from land-based human activities (Robinson and Pederson 2005). Even development projects that appear to have minimal individual impacts can have significant cumulative effects on the aquatic ecosystem (NMFS 2008).

#### 5.3.1 Dredging

The construction of ports, marinas, and harbors typically involves dredging sediments from intertidal and subtidal habitats to create navigational channels, turning basins, anchorages, and berthing docks. Additionally, periodic dredging is used to maintain the required depths after sediment is deposited into these facilities. Dredging is also used to create deepwater navigable channels or to maintain existing channels that periodically fill with sediments. (Impacts from dredging from marine mining are also addressed later.)

#### *Potential Adverse Impacts*

Dredging activities can adversely affect benthic and water-column habitat. The environmental effects of dredging on managed species and their habitat can include (1) direct removal/burial of organisms; (2) turbidity and siltation, including light attenuation from turbidity; (3) contaminant release and uptake, including nutrients, metals, and organics; (4) release of oxygen consuming substances (e.g., chemicals and bacteria); (5) entrainment; (6) noise disturbances; and (7) alteration to hydrodynamic regimes and physical habitat.

#### *Recommended Conservation Measures*

The recommended conservation measures for dredging are listed in the following section. They should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

- Avoid new dredging in sensitive habitat areas to the maximum extent practicable.
- Reduce the area and volume of material to be dredged to the maximum extent practicable.
- Avoid dredging and placement of equipment used in conjunction with dredging operations in special aquatic sites and other high value habitat areas.



- Implement seasonal restrictions to avoid impacts to habitat during species critical life history stages (e.g., spawning season, egg, and larval development period).
- Utilize BMPs to limit and control the amount and extent of turbidity and sedimentation.
- For new dredging projects, undertake multi-season, pre-, and post-dredging biological surveys to assess the cumulative impacts to EFH and allow for implementation of adaptive management techniques.
- Prior to dredging, test sediments for contaminants as per U.S. Environmental Protection Agency (EPA) and U.S. Army Corps of Engineers (USACE) requirements.
- Provide appropriate compensation for significant impacts (short-term, long-term, and cumulative) to benthic environments resulting from dredging.
- Identify excess sedimentation in the watershed that prompts excessive maintenance dredging activities, and implement appropriate management actions, if possible.

### 5.3.2 Material Disposal and Filling Activities

Material disposal and filling activities can directly remove important habitat and alter the habitat surrounding the developed area. The discharge of dredged materials or the use of fill material in aquatic habitats can result in covering or smothering existing submerged substrates, loss of habitat function, and adverse effects on benthic communities.

#### 5.3.2.1 *Disposal of Dredged Material*

##### *Potential Adverse Impacts (adapted from NMFS 2008)*

The disposal of dredged material can reduce the suitability of water bodies for managed species and their prey by (1) reducing floodwater retention in wetlands; (2) reducing nutrients uptake and release; (3) decreasing the amount of detrital input, an important food source for aquatic invertebrates (Mitsch and Gosselink 1993); (4) habitat conversion through alteration of water depth or substrate type; (5) removing aquatic vegetation and preventing natural revegetation; (6) impeding physiological processes to aquatic organisms (e.g., photosynthesis, respiration) caused by increased turbidity and sedimentation (Arruda et al. 1983, Cloern 1987, Dennison 1987, Barr 1993, Benfield and Minello 1996, Nightingale and Simenstad 2001a); (7) directly eliminating sessile or semi-mobile aquatic organisms via entrainment or smothering (Larson and Moehl 1990, McGraw and Armstrong 1990, Barr 1993, Newell et al. 1998); (8) altering water quality parameters (i.e., temperature, oxygen concentration, and turbidity); and (9) releasing contaminants such as petroleum products, metals, and nutrients (USEPA 2000a).

##### *Recommended Conservation Measures*

The following recommended conservation measures for dredged material disposal should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

- Avoid disposing dredged material in wetlands, submerged aquatic vegetation (SAV) and other special aquatic sites whenever possible.
- Test sediment compatibility for open-water disposal per EPA and USACE requirements.

- Ensure that disposal sites are properly managed and monitored to minimize impacts associated with dredge material.
- Where long-term maintenance dredging is anticipated, acquire and maintain disposal sites for the entire project life.
- Encourage beneficial uses of dredged materials.

### 5.3.2.2 *Fill Material*

Like the discharge of dredged material, the discharge of fill material to create upland areas can remove productive habitat and eliminate important habitat functions.

#### *Potential Adverse Impacts*

Adverse impacts to EFH from the introduction of fill material include (1) loss of habitat function and (2) changes in hydrologic patterns.

#### *Recommended Conservation Measures*

The following recommended conservation measures for the discharge of fill material should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

- Federal, state, and local resource management and permitting agencies should address the cumulative impacts of fill operations on EFH.
- Minimize the areal extent of any fill in EFH, or avoid it entirely.
- Consider alternatives to the placement of fill into areas that support managed species.
- Fill should be sloped to maintain shallow water, photic zone productivity; allow for unrestricted fish migration; and provide refugia for juvenile fish.
- In marine areas of kelp and other aquatic vegetation, fill (including artificial structure fill reefs) should be designed to maximize kelp colonization and provide areas for juvenile fish to find shelter from higher currents and exposure to predators.
- Fill materials should be tested and be within the neutral range of 7.5 to 8.4 pH.

### 5.3.3 Vessel Operations, Transportation, and Navigation

In Alaska, the growth in coastal communities is putting demands on port districts to increase infrastructure to accommodate additional vessel operations for cargo handling and marine transportation. Port expansion has become an almost continuous process due to economic growth, competition between ports, and significant increases in vessel size. In addition, increasing boat sales have put more pressure on improving and building new harbors, an important factor in Alaska because of the limited number of roads.

#### *Potential Adverse Impacts*

Activities associated with the expansion of port facilities, vessel/ferry operations, and recreational marinas can directly and indirectly impact EFH. Impacts include (1) loss and conversion of habitat; (2) altered light regimes and loss of submerged aquatic vegetation; (3)

altered temperature regimes; (4) siltation, sedimentation, and turbidity; (5) contaminant releases; and; and (6) altered tidal, current, and hydrologic regimes.

### ***Recommended Conservation Measures***

The following recommended conservation measures for vessel operations, transportation infrastructure, and navigation, should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

- Locate marinas in areas of low biological abundance and diversity.
- Leave riparian buffers in place to help maintain water quality and nutrient input.
- Include low-wake vessel technology, appropriate routes, and BMPs for wave attenuation structures as part of the design and permit process.
- Incorporate BMPs to prevent or minimize contamination from ship bilge waters, antifouling paints, shipboard accidents, shipyard work, maintenance dredging and disposal, and nonpoint source contaminants from upland facilities related to vessel operations and navigation.
- Locate mooring buoys in water deep enough to avoid grounding and to minimize the effects of prop wash.
- Use catchment basins for collecting and storing surface runoff to remove contaminants prior to delivery to any receiving waters.
- Locate facilities in areas with enough water velocity to maintain water quality levels within acceptable ranges.
- Locate marinas where they do not interfere with natural processes so as to affect adjacent habitats.
- To facilitate movement of fish around breakwaters, breach gaps and construct shallow shelves to serve as “fish benches,” as appropriate.
- Harbor facilities should be designed to include practical measures for reducing, containing, and cleaning up petroleum spills.

#### **5.3.4 Invasive Species**

Introductions of invasive species into estuarine, riverine, and marine habitats have been well documented (Rosecchi et al. 1993, Kohler and Courtenay 1986, Spence et al. 1996) and can be intentional (e.g., for the purpose of stock or pest control) or unintentional (e.g., fouling organisms). Exotic fish, shellfish, pathogens, and plants can be spread via shipping, recreational boating, aquaculture, biotechnology, and aquariums. The introduction of nonindigenous organisms to new environments can have many severe impacts on habitat (Omori et al. 1994).

Invasive aquatic species that are considered high priority threats to Alaska’s marine waters include Atlantic salmon (*Salmo salar*), green crab (*Carcinus maenas*), Chinese mitten crab (*Eriocheir sinensis*), signal crayfish (*Pacifastacus leniaculus*), zebra mussels (*Dreissena polymorpha*), New Zealand mudsnail (*Potamopyrgus antipodarum*), saltmarsh cordgrass

(*Spartina alterniflora*), purple loosestrife (*Lythrum salicaria*), and tunicates (*Botrylloides violaceus* and *Didemnum vexillum*).<sup>1</sup>

### ***Potential Adverse Impacts***

Invasive species can create five types of negative effects on EFH: (1) habitat alteration, (2) trophic alteration, (3) gene pool alteration, (4) spatial alteration, and (5) introduction of diseases.

### ***Recommended Conservation Measures***

The following recommended conservation measures for invasive species should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

- Uphold fish and game regulations of the Alaska Board of Fisheries (AS 16.05.251) and Board of Game (AS 16.05.255), which prohibit and regulate the live capture, possession, transport, or release of native or exotic fish or their eggs.
- Adhere to regulations and use best management practices outlined in the State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002).
- Encourage vessels to perform a ballast water exchange in marine waters to minimize the possibility of introducing invasive estuarine species into similar habitats.
- Discourage vessels that have not performed a ballast water exchange from discharging their ballast water into estuarine receiving waters.
- Require vessels brought from other areas over land via trailer to clean any surfaces that may harbor non-native plant or animal species (e.g., propellers, hulls, anchors, fenders).
- Treat effluent from public aquaria displays and laboratories and educational institutes using non-native species before discharge.
- Encourage proper disposal of seaweeds and other plant materials used for packing purposes when shipping fish or other animals.
- Undertake a thorough scientific review and risk assessment before any non-native species are introduced.

#### **5.3.5 Pile Installation and Removal (From NMFS 2005)**

Pilings are an integral component of many overwater and in-water structures. They provide support for the decking of piers and docks, function as fenders and dolphins to protect structures, support navigation markers, and help in the construction of breakwaters and bulkheads. Materials used in pilings include steel, concrete, wood (both treated and untreated), plastic, or a combination thereof. Piles are usually driven into the substrate by using either impact or vibratory hammers.

---

<sup>1</sup> <http://www.adfg.state.ak.us/special/invasive/invasive.ph>

### 5.3.5.1 Pile Driving

#### *Potential Adverse Impacts*

Pile driving can generate intense underwater sound pressure waves that may adversely affect EFH. These pressure waves have been shown to injure and kill fish (CalTrans 2001, Longmuir and Lively 2001, Stotz and Colby 2001, Stadler, pers. obs. 2002). Fish injuries associated directly with pile driving are poorly studied, but include rupture of the swim bladder and internal hemorrhaging (CalTrans 2001, Abbott and Bing-Sawyer 2002, Stadler pers. obs. 2002). Sound pressure levels (SPLs) 100 decibels (dB) above the threshold for hearing are thought to be sufficient to damage the auditory system in many fishes (Hastings 2002).

The type and intensity of the sounds produced during pile driving depend on a variety of factors, including the type and size of the pile, the firmness of the substrate into which the pile is being driven, the depth of water, and the type and size of the pile-driving hammer. Driving large hollow steel piles with impact hammers produces intense, sharp spikes of sound that can easily reach levels injurious to fish. Vibratory hammers, on the other hand, produce sounds of lower intensity, with a rapid repetition rate. A key difference between the sounds produced by impact hammers and those produced by vibratory hammers is the responses they evoke in fish. The differential responses to these sounds are due to the differences in the duration and frequency of the sounds.

Systems using air bubbles have been successfully designed to reduce the adverse effects of underwater SPLs on fish. Confined (i.e., metal or fabric sleeve) and unconfined air bubble systems have been shown to attenuate underwater sound pressures (Longmuir and Lively 2001, Christopherson and Wilson 2002, Reyff and Donovan 2003).

#### 5.3.5.2 *Recommended Conservation Measures*

The following recommended conservation measures for pile driving should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

- Install hollow steel piles with an impact hammer at a time of year when larval and juvenile stages of fish species with designated EFH are not present.

If the first measure is not possible, then the following measures regarding pile driving should be incorporated when practicable to minimize adverse effects:

- Drive piles during low tide when they are located in intertidal and shallow subtidal areas.
- Use a vibratory hammer when driving hollow steel piles.
- Implement measures to attenuate the sound should SPLs exceed the 180 dB (re: 1  $\mu$ Pa) threshold.
- Surround the pile with an air bubble curtain system or air-filled coffer dam.
- Use a smaller hammer to reduce sound pressures.
- Use a hydraulic hammer if impact driving cannot be avoided.

- Drive piles when the current is reduced in areas of strong current, to minimize the number of fish exposed to adverse levels of underwater sound.

### 5.3.5.3 Pile Removal

#### *Potential Adverse Impacts*

The primary adverse effect of removing piles is the suspension of sediments, which may result in harmful levels of turbidity and release of contaminants contained in those sediments (see earlier). Vibratory pile removal tends to cause the sediments to slough off at the mudline, resulting in relatively low levels of suspended sediments and contaminants. Breaking or cutting the pile below the mudline may suspend only small amounts of sediment, providing that the stub is left in place, and little digging is required to access the pile. Direct pull or use of a clamshell to remove broken piles may, however, suspend large amounts of sediment and contaminants. When the piling is pulled from the substrate using these two methods, sediments clinging to the piling will slough off as it is raised through the water column, producing a potentially harmful plume of turbidity and/or contaminants. The use of a clamshell may suspend additional sediment if it penetrates the substrate while grabbing the piling.

While there is a potential to adversely affect EFH during the removal of piles, many of the piles removed in Alaska are old creosote-treated timber piles. In some cases, the long-term benefits to EFH obtained by removing a chronic source of contamination may outweigh the temporary adverse effects of turbidity.

#### *Recommended Conservation Measures*

The following recommended conservation measures for pile removal should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

- Remove piles completely rather than cutting or breaking them off, if they are structurally sound.
- Minimize the suspension of sediments and disturbance of the substrate when removing piles. Measures to help accomplish this include, but are not limited to, the following:
  - When practicable, remove piles with a vibratory hammer.
  - Remove the pile slowly to allow sediment to slough off at, or near, the mudline.
  - The operator should first hit or vibrate the pile to break the bond between the sediment and the pile.
  - Encircle the pile, or piles, with a silt curtain that extends from the surface of the water to the substrate.
- Complete each pass of the clamshell to minimize suspension of sediment if pile stubs are removed with a clamshell.
- Place piles on a barge equipped with a basin to contain attached sediment and runoff water after removal.

- Using a pile driver, drive broken/cut stubs far enough below the mudline to prevent release of contaminants into the water column as an alternative to their removal.

### 5.3.6 Overwater Structures (from NMFS 2005)

Overwater structures include commercial and residential piers and docks, floating breakwaters, barges, rafts, booms, and mooring buoys. These structures typically are located in intertidal areas out to about 49 feet (15 meters) below the area exposed by the mean lower low tide (i.e., the shallow subtidal zone).

#### *Potential Adverse Impacts*

Overwater structures and associated developments may adversely affect EFH in a variety of ways, primarily by (1) changes in ambient light conditions, (2) alteration of the wave and current energy regime, (3) introduction of contaminants into the marine environment, and (4) activities associated with the use and operation of the facilities (Nightingale and Simenstad 2001b).

#### *Recommended Conservation Measures*

The following recommended conservation measures for overwater structures should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

- Use upland boat storage whenever possible to minimize need for overwater structures.
- Locate overwater structures in deep enough waters to avoid intertidal and shade impacts, minimize or preclude dredging, minimize groundings, and avoid displacement of submerged aquatic vegetation, as determined by a preconstruction survey.
- Design piers, docks, and floats to be multiuse facilities to reduce the overall number of such structures and to limit impacted nearshore habitat.
- Incorporate measures that increase the ambient light transmission under piers and docks.
  - Maximize the height and minimize the width to decrease the shade footprint.
  - Use reflective materials on the underside of the dock to reflect ambient light.
  - Use the fewest number of pilings necessary to support the structures.
  - Align piers, docks, and floats in a north-south orientation to allow the arc of the sun to cross perpendicular to the structure and to reduce the duration of light limitation.
- Use floating rather than fixed breakwaters whenever possible, and remove them during periods of low dock use. Encourage seasonal use of docks and off-season haul-out.
- Locate floats in deep water to avoid light limitation and grounding impacts to the intertidal or shallow subtidal zone.
- Maintain at least 1 foot (0.30 meter) of water between the substrate and the bottom of the float at extreme low tide.
- Conduct in-water work when managed species and prey species are least likely to be impacted.

- To the extent practicable, avoid the use of treated wood timbers or pilings.
- Mitigate for unavoidable impacts to benthic habitats.

### 5.3.7 Flood Control/Shoreline Protection (from NMFS 2005)

Structures designed to protect humans from flooding events can result in varying degrees of change in the physical, chemical, and biological characteristics of shoreline and riparian habitat. These structures also can have long-term adverse effects on tidal marsh and estuarine habitats. Tidal marshes are highly variable, but typically have freshwater vegetation at the landward side, saltwater vegetation at the seaward side, and gradients of species in between that are in equilibrium with the prevailing climatic, hydrographic, geological, and biological features of the coast. These systems normally drain through tidal creeks that empty into the bay or estuary. Freshwater entering along the upper edges of the marsh drains across the surface and enters the tidal creeks. Structures placed for coastal shoreline protection may include concrete or wood seawalls, rip-rap revetments (sloping piles of rock placed against the toe of the dune or bluff in danger of erosion from wave action), dynamic cobble revetments (natural cobble placed on an eroding beach to dissipate wave energy and prevent sand loss), vegetative plantings, and sandbags.

#### *Potential Adverse Impacts*

Dikes, levees, ditches, or other water controls at the upper end of a tidal marsh can cut off all tributaries feeding the marsh, preventing the flow of freshwater, annual renewal of sediments and nutrients, and the formation of new marshes. Water controls within the marsh can intercept and carry away freshwater drainage, thus blocking freshwater from flowing across seaward portions of the marsh, or conversely increase the speed of runoff of freshwater to the bay or estuary. This can result in lowering the water table, which may permit saltwater intrusion into the marsh, and create migration barriers for aquatic species. In deeper channels where anoxic conditions prevail, large quantities of hydrogen sulfide may be produced that are toxic to marsh grasses and other aquatic life (NMFS 2008). Acid conditions of these channels can also result in release of heavy metals from the sediments.

Long-term effects of shoreline protection structures on tidal marshes include land subsidence (sometimes even submergence), soil compaction, conversion to terrestrial vegetation, greatly reduced invertebrate populations, and general loss of productive wetland characteristics (NMFS 2005). Alteration of the hydrology of coastal salt marshes can reduce estuarine productivity, restrict suitable habitat for aquatic species, and result in salinity extremes during droughts and floods (NMFS 2008). Armoring shorelines to prevent erosion and to maintain or create shoreline real estate can reduce the amount of intertidal habitat, and affects nearshore processes and the ecology of numerous species (Williams and Thom 2001). Hydraulic effects on the shoreline include increased energy seaward of the armoring, reflected wave energy, dry beach narrowing, substrate coarsening, beach steepening, changes in sediment storage capacity, loss of organic debris, and downdrift sediment starvation (Williams and Thom 2001). Installation of breakwaters and jetties can result in community changes from burial or removal of resident biota, changes in cover and preferred prey species, and predator attraction (Williams and Thom 2001). As with armoring, breakwaters and jetties modify hydrology and nearshore sediment transport, as well as movement of larval forms of many species (Williams and Thom 2001).



### *Recommended Conservation Measures*

The following recommended conservation measures for flood and shoreline protection should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

- Avoid or minimize the loss of coastal wetlands as much as possible.
- Do not dike or drain tidal marshlands or estuaries.
- Wherever possible, use soft in lieu of “hard” shoreline stabilization and modifications.
- Ensure that the hydrodynamics and sedimentation patterns are properly modeled and that the design avoids erosion to adjacent properties when “hard” shoreline stabilization is deemed necessary.
- Include efforts to preserve and enhance fishery habitat to offset impacts.
- Avoid installing new water control structures in tidal marshes and freshwater streams.
- Ensure water control structures are monitored for potential alteration of water temperature, dissolved oxygen concentration, and other parameters.
- Use seasonal restrictions to avoid impacts to habitat during critical life history stages.
- Address the cumulative impacts of development activities in the review process for flood control and shoreline protection projects.
- Use an adaptive management plan with ecological indicators to oversee monitoring and to ensure that mitigation objectives are met. Take corrective action as needed.

#### **5.3.8 Log Transfer Facilities/In-Water Log Storage (from NMFS 2005)**

Rivers, estuaries, and bays were historically the primary ways to transport and store logs in the Pacific Northwest, and log storage continues in some tidal areas today. Using estuaries and bays and nearby uplands for storage of logs is common in Alaska, with most log transfer facilities (LTFs) found in Southeast Alaska and a few located in Prince William Sound. LTFs are facilities that are constructed wholly or in part in waterways and used to transfer commercially harvested logs to or from a vessel or log raft, or for consolidating logs for incorporation into log rafts (USEPA 2000b). LTFs may use a crane, A-frame structure, conveyor, slide, or ramp to move logs from land into the water. Logs can also be placed in the water at the site by helicopters.

#### ***Potential Adverse Impacts***

Log handling and storage in the estuaries and intertidal zones can result in modification of benthic habitat and water quality degradation within the area of bark deposition (Levings and Northcote 2004). EFH may be physically impacted by activities associated with LTFs. LTFs may cause shading and other indirect effects similar in many ways to those of floating docks and other over-water structures (see earlier).

### ***Recommended Conservation Measures***

The following recommended conservation measures for log transfer and storage facilities should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

The physical, chemical, and biological impacts of LTF operations can be substantially reduced by adherence to appropriate siting and operational constraints. Adherence to the Alaska Timber Task Force (ATTF) operational and siting guidelines and BMPs in the National Pollutant Discharge Elimination System (NPDES) General Permit will reduce (1) the amount of bark and wood debris that enters the marine and coastal environment, (2) the potential for displacement or harm to aquatic species, and (3) the accumulation of bark and wood debris on the ocean floor. The following conservation measures reflect those guidelines.<sup>2</sup>

- Restrict or eliminate storage and handling of logs from waters where state and federal water quality standards cannot be met at all times outside of the authorized zone of deposition.
- Minimize potential impacts of log storage by employing effective bark and wood debris control, collection, and disposal methods at log dumps, raft building areas, and mill-side handling zones; avoiding free-fall dumping of logs; using easy let-down devices for placing logs in the water; and bundling logs before water storage (bundles should not be broken except on land and at millside).
- Do not store logs in the water if they will ground at any time or shade sensitive aquatic vegetation such as eelgrass.
- Avoid siting log-storage areas and LTFs in sensitive habitat and areas important for specified species, as required by the ATTF guidelines.
- Site log storage areas and LTFs in areas with good currents and tidal exchanges.
- Use land-based storage sites where possible.

#### **5.3.9 Utility Line, Cables, and Pipeline Installation**

With the continued development of coastal regions comes greater demand for the installation of cables, utility lines for power and other services, and pipelines for water, sewage, and other utilities. The installation of pipelines, utility lines, and cables can have direct and indirect impacts on the offshore, nearshore, estuarine, wetland, beach, and rocky shore coastal zone habitats. Many of the direct impacts occur during construction, such as ground disturbance in the clearing of the right-of-way, access roads, and equipment staging areas. Indirect impacts can include increased turbidity, saltwater intrusion, accelerated erosion, and introduction of urban and industrial pollutants due to ground clearing and construction.

### ***Potential Adverse Impacts***

Adverse effects on EFH from the installation of pipelines, utility lines, and cables can occur through (1) destruction of organisms and habitat, (2) turbidity impacts, (3) resuspension and

---

<sup>2</sup> See also [http://www.fs.fed.us/r10/TLMP/F\\_PLAN/APPEND\\_G.PDF](http://www.fs.fed.us/r10/TLMP/F_PLAN/APPEND_G.PDF).

release of contaminants, (4) changes in hydrology, and (5) destruction of vertically complex hard bottom habitat (e.g., hard corals and vegetated rocky reef).

### *Recommended Conservation Measures*

The following recommended conservation measures for cable and utility line installation should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

- Align crossings along the least environmentally damaging route.
- Use horizontal directional drilling where cables or pipelines would cross anadromous fish streams, salt marsh, vegetated inter-tidal zones, or steep erodible bluff areas adjacent to the intertidal zone.
- Store and contain excavated material on uplands.
- Backfill excavated wetlands with either the same or comparable material capable of supporting similar wetland vegetation, and at original marsh elevations.
- Use existing rights-of-way whenever possible.
- Bury pipelines and submerged cables where possible.
- Remove inactive pipelines and submerged cables unless they are located in sensitive areas (e.g., marsh, reefs, sea grass).
- Use silt curtains or other barriers to reduce turbidity and sedimentation whenever possible.
- Limit access for equipment to the immediate project area. Tracked vehicles are preferred over wheeled vehicles.
- Limit construction equipment to the minimum size necessary to complete the work.
- Conduct construction during the time of year when it will have the least impact on sensitive habitats and species.
- Suspend transmission lines beneath existing bridges or conduct directional boring under streams to reduce the environmental impact.
- For activities on the Continental Shelf, implement the following to the extent practicable:
  - Shunt drill cuttings through a conduit and either discharge the cuttings near the sea floor, or transport them ashore.
  - Locate drilling and production structures, including pipelines, at least 1 mile (1.6 kilometers) from the base of a hard-bottom habitat.
  - Bury pipelines at least 3 feet (0.9 meter) beneath the sea floor whenever possible.
  - Locate alignments along routes that will minimize damage to marine and estuarine habitat.

### 5.3.10 Mariculture

Productive embayments are often used for commercial culturing and harvesting operations. These locations provide protected waters for geoduck, oyster, and mussel culturing. In 1988, Alaska passed the Alaska Aquatic Farming Act (AAF Act) which is designed to encourage establishment and growth of an aquatic farming industry in the state. The AAF Act establishes four criteria for issuance of an aquatic farm permit, including the requirement that the farm may not significantly affect fisheries, wildlife, or other habitats in an adverse manner. Aquatic farm permits are issued by the Alaska Department of Natural Resources (ADNR).

#### *Potential Adverse Impacts*

Shellfish aquaculture tends to have less impact on EFH than finfish aquaculture because the shellfish generally are not fed or treated with chemicals (OSPAR Commission 2009). Adverse impacts to EFH by mariculture operations include (1) risk of introducing undesirable species and disease; (2) physical disturbance of intertidal and subtidal areas; and (3) impacts on estuarine food webs, including disruption of eelgrass habitat (e.g., dumping of shell on eelgrass beds, repeated mechanical raking or trampling, and impacts from predator exclusion netting, though few studies have documented impacts). Hydraulic dredges used to harvest oysters in coastal bays can cause long-term adverse impacts to eelgrass beds by reducing or eliminating the beds (Phillips 1984).

#### *Recommended Conservation Measures*

The following recommended conservation measures for mariculture facilities should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

- Site mariculture operations away from kelp or eelgrass beds.
- Do not enclose or impound tidally influenced wetlands for mariculture.
- Undertake a thorough scientific review and risk assessment before any non-native species are introduced.
- Encourage development of harvesting methods to minimize impacts on plant communities and the loss of food and/or habitat to fish populations during harvesting operations.
- Provide appropriate mitigation for the unavoidable, extensive, or permanent loss of plant communities.
- Ensure that mariculture facilities, spat, and related items transported from other areas are free of nonindigenous species.

## 5.4 Coastal/Marine Activities

### 5.4.1 Point-Source Discharges

Point source pollutants are generally introduced via some type of pipe, culvert, or similar outfall structure. These discharge facilities typically are associated with domestic or industrial activities, or in conjunction with collected runoff from roadways and other developed portions of

the coastal landscape. Waste streams from sewage treatment facilities and watershed runoff may be combined in a single discharge. Point source discharges introduce inorganic and organic contaminants into aquatic habitats, where they may become bioavailable to living marine resources.

### ***Potential Adverse Impacts (adopted from NMFS 2008)***

The Clean Water Act (CWA) includes important provisions to address acute or chronic water pollution emanating from point source discharges. Under the NPDES program, most point-source discharges are regulated by the state or EPA. While the NPDES program has led to ecological improvements in U.S. waters, point sources continue to introduce pollutants into the aquatic environment, albeit at reduced levels.

Determining the fate and effect of natural and synthetic contaminants in the environment requires an interdisciplinary approach to identify and evaluate all processes sensitive to pollutants. This is critical as adverse effects may be manifested at the biochemical level in organisms (Luoma 1996) in a manner particular to the species or life stage exposed. Exposure to pollutants can inhibit (1) basic detoxification mechanisms, e.g., production of metallothioneins or antioxidant enzymes; (2) disease resistance; (3) the ability of individuals or populations to counteract pollutant-induced metabolic stress; (4) reproductive processes including gamete development and embryonic viability; (5) growth and successful development through early life stages; (6) normal processes including feeding rate, respiration, osmoregulation; and (7) overall Darwinian fitness (Capuzzo and Sassner 1977; Widdows et al. 1990; Nelson et al. 1991; Stiles et al. 1991; Luoma 1996; Thurberg and Gould 2005).

### ***Recommended Conservation Measures***

The following recommended conservation measures for point source discharges should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

- Locate discharge points in coastal waters well away from shellfish beds, sea grass beds, corals, and other similar fragile and productive habitats.
- Reduce potentially high velocities by diffusing effluent to acceptable velocities.
- Determine baseline benthic productivity by sampling before any construction activity.
- Provide for mitigation when degradation or loss of habitat occurs.
- Institute source-control programs that effectively reduce noxious materials.
- Ensure compliance with pollutant discharge permits, which set effluent limitations and/or specify operation procedures, performance standards, or BMPs.
- Treat discharges to the maximum extent practicable.
- Use land-treatment and upland disposal/storage techniques where possible.
- Avoid siting pipelines and treatment facilities in wetlands and streams.

## 5.4.2 Seafood Processing Waste—Shoreside and Vessel Operation

Seafood processing is conducted throughout much of coastal Alaska. Processing facilities may be vessel-based or located onshore (ADEC 2010a). Seafood processing facilities generally consist of mechanisms to offload the harvest from fishing boats; tanks to hold the seafood until the processing lines are ready to accept them; processing lines, process water, and waste collection systems; treatment and discharge facilities; processed seafood storage areas; and necessary support facilities such as electrical generators, boilers, retorts, water desalinators, offices, and living quarters. In addition, recreational fish cleaning at marinas and small harbors can produce a large quantity of fish waste.

Pollutants of concern from seafood processing wastewater are primarily components of the biological wastes generated by processing raw seafood into a marketable form, chemicals used to maintain sanitary conditions for processing equipment and fish containment structures, and refrigerants (ammonia and freon) that may leak from refrigeration systems used to preserve seafood (ADEC 2010b). Biological wastes include fish parts (e.g., heads, fins, bones, and entrails) and chemicals, which are primarily disinfectants that must be used in accordance with EPA specifications.

### *Potential Adverse Impacts*

Seafood processing operations have the potential to adversely affect EFH through the discharge of nutrients, chemicals, fish byproducts, and “stickwater” (water and entrained organics originating from the draining or pressing of steam-cooked fish products). Seafood processing discharges influence nutrient loading, eutrophication, and anoxic and hypoxic conditions significantly influencing marine species diversity and water quality (Therriault et al. 2006, Roy Consultants 2003, Lotze et al. 2003). Although fish waste is biodegradable, fish parts that are ground to fine particles may remain suspended for some time, thereby overburdening habitats from particle suspension (NMFS 2005). Scum and foam from seafood waste deposits can also occur on the water surface and/or increase turbidity. Turbidity decreases light penetration into the water column, reducing primary production. In addition, stickwater takes the form of a fine gel or slime that can concentrate on surface waters and move onshore to cover intertidal areas.

### *Recommended Conservation Measures*

The following recommended conservation measures for fish processing waste should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

- To the maximum extent practicable, base effluent limitations on site-specific water quality concerns.
- Encourage the use of secondary or wastewater treatment systems where possible.
- Do not allow designation of new zones of deposit for fish processing waste and instead seek disposal options that avoid an accumulation of waste.
- Promote sound recreational fish waste management through a combination of fish-cleaning restrictions, public education, and proper disposal of fish waste.
- Encourage alternative uses of fish processing wastes.

- Explore options for additional research.
- Monitor biological and chemical changes to the site of processing waste discharges.

#### 5.4.3 Water Intake Structures/Discharge Plumes

Withdrawals of riverine, estuarine, and marine waters are common for a variety of uses such as to cool power-generating stations and create temporary ice roads and ice ponds. In the case of power plants, the subsequent discharge of heated and/or chemically treated discharge water can also occur.

##### *Potential Adverse Impacts*

Water intake structures and effluent discharges can interfere with or disrupt EFH functions in the source or receiving waters by (1) entrainment, (2) impingement, (3) degrading water quality, (4) operation and maintenance, and (5) construction-related impacts.

##### *Recommended Conservation Measures*

The following recommended conservation measures for water intakes and discharges should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

- Locate facilities that rely on surface waters for cooling in areas other than estuaries, inlets, heads of submarine canyons, rock reefs, or small coastal embayments where managed species or their prey concentrate.
- Design intake structures to minimize entrainment or impingement.
- Design power plant cooling structures to meet the best technology available requirements as developed pursuant to section 316(b) of the CWA.
- Regulate discharge temperatures so they do not appreciably alter the ambient temperature to an extent that could cause a change in species assemblages and ecosystem function in the receiving waters.
- Avoid the use of biocides (e.g., chlorine) to prevent fouling where possible.
- Treat all discharge water from outfall structures to meet state water quality standards at the terminus of the pipe.

#### 5.4.4 Oil and Gas Exploration, Development, and Production

Two agencies, the Bureau of Ocean Energy Management and the Bureau of Safety and Environmental Enforcement are responsible for regulating oil and gas operations on the Outer Continental Shelf (OCS). The ADNDR Division of Oil and Gas exercises similar authority over State waters (ADNR1999). Offshore petroleum exploration, development, and production activities have been conducted in Alaska waters or on the Alaska OCS in since the 1960s (Kenai Peninsula Borough 2004). As demand for energy resources grows, the debate over trying to balance the development of oil and gas resources and the protection of the environment will also continue.

### ***Potential Adverse Impacts***

Offshore oil and gas operations can be classified into exploration, development, and production activities (which includes transportation). These activities occur at different depths in a variety of habitats, and can cause an assortment of physical, chemical, and biological disturbances (NMFS 2005, Helvey 2002). (Some of these disturbances are listed below; however, not all of the potential disturbances in this list apply to every type of activity.)

Noise from seismic surveys, vessel traffic, and construction of drilling platforms or islands

Physical alterations to habitat from the construction, presence, and eventual decommissioning and removal of facilities such as islands or platforms, storage and production facilities, and pipelines to onshore common carrier pipelines, storage facilities, or refineries

Waste discharges, including well drilling fluids, produced waters, surface runoff and deck drainage, domestic waste waters generated from the offshore facility, solid waste from wells (drilling muds and cuttings), and other trash and debris from human activities associated with the facility

Oil spills

Platform storage and pipeline decommissioning

The potential disturbances and associated adverse impacts on the marine environment have been reduced through operating procedures required by regulatory agencies and, in many cases, self-imposed by facilities operators. Most of the activities associated with oil and gas operations are conducted under permits and regulations that require companies to minimize impacts or avoid construction in sensitive marine habitats. New technological advances in operating procedures also reduce the potential for impacts.

### ***Recommended Conservation Measures***

The following recommended conservation measures for oil and gas exploration and development should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH:

- Avoid the discharge of produced waters into marine waters and estuaries.
- Avoid discharge of muds and cuttings into the marine and estuarine environment.
- To the extent practicable, avoid the placement of fill to support construction of causeways or structures in the nearshore marine environment.
- As required by federal and state regulatory agencies, encourage the use of geographic response strategies that identify EFH and environmentally sensitive areas.
- Evaluate potential impacts to EFH that may result from activities carried out during the decommissioning phase of oil and gas facilities.
- Vessel operations and shipping activities should be familiar with Alaska Geographic Response Strategies which detail environmentally sensitive areas of Alaska's coastline.



#### 5.4.5 Habitat Restoration and Enhancement

Habitat loss and degradation are major, long-term threats to the sustainability of fishery resources (NMFS 2002). Viable coastal and estuarine habitats are important to maintaining healthy fish stocks. Good water quality and quantity, appropriate substrate, ample food sources, and adequate shelter from predators are needed to sustain fisheries. Restoration and/or enhancement of coastal and riverine habitat that supports managed fisheries and their prey will assist in sustaining and rebuilding fish stocks by increasing or improving ecological structure and functions. Habitat restoration and enhancement may include, but is not limited to, improvement of coastal wetland tidal exchange or reestablishment of natural hydrology; dam or berm removal; fish passage barrier removal or modification; road-related sediment source reduction; natural or artificial reef, substrate, or habitat creation; establishment or repair of riparian buffer zones; improvement of freshwater habitats that support anadromous fishes; planting of native coastal wetland and submerged aquatic vegetation; and improvements to feeding, shade or refuge, spawning, and rearing areas that are essential to fisheries.

##### *Potential Adverse Impacts*

The implementation of restoration and enhancement activities may have localized and temporary adverse impacts on EFH. Possible impacts can include (1) localized nonpoint source pollution such as influx of sediment or nutrients, (2) interference with spawning and migration periods, (3) temporary removal feeding opportunities, (4) indirect effects from construction phase of the activity, (5) direct disturbance or removal of native species, and (6) temporary or permanent habitat disturbance.

##### *Recommended Conservation Measures*

The following recommended conservation measures for habitat restoration and enhancement should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

- Use BMPs to minimize and avoid potential impacts to EFH during restoration activities.
  - Use turbidity curtains, hay bales, and erosion mats.
  - Plan staging areas in advance, and keep them to a minimum size.
  - Establish buffer areas around sensitive resources.
  - Remove invasive plant and animal species from the proposed action area before starting work. Plant only native plant species.
  - Establish temporary access pathways before restoration activities.
- Avoid restoration work during critical life stages for fish such as spawning, nursery, and migration.
- Provide adequate training and education for volunteers and project contractors to ensure minimal impact to the restoration site.
- Conduct monitoring before, during, and after project implementation.
- To the extent practicable, mitigate any unavoidable damage to EFH.

- Remove and, if necessary, restore any temporary access pathways and staging areas used.
- Determine benthic productivity by sampling before any construction activity in the case of subtidal enhancement (e.g., artificial reefs). Avoid areas of high productivity to the maximum extent possible.

#### 5.4.6 Marine Mining

Mining activities, which are also described in Sections 3.1.1 and 3.1.2 of the EFH EIS (NMFS 2005), can lead to the direct loss or degradation of EFH for certain species. Offshore mining, such as the extraction of gravel and gold in the Bering Sea, can increase turbidity, and resuspension of organic materials could impact eggs and recently hatched larvae in the area. Mining large quantities of beach gravel can also impact turbidity, and may significantly affect the transport and deposition of sand and gravel along the shore, both at the mining site and down-current (NMFS 2005).

#### *Potential Adverse Impacts*

Impacts from mining on EFH include both physical impacts (i.e., intertidal dredging) and chemical impacts (i.e., additives such as flocculants) (NMFS 2005). Physical impacts may include the removal of substrates that serve as habitat for fish and invertebrates; habitat creation or conversion in less productive or uninhabitable sites, such as anoxic holes or silt bottom; burial of productive habitats, such as in near-shore disposal sites (as in beach nourishment); release of harmful or toxic materials either in association with actual mining, or in connection with machinery and materials used for mining; creation of harmful turbidity levels; and adverse modification of hydrologic conditions so as to cause erosion of desirable habitats. Submarine disposal of mine tailings can also alter the behavior of marine organisms.

#### *Recommended Conservation Measures*

The following recommended conservation measures for marine mining should be viewed as options to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH.

- To the extent practicable, avoid mining in waters containing sensitive marine benthic habitat, including EFH (e.g., spawning, migrating, and feeding sites).
- Minimize the areal extent and depth of extraction to reduce recolonization times.
- Monitor turbidity during operations, and cease operations if turbidity exceeds predetermined threshold levels.
- Monitor individual mining operations to avoid and minimize cumulative impacts.
- Use seasonal restrictions as appropriate; to avoid and minimize impacts to EFH during critical life history stages of managed species (e.g., migration and spawning).
- Deposit tailings within as small an area as possible.

## 5.5 References

- Abbe, T.B. and D.R. Montgomery. 1996. "Large woody debris jams, channel hydraulics, and habitat formation in large rivers." *Regulated Rivers: Research and Management*. 12:201-221.  
<http://www.cems.uvm.edu/ce361/papers/abbe1996.pdf>
- Abbott, R. and E. Bing-Sawyer. 2002. Assessment of pile driving impacts on the Sacramento blackfish (*Othodon microlepidotus*). Draft report prepared for Caltrans District 4. October 10, 2002.
- Alaska Department of Environmental Conservation (ADEC). 2010a. Ocean Discharge Criteria Evaluation Alaska Offshore Seafood Processors APDES General Permit AKG523000. Prepared by Tetra Tech, 10306 Eaton Place Suite 340, Fairfax, VA 22030. 152 pp.
- ADEC. 2010b. Wastewater Discharge Authorization Program, 555 Cordova Street, Anchorage, AK 99501. Fact Sheet Alaska Offshore Seafood Processors General Permit AKG523000. 43 pp.
- Alaska Department of Natural Resources (ADNR). 1999. Cook Inlet Areawide 1999 Oil and Gas Lease Sale, Final Finding of the Director. Volume II. Appendix B: "Laws and Regulations Pertaining to Oil and Gas Exploration, Development, Production, and Transportation."
- American Fisheries Society (AFS). 2000. AFS Policy Statement #13: Effects of Surface Mining on Aquatic Resources in North America (Revised). (Abbreviated) [http://www.fisheries.org/afs/docs/policy\\_13f.pdf](http://www.fisheries.org/afs/docs/policy_13f.pdf)
- Arruda, J.A., G.R. Marzolf, R.T. Faulk. 1983. The role of suspended sediments in the nutrition of zooplankton in turbid reservoirs. *Ecology* 64(5):1225-35.
- Atlantic States Marine Fisheries Commission. 1992. Fishery management plan for inshore stocks of winter flounder. Washington (DC): ASMFC. FMR No. 21. 138 p.
- Barr BW. 1993. Environmental impacts of small boat navigation: vessel/sediment interactions and management implications. In: Magoon OT, editor. Coastal Zone '93: proceedings of the eighth Symposium on Coastal and Ocean Management; 1993 Jul 19-23; New Orleans, LA. American Shore and Beach Preservation Association. p 1756-70.
- Benfield, M.C. and T. J. Minello. 1996. "Relative effects of turbidity and light intensity on reactive distance and feeding of an estuarine fish." *Environmental Biology of Fishes*. 46:211-216.
- Brix, K.V., D.K. DeForest, and W.J. Adams 2001. Assessing acute and chronic copper risks to freshwater aquatic life using species sensitivity distributions for different taxonomic groups. *Environmental Toxicology and Chemistry*. 20(8): 1846-1856.
- Caltrans. 2001. Fisheries Impact Assessment, Pile Installation Demonstration Project for the San Francisco - Oakland Bay Bridge, East Span Seismic Safety Project, August 2001. 59 pp.
- Capuzzo J.M., and J.J. Sassner Jr. 1977. The effect of chromium on filtration rates and metabolic activity of *Mytilus edulis* L. and *Mya arenaria* L. In: Vernberg FJ, and others, editors. Physiological responses of marine biota to pollutants. San Diego (CA): Academic Press. p 225-37.
- Center for Watershed Protection (CWP). 2003. Impacts of Impervious Cover on Aquatic Systems. Elliott City, MD, [www.cwp.org](http://www.cwp.org). 141 pp.
- Christopherson, A. and J. Wilson. 2002. Technical Letter Report Regarding the San Francisco-Oakland Bay Bridge East Span Project Noise Energy Attenuation Mitigation. Peratrovich, Nottingham & Drage, Inc. Anchorage, Alaska. 27 pp.

- Cloern, J.E. 1987. "Turbidity as a control on phytoplankton biomass and productivity in estuaries." *Continental Shelf Research*. 7:1367-1381.
- Conner, Billy, Director Alaska University Transportation Center. University of Alaska, Fairbanks PO Box 755900. 2007 Interview in Building Alaska. [http://www.buildingalaskamovie.com/interviews\\_billy.html](http://www.buildingalaskamovie.com/interviews_billy.html)
- Deegan, L.A. and R.N. Buchsbaum. 2005. The effect of habitat loss and degradation on fisheries. In: Buchsbaum R, Pederson J, Robinson WE, editors. The decline on fisheries resources in New England: evaluating the impact of overfishing, contamination, and habitat degradation. Cambridge (MA): MIT Sea Grant College Program; Publication No. MITSG 05-5. p 67-96.
- Dennison, W.C. 1987. "Effect of light on seagrass photosynthesis, growth and depth distribution." *Aquatic Botany*. 27:15-26.
- Dugan, J.E., D.M. Hubbard, D.L. Martin, J.M. Engle, D.M. Richards, G.E. Davis, K.D. Lafferty, and R.F. Ambrose. 2000. Macrofauna communities of exposed sandy beaches on the Southern California mainland and Channel Islands. pp 339-346. In Brown, D.R., K.L. Mitchell, and H.W. Chang, eds. Proceedings of the Fifth California Islands Symposium. Minerals Management Service Publication # 99-0038.
- Farang, A.M., D.A. Skaar, E. Nimick, C. MacConnell, and C. Hogstrand. 2003. Characterizing aquatic health using salmonids mortality, physiology, and biomass estimates in streams with elevated concentrations of arsenic, cadmium, copper, lead, and zinc in the Boulder River Watershed, Montana. *Transaction of the American Fisheries Society* 132(3): 450-457.
- Fay, V. 2002. Alaska Aquatic Nuisance Species Management Plan. Alaska Department of Fish and Game Publication. Juneau, AK. [http://www.adfg.state.ak.us/special/invasive/ak\\_ansmp.pdf](http://www.adfg.state.ak.us/special/invasive/ak_ansmp.pdf).
- Goldstein, J.N., D.F. Woodward, and A.M. Farang. 1999. Movement of adult Chinook salmon during spawning migration in a metals-contaminated system, Coeur d'Alene River, Idaho. *Transactions of the American Fisheries Society* 128:121-129.
- Gregory, S.V. and P.A. Bisson. 1997. Degradation and loss of anadromous salmonid habitat in the Pacific Northwest. In Stouder, J.D., P.A. Bisson, and R.J. Naiman, eds. *Pacific Salmon and Their Ecosystems: Status and Future Options*, pp. 277-314. Chapman and Hall, New York.
- Groundwater Protection Council. 2010. State Groundwater Fact Sheets. [http://www.gwpc.org/e-library/documents/state\\_fact\\_sheets/alaska.pdf](http://www.gwpc.org/e-library/documents/state_fact_sheets/alaska.pdf). Ground Water Protection Council, 13308 N. MacArthur Blvd., Oklahoma City, OK 73142.
- Hansen, J.A., Lipton J., and Welsh P.G. 2002. *Environmental toxicology and chemistry*. 21 (3): 633-639
- Hastings, M.C. 2002. Clarification of the meaning of sound pressure levels and the known effects of sound on fish. Document in support of Biological Assessment for San Francisco-Oakland Bay Bridge East Span Seismic Safety Project. August 26, 2002. Revised August 27, 2002. 8 pp.
- Helvey, M. 2002. "Are southern California oil and gas platforms essential fish habitat?" *ICES Journal of Marine Science*. 59:S266-S271.
- Kenai Peninsula Borough. 2004. Cook Inlet Oil and Gas, Kenai Peninsula Borough Oil and Gas History. <http://www.cookinletoilandgas.org/kpb/history.htm>
- Kohler, C.C. and W.R. Courtenay, Jr. 1986. "Introduction of aquatic species." *Fisheries*. 11(2):39-42. Proceedings of the Seventh International Zebra Mussel and Aquatic Nuisance Species Conference. 1997.

- Koski, K.V. 1992. Restoring stream habitats affected by logging activities. Pages 343-404 in G. W. Thayer (editor) Restoring the nation's marine environment. Publication UM-SG-TS-92-06. Maryland Sea Grant College, College Park, MD.
- Larson, K. and C. Moehl. 1990. Entrainment of anadromous fish by hopper dredge at the mouth of the Columbia River. In C.A. Simenstad, ed. Effects of dredging on anadromous Pacific coast fishes. University of Washington Sea Grant. pp. 102-112.
- Levings, C.D. and T. G. Northcote. 2004. Effects of forestry on estuarine ecosystems supporting fishes. In T.G. Northcote and G.F. Hartman, editors, Fishes and Forestry Worldwide Watershed Interactions and Management, Blackwell Publishing, pp 320 -335.
- Longmuir, C. and T. Lively. 2001. Bubble curtain systems for use during marine pile driving. Report by Fraser River Pile & Dredge Ltd., New Westminster, British Columbia. 9 pp.
- Lotze, H., I. Milewski, B. Worm, and Z. Koller. 2003 Nutrient Pollution: A Eutrophication Survey of Eelgrass Beds in Estuaries and Coastal Bays in Northern and Eastern New Brunswick. Conservation Council of New Brunswick Inc.
- Luce, A. and M. Crowe. 2001. "Invertebrate terrestrial diversity along a gravel road on Barrie Island, Ontario, Canada." *Great Lakes Entomologist*. 34(1):55-60 SPR-SUM.
- Luoma, S.N. 1996. The developing framework of marine ecotoxicology: pollutants as a variable in marine ecosystems. *Journal of Experimental Marine Biology and Ecology* 200:29-55.
- Maser, C. and J.R. Sedell. 1994. From the Forest to the Sea: the Ecology of Wood in Streams, Estuaries and Oceans. St. Lucie Press, Delray Beach, FL. 200 pp.
- McGraw, K. and D. Armstrong. 1990. Fish entrainment by dredges in Grays Harbor, Washington. In C.A. Simenstad, ed. Effects of dredging on anadromous Pacific coast fishes. University of Washington Sea Grant. pp. 113-131.
- Mitsch WJ, Gosselink JG. 1993. Wetlands. 2nd ed. New York (NY): Van Nostrand Reinhold. 722 pp.
- Montgomery, D.R., R.D. Smith, K.M. Schmidt, and G.R. Pess. 1995. "Pool Spacing in Forest Channels." *Water Resources Research*. 31:1097-1105.
- NMFS. 2011. Impacts to Essential Fish Habitat from Non-fishing Activities in Alaska. National Marine Fisheries Service, Alaska Region. Juneau, Alaska. November, 2011.
- NMFS. 2008. Impacts to Marine Fisheries Habitat from Nonfishing Activities in the Northeastern United States. Northeast Regional Office Gloucester, Massachusetts NOAA Technical Memorandum NMFS-NE-209.
- NMFS. 2005. Final Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska, Appendix G Non-fishing Impacts to Essential Fish Habitat and Recommended Conservation Measures.
- NMFS. 2004. Draft National Gravel Extraction Policy. 1335 East-West Highway, Silver Spring, MD 20910. <http://www.nmfs.noaa.gov/habitat/habitatprotection/pdf/gravelguidance.pdf>
- NMFS. 2002. Environmental Assessment, NMFS' Restoration Plan for the Community-Based Restoration Program. Prepared by the NOAA Restoration Center, Office of Habitat Conservation. Silver Spring, MD.
- NMFS. 1998a. Draft document - Non-fishing threats and water quality: A reference for EFH consultation

- NMFS. 1998b. Final recommendations: Essential Fish Habitat for Pacific Coast Groundfish. Prepared by: The Core Team for EFH for Pacific Coast Groundfish June 3, 1998. 2725 Montlake Blvd. E. Seattle, WA 98112. [http://www.psmfc.org/efh/groundfish\\_desc.pdf](http://www.psmfc.org/efh/groundfish_desc.pdf).
- National Oceanic and Atmospheric Agency (NOAA). 2010. Office of Ocean and Coastal Resource Management. Ocean and Coastal Management in Alaska. <http://coastalmanagement.noaa.gov/mystate/ak.html>.
- National Research Council. 1999. Committee on Hardrock Mining. Hardrock Mining on Federal Lands. Appendix B. Potential Environmental Impacts of Hardrock Mining. ([http://www.nap.edu/html/hardrock\\_fed\\_lands/appB.html](http://www.nap.edu/html/hardrock_fed_lands/appB.html)).
- Nelson D, Miller J, Rusanowsky D, Greig R, Sennefelder G, Mercaldo-Allen R, Kuropat C, Gould E, Thurberg F, Calabrese A. 1991. Comparative reproductive success of winter flounder in Long Island Sound: a three-year study (biology, biochemistry, and chemistry). *Estuaries* 14(3):318-31.
- Newell, R.C., L.J. Seiderer, and D.R. Hitchcock. 1998. "The impact of dredging on biological resources of the sea bed." *Oceanography and Marine Biology Annual Review*. 36:127-178.
- Nightingale, B. and C.A. Simenstad. 2001a. Dredging activities: Marine issues. Washington State Transportation Center, University of Washington, Seattle, WA 98105. (Document available through the National Technical Information Service, Springfield, VA 22616).
- Nightingale, B. and C.A. Simenstad. 2001b. Overwater Structures: Marine Issues. White paper submitted to Washington Department of Fish and Wildlife, Washington Department of Ecology and Washington Department of Transportation. [www.wa.gov/wdfw/hab](http://www.wa.gov/wdfw/hab). 133 pp.
- North Pacific Fishery Management Council and NMFS. 2010. Essential Fish Habitat (EFH) 5-year Review for 2010 Summary Report: Final. April 2010. <http://alaskafisheries.noaa.gov/habitat/efh/review.htm>.
- Northcote, T.G. and G.F. Hartman. 2004. *Fishes and Forestry - Worldwide Watershed Interactions and Management*, Blackwell Publishing, Oxford, UK, 789 pp.
- Omori, M., S. Van der Spoel, C.P. Norman. 1994. Impact of human activities on pelagic biogeography. *Progress in Oceanography* 34 (2-3):211-219.
- Oregon Water Resource Research Institute (OWRRI). 1995. Gravel disturbance impacts on salmon habitat and stream health, volume 1. Summary report. Oregon State University, Corvallis, Oregon. (Also available Vol. II: Technical background report). Available from Oregon Division of State Lands, Salem, Oregon, 503-378-3805.
- OSPAR Commission. 2009. Assessment of Impacts of Mariculture . Publication Number: 442/2009. London, UK
- Pacific Fishery Management Council. 1999. Appendix A: Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon. Amendment 14 to the Pacific Coast Salmon Plan. Portland, OR. 146 pp.
- Packer, D.B., Griffin K., McGlynn K.E. 2005. National Marine Fisheries Service national gravel extraction guidance. Washington (DC): US Department of Commerce. NOAA Technical Memorandum NMFS-F/SPO-70. [cited 2008 Jul 15]. 27 p. Available from: <http://www.nmfs.noaa.gov/habitat/habitatprotection/anadfish/gravel.htm>.
- Phillips, R.C. 1984. The ecology of eelgrass meadows in the Pacific Northwest: a community profile. U.S. Fish and Wildlife Service. FWS/OBS-84/24. 85 pp.

- Ralph, S., G. Poole, L. Conquest, and R. Naiman. 1994. "Stream channel morphology and woody debris in logged and unlogged basins in western Washington." *Can. J. Fish. Aquatic Sciences*. 51:37-51.
- Reyff, J.A and P. Donovan. 2003. Benicia-Martinez Bridge Bubble Curtain Test - Underwater Sound Measurement Data. Memo to Caltrans dated January 31, 2003. 3 pp.
- Robinson W.E., and Pederson J. 2005. Contamination, habitat degradation, overfishing - An "either-or" debate? In: Buchsbaum R, Pederson J, Robinson WE, editors. The decline of fisheries resources in New England: evaluating the impact of overfishing, contamination, and habitat degradation. Cambridge (MA): MIT Sea Grant College Program; Publication No. MITSG 05-5. p 1-10.
- Rosecchi, E., A.J. Crivelli, G. Catsadorakis. 1993. The establishment and impact of *Pseudorabara parva*, an exotic fish species introduced into lake Mikri Prespa (northwestern Greece). *Aquatic Conservation: Marine and Freshwater Ecosystems* 3:223-231.
- Roy Consultants Ltd., NATECH Environmental Services Inc. and OCL Group. Environmental Management Consultants. 2003. Lamèque Bay environmental management study. Report No. 133-01.
- Scott G.I., M.H. Fulton, D.W. Moore, E.F. Wirth, G.T. Chandler, P.B. Key, J.W. Daugomah, E.D. Strozier, J. Devane, J.R. Clark, M.A. Lewis, D.B. Finley, W. Ellenberg, and K.J. Karnaky. 1999. "Assessment of risk reduction strategies for the management of agricultural nonpoint source pesticide runoff in estuarine ecosystems." *Toxicology and Industrial Health*. 15:200-213.
- Sedell, J.R., and K.J. Luchessa. 1982. Using the historical record as an aid to salmonid habitat enhancement. In Armantrout, N.B. (ed.), Acquisition and utilization of aquatic habitat inventory information, p. 210-222. American Fisheries Society, Western Division, Bethesda, MD.
- Sengupta, M. 1993. Environmental Impacts of Mining: Monitoring, Restoration, and Control. CRC Press, Inc. 2000 Corporate Blvd., N.W. Boca Raton, FL. 33431. p.1.
- Spence, B.C., G.A. Lomnický, R.M. Hughes, and R.P. Novitzki. 1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. ManTech Environmental Research Services Corp., Corvallis, OR. 356 pp. (Available from the NMFS Habitat Branch, Portland, OR).
- Stadler, J.H. 2002. Personal observation of fish-kill occurring during pile driving activity at the Winslow Ferry Terminal, Winslow, WA. October 7, 2002. Fish Biologist, DOC/NOAA/National Marine Fisheries Service/HCD, Lacey, WA.
- Stiles, S., J. Choromanski, D. Nelson, J. Miller, R. Grieg, and G. Sennefelder. 1991. Early reproductive success of the hard clam (*Mercenaria mercenaria*) from five sites in Long Island Sound. *Estuaries* 14(3):332-42.
- Stotz, T. and J. Colby. 2001. January 2001 dive report for Mukilteo wingwall replacement project. Washington State Ferries Memorandum. 5 pp. + appendices.
- Therriault, M.H., S.C. Courtenay, C. Godin and W.B. Ritchie. 2006. Evaluation of the Community Aquatic Monitoring Program (CAMP) to assess the health of four coastal areas within the southern Gulf of St. Lawrence with special reference to the impacts of effluent from seafood processing plants. *Can. Tech. Rep. Fish. Aquat. Sci.* 2649: vii + 60 p.
- Thurberg, F.P., and E. Gould. 2005. Pollutant effects upon cod, haddock, pollock, and flounder of the inshore fisheries of Massachusetts and Cape Cod Bays. In: Buchsbaum R, Pederson J, Robinson WE, editors. The decline of fisheries resources in New England: evaluating the impact of overfishing, contamination, and habitat degradation. Cambridge (MA): MIT Sea Grant College Program; Publication No. MITSG 05-5. p 43-66.

- Trombulak, S.C. and C.A. Frissell. 2000. "Review of ecological effects of roads on terrestrial and aquatic communities." *Conservation Biology*. 14(10):18-30. February.
- USDA Forest Service. 2008. Tongass Monitoring and Evaluation Report – Appendix B  
[http://www.fs.fed.us/r10/tongass/projects/tlmp/2008\\_monitoring\\_report/index2008.shtml](http://www.fs.fed.us/r10/tongass/projects/tlmp/2008_monitoring_report/index2008.shtml)
- USEPA. 2000a. Environmental Screening Checklist and Workbook for the Water Transportation Industry. August 2000.
- USEPA, Region 10. 2000b. Authorization to discharge under the National Pollutant Discharge Elimination System (NPDES) for Section 402 modifications of Section 404 permits for log Transfer Facilities which received a Section 404 permit prior to October 22, 1985. NPDES Permit Number AK-G70-0000. March 2000. 1200 Sixth Avenue, OW-130 Seattle, Washington 98101.
- USEPA. 1993. Guidance for specifying management measures for sources of nonpoint pollution in coastal waters. EPA Office of Water. 840-B-92-002. 500+ pp.
- Washington Department of Fish and Wildlife. 2009. Gold and fish. Rules for mineral prospecting and placer mining. 2nd edition. April 2009. Olympia, WA.
- Widdows J, Burns KA, Menon NR, Page D, Soria S. 1990. Measurement of physiological energetics (scope for growth) and chemical contaminants in mussel (*Arca zebra*) 220 transplanted along a contamination gradient in Bermuda. *Journal of Experimental Marine Biology and Ecology* 138:99-117.
- Williams, G.D. and R.M. Thom. 2001. Marine and estuarine shoreline modification issues. White paper submitted to Washington Department of Fish and Wildlife, Washington Department of Ecology and Washington Department of Transportation. [www.wa.gov/wdfw/hab/ahg](http://www.wa.gov/wdfw/hab/ahg). 99 pp.