



**Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion**

Consultation on the U.S. Environmental Protection Agency’s Proposed Approval of the State of Alaska’s Mixing Zone Regulation Section of the State of Alaska’s Water Quality Standards (Reinitiation)

**Environmental Consultation Organizer (ECO) Number: AKRO-2018-00362**

**Action Agency:** U.S. Environmental Protection Agency

**Affected Species and Determinations:**

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Beluga whale, Cook Inlet DPS ( <i>Delphinapterus leucas</i> )	Endangered	Yes	Yes	No	No
Bowhead whale ( <i>Balaena mysticetus</i> )	Endangered	No	N/A	No	N/A
North Pacific right whale ( <i>Eubalaena japonica</i> )	Endangered	No	No	No	No
Blue whale ( <i>Balaenoptera musculus</i> )	Endangered	No	N/A	No	N/A
Fin whale ( <i>Balaenoptera physalus</i> )	Endangered	No	N/A	No	N/A
Sei whale ( <i>Balaenoptera borealis</i> )	Endangered	No	N/A	No	N/A
Humpback whale, western North Pacific DPS ( <i>Megaptera novaeangliae</i> )	Endangered	No	N/A	No	N/A
Humpback whale, Mexico DPS ( <i>Megaptera novaeangliae</i> )	Threatened	No	N/A	No	N/A
Gray whale, western North Pacific DPS ( <i>Eschrichtius robustus</i> )	Endangered	No	N/A	No	N/A
Sperm whale ( <i>Physeter macrocephalus</i> )	Endangered	No	N/A	No	N/A
Steller sea lion, western DPS ( <i>Eumetopias jubatus</i> )	Endangered	No	No	No	No

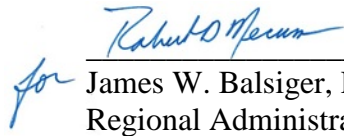


ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Bearded seal, Beringia DPS ( <i>Erignathus barbatus nauticus</i> )	Threatened	No	N/A	No	N/A
Ringed seal, Arctic subspecies ( <i>Pusa hispida hispida</i> )	Threatened	No	N/A	No	N/A
Green turtle, Central North Pacific and East Pacific DPSs ( <i>Chelonia mydas</i> )	Threatened	No	N/A	No	N/A
Loggerhead turtle, North Pacific Ocean DPS ( <i>Caretta caretta</i> )	Endangered	No	N/A	No	N/A
Olive ridley turtle ( <i>Lepidochelys olivacea</i> )	Threatened	No	N/A	No	N/A
Leatherback turtle ( <i>Dermochelys coriacea</i> )	Endangered	No	No	No	No
North American green sturgeon, Southern DPS ( <i>Acipenser medirostris</i> )	Threatened	No	No	No	No
Chum salmon, Hood Canal summer-run ESU ( <i>Oncorhynchus keta</i> )	Threatened	No	No	No	No
Chum salmon, Columbia River ESU ( <i>Oncorhynchus keta</i> )	Threatened	No	No	No	No
Coho salmon, Lower Columbia River ESU ( <i>Oncorhynchus kisutch</i> )	Threatened	No	No	No	No
Sockeye salmon, Snake River ESU ( <i>Oncorhynchus nerka</i> )	Endangered	No	No	No	No
Sockeye salmon, Ozette Lake ESU ( <i>Oncorhynchus nerka</i> )	Threatened	No	No	No	No
Chinook salmon, Lower Columbia River ESU ( <i>Oncorhynchus tshawytscha</i> )	Threatened	No	No	No	No
Chinook salmon, Upper Columbia River spring-run ESU ( <i>Oncorhynchus tshawytscha</i> )	Endangered	No	No	No	No
Chinook salmon, Puget Sound ESU ( <i>Oncorhynchus tshawytscha</i> )	Threatened	No	No	No	No

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Chinook salmon, Snake River fall-run ESU ( <i>Oncorhynchus tshawytscha</i> )	Threatened	No	No	No	No
Chinook salmon, Snake River spring/summer-run ESU ( <i>Oncorhynchus tshawytscha</i> )	Threatened	No	No	No	No
Chinook salmon, Upper Willamette River ESU ( <i>Oncorhynchus tshawytscha</i> )	Threatened	No	No	No	No
Steelhead trout, Lower Columbia DPS ( <i>Oncorhynchus mykiss</i> )	Threatened	No	No	No	No
Steelhead trout, Middle Columbia River DPS ( <i>Oncorhynchus mykiss</i> )	Threatened	No	No	No	No
Steelhead trout, Upper Columbia River DPS ( <i>Oncorhynchus mykiss</i> )	Threatened	No	No	No	No
Steelhead trout, Snake River Basin DPS ( <i>Oncorhynchus mykiss</i> )	Threatened	No	No	No	No
Steelhead trout, Upper Willamette River DPS ( <i>Oncorhynchus mykiss</i> )	Threatened	No	No	No	No
Steelhead trout, Puget Sound DPS ( <i>Oncorhynchus mykiss</i> )	Threatened	No	No	No	No

**Consultation Conducted By:** National Marine Fisheries Service, Alaska Region

**Issued By:**

  
 for James W. Balsiger, Ph.D.  
 Regional Administrator

**Date:**

July 2, 2019

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**ACRONYMS AND ABBREVIATIONS**

AAC	Alaska Administrative Code
ACR	acute to chronic ratio
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
AMMTAP	Alaska Marine Mammal Tissue Archival Project
APDES	Alaska Pollutant Discharge Elimination System
APE	alkylphenol ethoxylate
ATSDR	Agency for Toxic Substances and Disease Registry
BE	biological evaluation
BOD	biochemical oxygen demand
BPA	Bisphenol A
BTEX	benzene, toluene, ethylbenzene, and xylene
CCC	Criterion Continuous Concentration
CFR	U.S. Code of Federal Regulations
cm/s	centimeters per second
CMC	Criterion Maximum Concentration
COSEWIC	Committee on the State of Endangered Wildlife in Canada
CWA	Clean Water Act
dB	decibel
DDT	dichlorodiphenyltrichloroethane
DMR	Discharge Monitoring Report
DO	dissolved oxygen
DOT&PF	Alaska Department of Transportation and Public Facilities
DQA	Data Quality Act
EC <sub>20</sub>	concentration that resulted in an effect to 20 percent of the test organisms
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FAV	final acute value
FCV	final chronic value
ft	foot/feet
ft <sup>3</sup>	cubic feet
HBCD	hexabromocyclododecane
HCB	hexachlorobenzene

HCH	hexachlorohexane
HMW	high molecular weight
ICIS	Integrated Compliance Information System
IHA	incidental harassment authorization
in <sup>3</sup>	cubic inch(es)
IPCC	Intergovernmental Panel on Climate Change
ITS	incidental take statement
JBER	Joint Base Elmendorf Richardson
kg	kilogram(s)
km	kilometer(s)
km <sup>3</sup>	cubic kilometers
L	liter(s)
lb	pound(s)
LC <sub>50</sub>	lethal concentration of substance killing 50 percent of an exposed organism over a specific time interval
LC <sub>Low</sub>	a low level of morality that is still statistically different than the control mortality
LMW	low molecular weight
LNG	liquefied natural gas
m	meter(s)
m/s	meters per second
MF	membrane filter
MF trans, M-E , EIA	filtration using membrane-Enterococcus-Esculin iron agar
MFC	membrane-fecal coliform
mg	milligram(s)
mgpd	million gallons per day
MHW	mean high water
mL	milliliter(s)
MLLW	mean lower low water
MPN, EC med	most probable number, <i>Escherichia coli</i> medium
MZR	State of Alaska mixing zone regulation
<i>n</i>	sample size
NMFS	National Marine Fisheries Service
no.	number
NOAA	National Oceanic and Atmospheric Administration

NOEC	no observable effects concentration that was statistically different from control
NPDES	National Pollutant Discharge Elimination System
PAH	polycyclic aromatic hydrocarbon
PBDE	polybrominated diphenyl ether
PBF	physical or biological feature
PCB	polychlorinated biphenyl
PCE	primary constituent element
PFAS	perfluoroalkyl and polyfluoroalkyl substances
PFOS	perfluorooctane sulfonate
PFOSA	perfluorooctane sulfonamide
pg	picogram(s)
POA	Port of Alaska
re 1 $\mu$ Pa rms	references to 1 micropascal rms
rms	root-mean-square
SSD	species sensitivity distribution
SU	standard units
TAH	total aromatic hydrocarbons
TAqH	total aqueous hydrocarbons
TSS	total suspended solids
TU <sub>a</sub>	toxicity units, acute (100/LC50)
TU <sub>c</sub>	toxicity units, chronic (100/no observed effect concentration)
UCI management unit	Upper Cook Inlet management unit
$\mu$ g	microgram(s)
UIA	un-ionized ammonia
USFWS	U.S. Fish and Wildlife Service
$\bar{x}$	mean
WQBEL	water quality based effluent limit
WQC	water quality criterion/criteria
WQS	Water Quality Standards
WWTF	wastewater treatment facility
ZOD	zone of deposit

## 1 Introduction

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1536(a)(2)) requires each Federal agency to ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When a Federal agency's action "may affect" a protected species, that agency is required to consult with the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS), depending upon the endangered species, threatened species, or designated critical habitat that may be affected by the action (50 CFR 402.14(a)). Federal agencies may fulfill this general requirement informally if they conclude that an action may affect, but "is not likely to adversely affect" endangered species, threatened species, or designated critical habitat, and NMFS or USFWS concurs with that conclusion (50 CFR 402.14(b)).

Section 7(b)(3) of the ESA requires that at the conclusion of consultation, NMFS and/or USFWS provide an opinion stating how the Federal agency's action is likely to affect ESA-listed species and their critical habitat. If incidental take is reasonably certain to occur, section 7(b)(4) of the ESA requires the consulting agency to provide an Incidental Take Statement (ITS) that specifies the impact of any incidental taking, specifies those reasonable and prudent measures necessary to minimize such impact, and sets forth terms and conditions to implement those measures.

The U.S. Environmental Protection Agency (EPA) is proposing to approve revisions to the State of Alaska's mixing zone regulation section of the State of Alaska Administrative Code (18 AAC 70.240) for Alaska Water Quality Standards (WQS) (18 AAC 70) that were adopted into Alaska law on March 23, 2006 (hereafter referred to as the MZR). By letter dated August 14, 2006, the Alaska Department of Environmental Conservation (ADEC) formally submitted the newly adopted MZR to EPA for approval.

In this document, the action agency is EPA, which proposes to approve the MZR. The consulting agency for this proposed action is NMFS's Alaska Region. This document represents NMFS's biological opinion (opinion) on the effects of this action on endangered and threatened species and designated critical habitats under NMFS's jurisdiction.

As described in more detail below, in 2006 NMFS first completed section 7 consultation on the effects of the proposed action on ESA-listed species and their critical habitat. Consultation was reinitiated in 2010 to the address effects of the proposed action on the newly listed endangered Cook Inlet beluga whale, and we issued a biological opinion the same year. The 2010 opinion did not address the effects of the proposed action on Cook Inlet beluga whale critical habitat, which NMFS designated in 2011. This was the impetus behind EPA's subsequent request for reinitiation of consultation and our issuance of this opinion.

The opinion and ITS were prepared by NMFS in accordance with section 7(b) of the ESA (16 U.S.C. 1531–1544), and implementing regulations at 50 CFR Part 402. The opinion and ITS are in compliance with the Data Quality Act (44 U.S.C. 3504(d)(1)) and underwent pre-dissemination review.

## 1.1 Background

This opinion considers the effects of EPA approval of the MZR. This action has the potential to affect the endangered and threatened species and designated critical habitats under NMFS's jurisdiction identified in Table 1. This opinion is based on information provided in EPA's December 19, 2016, *Biological Evaluation for Cook Inlet Beluga Whale Designated Critical Habitat and EPA's Proposed Approval of Alaska's Revised Mixing Zone Regulation* (BE) (EPA 2016b), a report prepared under contract to assist NMFS with the effects analysis (ECO49 2018), NMFS' 2010 opinion on effects of the proposed action on Cook Inlet beluga whales (NMFS 2010), documents submitted by EPA to inform the previous ESA section 7 consultations with NMFS on the proposed action (EPA 2006c, 2009), email and telephone conversations between NMFS Alaska Region and EPA, and other sources of information. A complete record of this consultation is on file at NMFS's Anchorage, Alaska office.

## 1.2 Consultation History

ADEC originally incorporated, with EPA approval, mixing zone provisions into the State of Alaska's WQS in 1979 and since that time the provisions have been revised several times. EPA last fully approved a revised version of the mixing zone provisions in 1988 (EPA 2006c). As explained above, the MZR, which EPA proposes to approve, is the revised version that was incorporated into Alaska law on March 23, 2006, and submitted to EPA for review on August 14, 2006 (see Appendix A). Subsequently, ADEC transmitted to EPA by letter on February 13, 2009, implementation guidance for the MZR (ADEC 2009; hereafter referred to as the MZR Guidance). Rather than providing comprehensive guidance, this non-regulatory guidance focuses on significant revisions to the MZR and how Alaska interprets and intends to implement the MZR.

On September 29, 2006, EPA submitted its *Revisions to the Mixing Zone Regulations of Alaska State Water Quality Standards Biological Assessment* (EPA 2006c), which addressed the effects of the proposed action on the following endangered or threatened species under NMFS's jurisdiction and their designated critical habitats: bowhead whale (*Balaena mysticetus*), northern right whale<sup>1</sup> (*Eubalaena glacialis*), blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*), humpback whale<sup>2</sup> (*Megaptera novaeangliae*), sperm (*Physeter macrocephalus*) whale, Steller sea lion (eastern<sup>3</sup> and western distinct population segments [DPSs]), Snake River evolutionarily significant unit (ESU) of sockeye salmon (*Oncorhynchus nerka*), and Snake River fall- and spring/summer-run ESUs of

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<sup>1</sup> On March 6, 2008, NMFS listed the endangered northern right whale as two separate endangered species, North Pacific right whale (*Eubalaena japonica*) and North Atlantic right whale (*Eubalaena glacialis*) (73 FR 12024). On April 8, 2008, NMFS designated as critical habitat for the North Pacific right whale the same two areas that NMFS had previously designated as critical habitat for the northern right whale in the Pacific Ocean (73 FR 19000).

<sup>2</sup> On October 11, 2016, NMFS divided the globally-listed endangered humpback whale into 14 DPSs, removed the species-level listing, and in its place listed four of the DPSs as endangered and one as threatened (81 FR 62259). The endangered western North Pacific DPS and threatened Mexico DPS of humpback whale occur in waters off the coast of Alaska.

<sup>3</sup> On November 4, 2013, NMFS determined that that the eastern DPS of Steller sea lion no longer met the definition of an endangered or threatened species under the ESA and removed it from the List of Endangered and Threatened Wildlife (78 FR 66140).

Chinook salmon (*Oncorhynchus tshawytscha*). Although the 2006 revision of the existing mixing zone provisions was the impetus for EPA to initiate section 7 consultation with NMFS, EPA had not previously consulted with NMFS on the mixing zone provisions. Consequently, EPA and NMFS agreed that the consultation would encompass EPA approval of the entire MZR and not just the incremental change due to revisions. On August 5, 2008, NMFS concurred by letter with EPA's determination that its approval of the MZR was not likely to adversely affect northern right, sei, blue, fin, and sperm whales, Snake River sockeye salmon, and Snake River spring/summer Chinook salmon. As discussed in the letter, NMFS also determined that the action was not likely to adversely affect bowhead and humpback whales, Steller sea lions, Snake River fall Chinook salmon, and designated critical habitats for northern right whales and Steller sea lions (no critical habitat was designated in Alaska for any of the other listed species). The proposed action remains the same and we have not identified any new information that reveals effects of the action that may affect these species or critical habitat in a manner or to an extent not previously considered. Therefore, we maintain our previous determinations that the proposed action is not likely to adversely affect the aforementioned species and critical habitats. Information and analyses contained in the letter of concurrence is incorporated into this opinion by reference, unless updated herein.

Although the Cook Inlet beluga whale was addressed in the biological assessment/evaluation that was submitted in 2006, at that time the species was not listed as endangered under the ESA, though the population was a candidate species. NMFS chose not to consult on Cook Inlet beluga whales pending the listing decision. NMFS listed Cook Inlet beluga whales as endangered on October 22, 2008 (73 FR 62919). On April 15, 2009, NMFS received a letter from EPA requesting reinitiation of section 7 consultation to analyze the effects of EPA approval of the MZR on the newly listed Cook Inlet beluga whale. Included with the letter of request from EPA was a document entitled *Cook Inlet Beluga Whale Effects Analysis for Alaska's Mixing Zone WQS Revisions* (EPA 2009). NMFS subsequently requested further information from EPA, and all the components necessary to initiate formal consultation were received by April 14, 2010. NMFS issued an opinion on December 20, 2010, and concluded EPA approval of the MZR was not likely to jeopardize the continued existence of the Cook Inlet beluga whale (NMFS 2010). The proposed action (EPA approval of the MZR) remains the same and we have not identified any new information that reveals effects of the action that may affect this species in a manner or to an extent not previously considered. Therefore, we maintain our determination that the proposed action is not likely to jeopardize the continued existence of the Cook Inlet beluga whale. Information and analyses from the 2010 opinion are incorporated into this opinion by reference, unless updated herein.

On April 11, 2011, NMFS issued a final rule designating critical habitat for the Cook Inlet beluga whale (76 FR 20180). In a letter dated December 9, 2011, EPA requested NMFS's concurrence under section 7 of the ESA with EPA's determination that approval of the MZR was not likely to adversely affect Cook Inlet beluga whale critical habitat. EPA based its determination upon the results of the formal consultation between EPA and NMFS on the Cook Inlet beluga whale, which concluded in December 2010. According to EPA, NMFS's opinion (NMFS 2010) did not identify any adverse effects on the "Cook Inlet beluga whale or its habitat." EPA expressed the view that a conclusion that an action will not jeopardize the continued existence of a species "would not be complete without consideration of the action's effects on the species' habitat", i.e., the conclusion that the EPA actions would not result in

jeopardy to the Cook Inlet beluga whale inherently means that the action would not adversely modify critical habitat. In a letter dated January 6, 2012, NMFS informed EPA that it had not provided sufficient evidence for a “not likely to adversely affect” determination, in that: “[t]he conclusion of the 2010 opinion was simply that insufficient data and/or evidence existed at that time to indicate that exposure to mixing zone contaminants resulted in pathology and/or mortality to Cook Inlet beluga whales”; and “the [opinion] was specific to the Cook Inlet beluga whale as a species and did not include an assessment of proposed critical habitat through the conference process.”

During August 2012, NMFS discussed the matter further with EPA by phone and email; and EPA re-engaged on the matter by phone and email over the course of the latter half of 2014, and again in early 2016, when EPA informed NMFS that it was in the process of developing the BE addressing Cook Inlet beluga whale critical habitat. On July 1 and 13, 2016, and November 17, 2016, EPA provided to NMFS by email draft versions of portions of the BE for discussion.

On December 20, 2016, NMFS received a letter from EPA requesting reinitiation of formal consultation on the effects of EPA approval of the MZR following designation of Cook Inlet beluga whale critical habitat, along with the final version of the BE. EPA determined the proposed action is likely to adversely affect three of the physical or biological features (PBFs) of Cook Inlet beluga whale critical habitat, specifically: (1) intertidal and subtidal waters of Cook Inlet with depths less than 30 feet (ft) mean lower low water (MLLW) and within 5 miles of high and medium flow anadromous fish streams; (2) primary prey species consisting of four species of Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole; and (3) waters free of toxins or other agents of a type and amount harmful to Cook Inlet beluga whales. EPA also determined the proposed action is not likely to adversely affect unrestricted passage within or between the critical habitat areas (PBF 4), and will have no effect on PBF 5 (waters with in-water noise below levels resulting in the abandonment of critical habitat areas by Cook Inlet beluga whales). In discussing the draft versions of the BE with EPA, and in follow-up to receipt of the request for formal consultation, NMFS noted that the Alaska Region anticipated seeking outside technical support to assist in evaluating the supplemental analysis, and that this could affect the timeframe for the consultation. NMFS subsequently sought review of the BE by two NMFS staff in the West Coast Region with water quality and ESA section 7 expertise.

In March 2017, NMFS received written comments from the two NMFS reviewers. Concurrently, NMFS arranged for a contractor to aid in assessing the BE. The contractor developed a draft report to supplement the BE, and the draft report was subsequently revised several times in response to NMFS comments on the drafts, including numerous clarifying emails and phone discussions. In February 2018, a final version of the report was submitted to NMFS (ECO49 2018). This opinion includes information presented in this report; however, due to errors and certain deficiencies that NMFS identified in the document, the report is not hereafter referenced directly. Rather, relevant information contained in the report was first corrected and modified as necessary before being included in this opinion.

On April 6, 2018, following NMFS's receipt and final review of the ECO49 report (ECO49 2018), NMFS notified EPA by email that all the necessary information had been received and that formal consultation could be reinitiated. Concurrently, pursuant to the *Revised Interagency*



*Cooperative Policy Regarding the Role of State Agencies in Endangered Species Act Activities* (81 FR 8663; February 22, 2016), NMFS sent a notification letter to the Alaska Department of Fish and Game (ADF&G). NMFS did not receive information from ADF&G in response to this letter.

NMFS believes that the proposed action may also affect the following ESA-listed species under our jurisdiction that were not addressed in our previous analyses: western North Pacific DPS of gray whale (*Eschrichtius robustus*), Beringia DPS of bearded seal (*Erignathus barbatus nauticus*)<sup>4</sup>, Arctic ringed seal (*Pusa hispida hispida*)<sup>5</sup>, five listed species/DPSs of sea turtles, Southern DPS of North American green sturgeon (*Acipenser medirostris*; hereafter, “green sturgeon”), and several listed salmonid stocks (see Table 1). Therefore, in addition to analyzing the effects of the proposed action on Cook Inlet beluga whale critical habitat as requested by EPA in its request for reinitiation, this opinion also analyzes the potential effects of the proposed action on these species.

On May 9, 2019, NMFS provided EPA with a copy of the draft biological opinion on the proposed action. On June 28, 2019, EPA indicated via email that it was not requesting any changes to the draft biological opinion.

## 2 Description of the Proposed Action and Action Area

“Action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies. “Interrelated actions” are those that are part of a larger action and depend on the larger action for their justification. “Interdependent actions” are those that have no independent utility apart from the action under consideration (50 CFR 402.02).

### 2.1 General Overview

In this section we provide a general overview of WQS and provisions addressing mixing zones based primarily on information provided by EPA (EPA 2006c, 2016b). The proposed action remains the same as was described in the 2010 opinion. For clarity, and to update the status of the administration of National Pollutant Discharge Elimination System (NPDES) permit program we include an updated description of the action here. The WQS program administered by EPA is authorized by the Clean Water Act (CWA), which defines broad water quality goals and provides the statutory basis for WQS. Within the CWA is a requirement that all states adopt legally binding WQS and that EPA review and approve these standards. A WQS defines the water quality goals of a waterbody by designating the use or uses to be made of the water, by setting criteria necessary to protect the uses (i.e., water quality criteria [WQC]), and by preventing or limiting degradation of water quality through anti-degradation provisions. For example, the Alaska WQS specify WQC relative to beneficial or designated water use classes and subclasses that include: water supply; water recreation; growth and propagation of fish,

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<sup>4</sup> The Beringia DPS of bearded seal was listed as threatened under the ESA on December 28, 2012 (77 FR 76704). The listing was vacated by the U.S. District Court for the District of Alaska on July 25, 2014. This decision was reversed by the U.S. Court of Appeals for the Ninth Circuit, and the listing was reinstated on May 12, 2017.

<sup>5</sup> The Arctic ringed seal was listed as threatened under the ESA on December 28, 2012 (77 FR 76706). The listing was vacated by the U.S. District Court for the District of Alaska on March 11, 2016. This decision was reversed by the U.S. Court of Appeals for the Ninth Circuit, and the listing was reinstated on May 15, 2018.

shellfish, other aquatic life, and wildlife; and harvesting for consumption of raw mollusks or other raw aquatic life (18 AAC 70). States may, at their discretion, adopt certain policies affecting the application and implementation of state WQS, which may include policies concerning mixing zones. A state mixing zone policy is a legally binding policy that is adopted into the state's WQS and describes the general characteristics and requirements for authorizing a mixing zone in a discharge permit (or certification). EPA reviews such policies to ensure they are compatible with state WQS, technically well-founded, and consistent with the CWA.

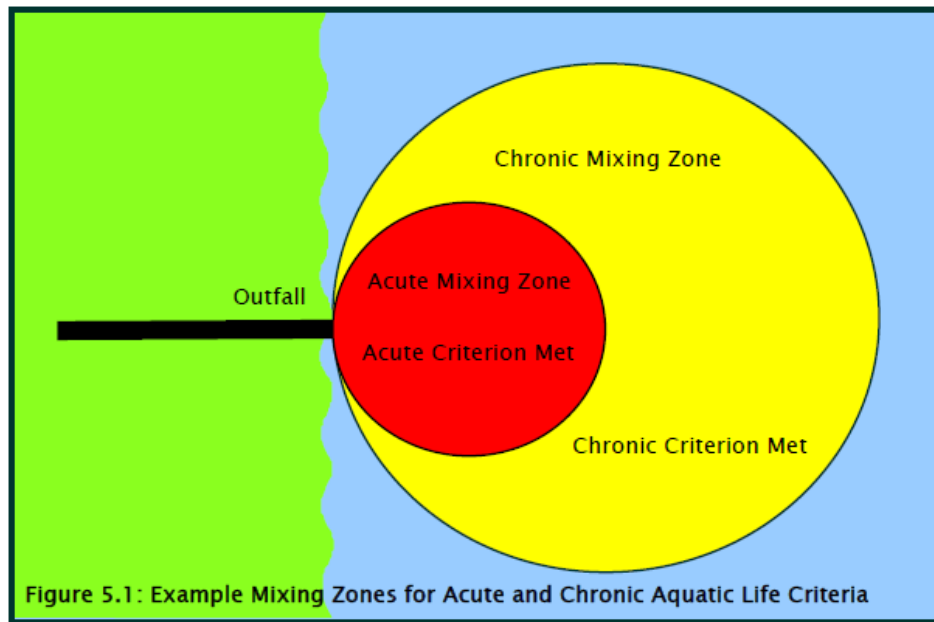
EPA guidance explains that it is not always necessary to meet all applicable WQC within the discharge pipe to protect the integrity of the water body as a whole. Rather, it is possible to allow for ambient concentrations to exceed the criteria in small areas for a short duration within a defined limited area, i.e., "mixing zone," and still maintain the designated use of the waterbody as a whole (EPA 2014). The basic premise of a mixing zone is that the capacity for dilution of the receiving waters is sufficient to allow for specified WQC to be met within an acceptable distance beyond the end of the effluent pipe rather than at the point of discharge. EPA guidance also states that "[f]or aquatic life criteria, there may be up to two types of mixing zones: one for the acute criterion and one for the chronic criterion," with the acute mixing zone "sized to prevent lethality to passing organisms" (EPA 2014). Consistent with this guidance, ADEC's MZR Guidance (ADEC 2009) states that acute aquatic life criteria may be exceeded within a smaller "initial mixing/acute zone" within the larger authorized mixing zone (often referred to as the chronic mixing zone), though the acute criteria may not be exceeded at the edge of the acute zone, and certain size limitations must be met (Figure 1). The term "acute" is defined in the Alaska WQS at 18 AAC 70.990(1) as "...of, relating to, or resulting from a level of toxicity of a substance, a substance combination, or an effluent sufficient to produce observable lethal or sublethal effects in aquatic organisms exposed for short periods of time, typically 96 hours or less." The term "chronic" is defined in the Alaska WQS at 18 AAC 90.990(11) as "...of, relating to, or resulting from a level of toxicity of a substance, a substance combination, or an effluent sufficient to produce observable lethal or sublethal effects, including effects on growth, development, behavior, reproduction, or survival, in aquatic organisms exposed for a period of time that generally is one-tenth or more of their life span." A mixing zone, therefore is a limited area or volume of water where initial dilution of a discharge takes place, and within which specified WQC may be exceeded, but lethality to organisms passing through a mixing zone is prevented.

As authorized by the CWA and administered by EPA, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Under the NPDES program, all facilities which discharge pollutants from any point source into waters of the United States are required to obtain an NPDES permit. EPA may authorize states, territories, or tribes to implement all or parts of the national program. EPA administered the program in Alaska until permitting authority was transferred to the State of Alaska, through the Alaska Pollution Discharge Elimination System (APDES) Program, beginning in 2008. The phased transfer was completed in October 2012. Under the APDES Program, EPA delegated to the State of Alaska authority to issue new permits and re-issue NPDES permits, as well as to assume compliance monitoring and enforcement responsibilities. Facilities permitted under the APDES Program include domestic wastewater treatment facilities (WWTFs), log storage and transfer facilities, seafood processors, fish hatcheries, mines, and oil and gas facilities. APDES permits are also

required for storm water, cooling water intakes and discharges, munitions, and pretreatment of industrial wastes discharged to municipal wastewater systems. EPA retained permitting and enforcement authority over some facilities in Alaska. These include Federal facilities located in Denali National Park and Preserve, facilities located in Indian Country, facilities operating outside state waters, and facilities issued CWA section 301(h) waivers from secondary treatment standards.

Each NPDES/APDES permit identifies the pollutants that are expected to be released and establishes effluent limits for these pollutants to ensure that the existing water uses and the level of water quality necessary to protect existing uses (e.g., the WQC set out in the Alaska WQS) are maintained and protected. For point source discharges, the CWA requires that permit limitations on the particular pollutants in the effluent authorized for discharge be the more stringent of either technology-based treatment requirements or water quality-based effluent limits (WQBELs). As explained in the BE, technology-based requirements, in short, are set according to the level of treatment determined to be achievable by a group of discharges with common characteristics using available technology, regardless of the assimilative capacity of any particular waterbody that may receive a discharge. WQBELs are established on a case-by-case basis when either technology-based requirements do not exist for the pollutants of concern or are not stringent enough to ensure that the WQS of a waterbody are met. The consideration of the need for WQBELs is generally limited to those pollutants for which EPA has developed numeric WQC guidance that the state has adopted into its WQS. Monitoring requirements must also be included in the permit to determine compliance with effluent limitations. Additional effluent and/or ambient monitoring may also be required under the permit to gather data for future effluent characterization and permit development. Although a WQBEL may in certain cases require WQC to be met at the point of discharge, often WQBELs reflect the allowance of dilution in a regulatory mixing zone.

In Alaska, an applicant can request authorization for a mixing zone (or multiple mixing zone) by ADEC in a discharge permit. Though the burden of proof for justifying and establishing a mixing zone lies with the applicant, ADEC has the ultimate discretion in evaluating, authorizing or denying a mixing zone. Evidence presented must reasonably demonstrate that the designated uses and overall biological integrity of the water body will be maintained and that the mixing zone conforms to the requirements and considerations set out in the MZR (see Appendix A and summary in Section 2.2). Requirements include that the mixing zone will not: result in acute or chronic toxic effects (as defined under the Alaska WQS) outside the boundary of the mixing zone, reduce fish or shellfish populations, result in irreparable displacement of indigenous organisms, or adversely affect threatened or endangered species except as authorized under 16 U.S.C. 1531–1544 (ESA).



**Figure 1. Mixing zone configuration and WQC (from EPA 2014).**

## 2.2 Summary of Alaska Mixing Zone Regulations

A complete copy of the MZR is provided in the Appendix A to this opinion. The following are descriptions of the MZR that EPA proposes to approve, as provided in the BE:

- Section 18 AAC 70.240(a) establishes the authority for ADEC to authorize mixing zones in which WQC may be exceeded, places the burden of demonstrating that a mixing zone would comply with 18 AAC 70.240 on the applicant, and makes it clear that mixing zones are not entitlements by specifying that ADEC has the option to approve, approve with condition, or deny a mixing zone application.
- Section 18 AAC 70.240(b) contains a list of factors ADEC is to consider in determining whether to authorize a mixing zone, which include biological, chemical, and physical characteristics of the receiving water; effluent characteristics; the effects that a discharge would have on the receiving water's use, including cumulative effects of multiple sources, point and nonpoint; and any other factors ADEC finds must be considered to determine whether a mixing zone will comply with 18 AAC 70.240.
- Section 18 AAC 70.240(c) contains a list of conditions upon which ADEC's approval of a mixing zone is contingent. This section provides that minimum treatment requirements of state and federal law are to be applied to discharges, and that designated and existing uses and the biological integrity of the water body are to be protected. There are also a number of "the mixing zone will not" provisions that are more specific to the protection of critical resources. Those provisions prohibit acute and chronic toxicity outside of a mixing zone; protect existing water supply and contact recreation uses; protect established processing activities or established commercial, sport, personal-use, or subsistence fish and shellfish harvesting; prohibit reduction of fish and shellfish populations; prohibit permanent or irreparable displacement of indigenous organisms; prohibit adverse effects to threatened or endangered species except as authorized under

the ESA; and prohibit mixing zones from forming a barrier to migratory species or fish passage.

- Section 18 AAC 70.240(d) contains a list of conditions for in-zone water quality (i.e., the quality of water within a mixing zone) upon which ADEC's approval of a mixing zone is contingent. These provisions prohibit pollutants that bioaccumulate, bioconcentrate, or persist above natural levels in sediments, water, or biota to significantly adverse levels; settle to form objectionable deposits (except as authorized under 18 AAC 70.210); produce floating debris, oil, scum, etc., that form nuisances; cause lethality to passing organisms; or that exceed acute aquatic life criteria at and beyond the boundaries of an initial acute mixing zone.
- Section 18 AAC 70.240(k) provides that mixing zones are to be as small as practicable and specifies mixing zone "size limitations" for various waterbody types. Those size limitations are allowed to be increased, however, upon demonstration that it can be done safely.
- Section 18 AAC 70.240(m) specifies that if a mixing zone is having a significant unforeseen adverse environmental effect, ADEC will terminate, modify, or deny renewal of the permit or certification authorizing the mixing zone.
- Section 18 AAC 70.240(l) specifies receiving water design flows for streams rivers, and other flowing fresh waters that are to be used in calculating maximum pollutant discharge limitations, and sections 18 AAC 70.240(e), (f), (g), (h), (i), (j), (n), (o), and (p) are related to spawning areas and mixing zones in lakes, streams, rivers, and other flowing fresh waters.

### **2.3 Mixing Zone Regulation Provisions that Address Effects of the Proposed Action**

EPA identified the following selected provisions of the MZR (see Appendix A to this opinion for the full text of the MZR) as most relevant to considering the potential effects of authorization of mixing zones on species listed under the ESA and their designated critical habitats:

- (c) The department will approve a mixing zone, as proposed or with conditions, only if the department finds that available evidence reasonably demonstrates that
- (2) designated and existing uses of the waterbody as a whole will be maintained and protected;
  - (3) the overall biological integrity of the waterbody will not be impaired; and
  - (4) the mixing zone will not
    - (A) result in an acute or chronic toxic effect in the water column, sediments, or biota outside the boundaries of the mixing zone;
    - (D) result in a reduction in fish or shellfish population levels;
    - (E) result in permanent or irreparable displacement of indigenous organisms;
    - (F) adversely affect threatened or endangered species except as authorized under 16 U.S.C. 1531–1544 (Endangered Species Act); or
    - (G) form a barrier to migratory species or fish passage.
- (d) The department will approve a mixing zone, as proposed or with conditions, only if the department finds that available evidence reasonably demonstrates that within the mixing zone the pollutants discharged will not

- (1) bioaccumulate, bioconcentrate, or persist above natural levels in sediments, water, or biota to significantly adverse levels, based on consideration of bioaccumulation and bioconcentration factors, toxicity, and exposure;
- (3) settle to form objectionable deposits, except as authorized under 18 AAC 70.210;
- (4) produce floating debris, oil, scum and other material in concentrations that form nuisances;
- (7) cause lethality to passing organisms; or
- (8) exceed acute aquatic life criteria at and beyond the boundaries of a smaller initial mixing zone surrounding the outfall, the size of which shall be determined using methods approved by the department.

In addition, the following provisions of the MZR are most pertinent with respect to the effects of the proposed action in fresh water:

- (e) In lakes, streams, rivers, or other flowing fresh waters, a mixing zone will not be
  - (1) authorized in a spawning area of any of the five species of anadromous Pacific salmon found in the state; or
  - (2) allowed to adversely affect the present and future capability of an area to support spawning, incubation, or rearing of any of the five species of anadromous Pacific salmon found in the state.<sup>6</sup>

## 2.4 Action Area

“Action area” means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). For this reason, the action area is typically larger than the project area and extends out to a point where no measurable effects from the proposed action occur. Under the CWA, state WQS apply to surface waters within state boundaries. The line of ordinary low water and the line marking the seaward limit of inland waters are known as “baseline”. Within the first 3 nautical miles (5.6 kilometers [km]) seaward from the baseline, state boundaries overlap with the territorial seas of the United States. Territorial seas are defined as “the belt of the seas measured from the line of ordinary low water along that portion of the coast which is in direct contact with the open sea and the line marking the seaward limit of inland waters, and extending seaward a distance of three [nautical] miles” (CWA section 502(8)). Therefore, NMFS defined the action area to include all the surface waters of the State of Alaska and marine waters within state boundaries up to 3 nautical miles from baseline (Figure 2).

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<sup>6</sup> It should be noted that the MZR also provides at 18 AAC 70.240(i) that: “The provisions of (e), (f), and (g) of this section do not apply to the renewal of a mixing zone authorization where spawning was not occurring at the time of the initial authorization, but successful spawning, incubation, and rearing has occurred within the mixing zone after the initial authorization of that mixing zone.”



**Figure 2. The action area for this opinion includes the surface waters of Alaska and marine waters within state boundaries up to 3 nautical miles from baseline**

### 3 Approach to the Assessment

Section 7(a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. The jeopardy analysis considers both survival and recovery of the species. The adverse modification analysis considers the impacts to the conservation value of the designated critical habitat.

“To jeopardize the continued existence of a listed species” means to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR 402.02). As NMFS explained when it promulgated this definition, NMFS considers the likely impacts to a species’ survival as well as likely impacts to its recovery. Further, it is possible that in certain exceptional circumstances, injury to recovery alone may result in a jeopardy biological opinion (51 FR 19926, 19934; June 3, 1986).

Under NMFS’s regulations, the destruction or adverse modification of critical habitat “means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features” (50 CFR 402.02).

The designations of critical habitat for species that occur within the action area use the term primary constituent element (PCE) or essential features. The critical habitat regulations (81 FR

7414) that became effective March 14, 2016, replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a “destruction or adverse modification” analysis, which is the same regardless of whether the original designation identified primary constituent elements (PCEs), PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature.

We use the following approach to determine whether the proposed action described in Section 2 is likely to jeopardize the continued existence of listed species or destroy or adversely modify critical habitat:

- Identify the current status of listed species and critical habitat likely to be affected by the proposed action (Section 4 of this opinion). We determine the rangewide status of the critical habitat by examining the condition of the PBFs, which were identified when the critical habitat was designated.
- Describe the environmental baseline including: past and present impacts of Federal, state, or private actions and other human activities in the action area; anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation; and the impacts of state or private actions that are contemporaneous with the consultation in process (Section 5 of this opinion).
- Analyze the effects of the proposed action. Identify the listed species that are likely to co-occur with these effects in space and time and the nature of that co-occurrence (these represent our exposure analyses). NMFS also evaluates the proposed action’s effects on critical habitat features. The effects of the action are described in Section 6 of this opinion, with the exposure analysis described in Section 6.3.
- Once we identify which listed species and PBFs of critical habitat are likely to be exposed to the action’s effects and the nature of that exposure, we examine the scientific and commercial data available to determine whether and how they are likely to respond given their exposure (i.e., our response analyses). The response analyses are considered in Sections 6.4 of this opinion.
- Describe any cumulative effects (Section 7 of this opinion). Cumulative effects, as defined in NMFS’s implementing regulations (50 CFR 402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered because they require separate ESA section 7 consultation.
- Integrate and synthesize the above factors to assess the risk that the proposed action poses to listed species and critical habitat (Section 8 of this opinion). In this step, NMFS adds the effects of the action (Section 6) to the environmental baseline (Section 5) and the cumulative effects (Section 7) to assess whether the action could reasonably be expected to: (1) appreciably reduce the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated critical habitat for the conservation of the species. These assessments are made in full consideration of the status of the species and critical habitat (Section 4).
- Reach jeopardy and adverse modification conclusions, which flow from the logic and rationale presented in the “Integration and Synthesis” (Section 8) of this opinion. Conclusions are presented in Section 9 of this opinion.



If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence of ESA-listed species or destroy or adversely modify designated critical habitat, we try to identify a reasonable and prudent alternative to the action, which must not be likely to jeopardize the continued existence of ESA-listed species nor adversely modify their designated critical habitat and it must meet other regulatory requirements. For all analyses, we use the best available scientific and commercial data.

#### 4 Rangewide Status of the Species and Critical Habitat

The following species listed as endangered or threatened under the ESA under NMFS's jurisdiction may occur within the action area and have the potential to be affected by the proposed action (Table 1). The action area also includes critical habitat for North Pacific right whales, Cook Inlet beluga whales, and Steller sea lions (Table 1) that may be affected by the proposed action. No critical habitat has been designated in Alaska for any of the other species identified in Table 1.

**Table 1. ESA listing status and critical habitat designation for species under NMFS's jurisdiction that have the potential to be affected by the proposed action.**

Species	Status	Listing	Critical Habitat
Bowhead whale ( <i>Balaena mysticetus</i> )	Endangered	NMFS 1970, <a href="#">35 FR 18319</a>	Not designated
North Pacific right whale ( <i>Eubalaena japonica</i> )	Endangered	NMFS 2008, <a href="#">73 FR 12024</a>	Not designated
Blue whale ( <i>Balaenoptera musculus</i> )	Endangered	NMFS 1970, <a href="#">35 FR 18319</a>	Not designated
Fin whale ( <i>Balaenoptera physalus</i> )	Endangered	NMFS 1970, <a href="#">35 FR 18319</a>	Not designated
Sei whale ( <i>Balaenoptera borealis</i> )	Endangered	NMFS 1970, <a href="#">35 FR 18319</a>	Not designated
Humpback whale, western North Pacific DPS ( <i>Megaptera novaeangliae</i> )	Endangered	NMFS 2016, <a href="#">81 FR 62259</a>	Not designated
Humpback whale, Mexico DPS ( <i>Megaptera novaeangliae</i> )	Threatened	NMFS 2016, <a href="#">81 FR 62259</a>	Not designated
Gray whale, western North Pacific DPS ( <i>Eschrichtius robustus</i> )	Endangered	NMFS 1970, <a href="#">35 FR 18319</a>	Not designated
Sperm whale ( <i>Physeter macrocephalus</i> )	Endangered	NMFS 1970, <a href="#">35 FR 18319</a>	Not designated
Beluga whale, Cook Inlet DPS ( <i>Delphinapterus leucas</i> )	Endangered	NMFS 2008, <a href="#">73 FR 62919</a>	NMFS 2011, <a href="#">76 FR 20180</a>
Steller sea lion, western DPS ( <i>Eumetopias jubatus</i> )	Endangered	NMFS 1997, <a href="#">62 FR 24345</a>	NMFS 1993, <a href="#">58 FR 45269</a>
Bearded seal, Beringia DPS ( <i>Erignathus barbatus nauticus</i> )	Threatened	NMFS 2012, <a href="#">77 FR 76740</a>	Not designated
Ringed seal, Arctic subspecies ( <i>Pusa hispida hispida</i> )	Threatened	NMFS 2012, <a href="#">77 FR 76706</a>	Not designated

Species	Status	Listing	Critical Habitat
Green turtle, Central North Pacific and East Pacific DPSs ( <i>Chelonia mydas</i> )	Threatened	NMFS 2016, <a href="#">81 FR 20058</a>	No designated
Loggerhead turtle, North Pacific Ocean DPS ( <i>Caretta caretta</i> )	Endangered	NMFS 2011, <a href="#">76 FR 58868</a>	Not designated
Olive ridley turtle ( <i>Lepidochelys olivacea</i> )	Threatened	NMFS 1978, <a href="#">43 FR 32800</a>	Not designated
Leatherback turtle ( <i>Dermochelys coriacea</i> )	Endangered	NMFS 1970, <a href="#">35 FR 8491</a>	NMFS 2012, <a href="#">77 FR 4170</a>
North American green sturgeon, Southern DPS ( <i>Acipenser medirostris</i> )	Threatened	NMFS 2006, <a href="#">71 FR 17757</a>	NMFS 2009, <a href="#">74 FR 52300</a>
Chum salmon, Hood Canal summer-run ESU ( <i>Oncorhynchus keta</i> )	Threatened	NMFS 2005, <a href="#">70 FR 37160</a>	NMFS 2005, <a href="#">70 FR 52630</a>
Chum salmon, Columbia River ESU ( <i>Oncorhynchus keta</i> )	Threatened	NMFS 2005, <a href="#">70 FR 37160</a>	NMFS 2005, <a href="#">70 FR 52630</a>
Coho salmon, Lower Columbia River ESU ( <i>Oncorhynchus kisutch</i> )	Threatened	NMFS 2005, <a href="#">70 FR 37160</a>	NMFS 2016, <a href="#">81 FR 9252</a>
Sockeye salmon, Snake River ESU ( <i>Oncorhynchus nerka</i> )	Endangered	NMFS 2005, <a href="#">70 FR 37160</a>	NMFS 1993, <a href="#">58 FR 68543</a>
Sockeye salmon, Ozette Lake ESU ( <i>Oncorhynchus nerka</i> )	Threatened	NMFS 2005, <a href="#">70 FR 37160</a>	NMFS 2005, <a href="#">70 FR 52630</a>
Chinook salmon, Lower Columbia River ESU ( <i>Oncorhynchus tshawytscha</i> )	Threatened	NMFS 2005, <a href="#">70 FR 37160</a>	NMFS 2005, <a href="#">70 FR 52630</a>
Chinook salmon, Upper Columbia River spring-run ESU ( <i>Oncorhynchus tshawytscha</i> )	Endangered	NMFS 2005, <a href="#">70 FR 37160</a>	NMFS 2005, <a href="#">70 FR 52630</a>
Chinook salmon, Puget Sound ESU ( <i>Oncorhynchus tshawytscha</i> )	Threatened	NMFS 2005, <a href="#">70 FR 37160</a>	NMFS 2005, <a href="#">70 FR 52630</a>
Chinook salmon, Snake River fall-run ESU ( <i>Oncorhynchus tshawytscha</i> )	Threatened	NMFS 2005, <a href="#">70 FR 37160</a>	NMFS 2005, <a href="#">70 FR 52630</a>
Chinook salmon, Snake River spring/summer-run ESU ( <i>Oncorhynchus tshawytscha</i> )	Threatened	NMFS 2005, <a href="#">70 FR 37160</a>	NMFS 2005, <a href="#">70 FR 52630</a>
Chinook salmon, Upper Willamette River ESU ( <i>Oncorhynchus tshawytscha</i> )	Threatened	NMFS 2005, <a href="#">70 FR 37160</a>	NMFS 2005, <a href="#">70 FR 52630</a>
Steelhead trout, Lower Columbia DPS ( <i>Oncorhynchus mykiss</i> )	Threatened	NMFS 2006, <a href="#">71 FR 834</a>	NMFS 2005, <a href="#">70 FR 52630</a>
Steelhead trout, Middle Columbia River DPS ( <i>Oncorhynchus mykiss</i> )	Threatened	NMFS 2006, <a href="#">71 FR 834</a>	NMFS 2005, <a href="#">70 FR 52630</a>
Steelhead trout, Upper Columbia River DPS ( <i>Oncorhynchus mykiss</i> )	Threatened	NMFS 2006, <a href="#">71 FR 834</a>	NMFS 2005, <a href="#">70 FR 52630</a>
Steelhead trout, Snake River Basin DPS ( <i>Oncorhynchus mykiss</i> )	Threatened	NMFS 2006, <a href="#">71 FR 834</a>	NMFS 2005, <a href="#">70 FR 52630</a>
Steelhead trout, Upper Willamette River DPS ( <i>Oncorhynchus mykiss</i> )	Threatened	NMFS 2006, <a href="#">71 FR 834</a>	NMFS 2005, <a href="#">70 FR 52630</a>
Steelhead trout, Puget Sound DPS ( <i>Oncorhynchus mykiss</i> )	Threatened	NMFS 2007, <a href="#">72 FR 26722</a>	NMFS 2016, <a href="#">81 FR 9252</a>

#### **4.1 Species and Critical Habitat Not Likely to be Adversely Affected by the Proposed Action**

If an action's effects on ESA-listed species will be insignificant, discountable, or completely beneficial, we conclude that the action is not likely to adversely affect those species and further analysis is not required. Insignificant effects relate to the size of impact and are those that one would not be able to meaningfully measure, detect, or evaluate, and should never reach the scale where take occurs. Discountable effects are those that are extremely unlikely to occur. Similarly, if proposed activities are not likely to destroy or adversely modify critical habitat, further analysis is not required.

Mixing zones within the action area are currently associated with various industrial activities as well as municipal WWTFs (EPA 2006c, NMFS 2010, EPA 2016b). Mixing zones authorized under the MZR, which EPA proposes to approve, may result in small localized areas of reduced water quality, accumulations of contaminants in the sediments, degraded benthic habitat, and related impacts on aquatic communities. Resultant effects on listed species may include bioaccumulation of contaminants and consequent health effects and degradation or reductions in usable habitat (e.g., reductions in prey quantity and/or quality). In addition, certain chemicals, e.g., copper, have been found to alter olfaction in salmonids, which may affect their ability to avoid toxicants, as well as their homing and migration (see Section 6.3.2.1.3 for additional information).

As discussed in Section 1.2, in a letter dated August 5, 2008, NMFS concurred with EPA's determination that the proposed action is not likely to adversely affect northern right, sei, blue, fin, and sperm whales, Snake River sockeye salmon, and Snake River spring/summer-run Chinook salmon. At that time, NMFS also determined that the action is not likely to adversely affect bowhead and humpback whales, Steller sea lions, Snake River fall-run Chinook salmon and critical habitat designated for northern right whales and Steller sea lions (no critical habitat was designated in Alaska for any of the other listed species). Although for a few of these species, the listing status has been updated since 2008 (see Section 1.2), we have not identified any effects to these species (as currently listed) or their designated critical habitats that were not previously considered. Therefore, we maintain our previous determinations for bowhead whales, North Pacific right whales, blue whales, fin whales, sei whales, the western North Pacific and Mexico DPSs of humpback whales, sperm whales, the western DPS of Steller sea lions, Snake River sockeye salmon, Snake River spring/summer- and fall-run Chinook salmon, and critical habitat designated for North Pacific right whales and Steller sea lions.

We have concluded that the western North Pacific DPS of gray whale, Beringia DPS of bearded seal, Arctic ringed seal, as well as listed sea turtles, and other listed fishes identified above in Table 1, are not likely to be adversely affected by the proposed action. Our findings for these species are summarized below. Because the critical habitats designated for leatherback turtles and listed fishes are located outside the action area, we do not discuss them further in this opinion.

#### 4.1.1 Western North Pacific DPS of Gray Whale

The gray whale is a large baleen whale that is found in the North Pacific Ocean and adjacent seas, where it occurs as two recognized stocks: the western North Pacific and the eastern North Pacific (Carretta et al. 2016). The gray whale was listed as endangered under the Endangered Species Conservation Act on December 2, 1970 (35 FR 18319), and continued to be listed as endangered following passage of the ESA, having been severely depleted by commercial whaling (Weller 2010). Although the western North Pacific gray whale is listed as endangered under the ESA, the eastern North Pacific gray whale was delisted in 1994 when it was determined the stock had recovered (59 FR 31094; June 16, 1994).

The range of the western North Pacific gray whale includes summering areas in the Okhotsk Sea off Sakhalin Island and the southeastern Kamchatka Peninsula, and wintering areas in the western and eastern Pacific Ocean (Mate et al. 2015, Cooke 2018). The most recent stock assessment estimated the non-calf size of the western North Pacific gray whale stock in 2012 at 140 individuals (standard error  $\pm$  6), with the population showing a 10-year (2002 to 2012) average annual rate of increase of 3.3 percent (Carretta et al. 2016). Information on the whale's migratory routes and winter habitats are limited. Tagging data show that some gray whales that summer off Sakhalin Island migrate through the Bering Sea and Gulf of Alaska to the west coast of the North America in winter (Mate et al. 2015).

Additional information on gray whale biology and habitat is available at:

<https://www.fisheries.noaa.gov/species/gray-whale>

<https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-species-stock>

Given that gray whales of the western North Pacific DPS are uncommon in Alaskan waters, and their occurrence in these waters is seasonal and migratory, it is extremely unlikely that these whales would experience adverse effects from the proposed action. In addition, given the mobility of this species, any exposure to mixing zones would be transient. We therefore conclude that any such effects are insignificant and discountable.

#### 4.1.2 Beringia DPS of Bearded Seal

The bearded seal exists as two widely recognized subspecies: *E. b. barbatus*, often described as inhabiting the Atlantic sector, and *E. b. nauticus*, inhabiting the Pacific sector of the range (Cameron et al. 2010). Based on evidence of discreteness and ecological uniqueness of bearded seals in the Sea of Okhotsk, NMFS determined that the *E. b. nauticus* subspecies consists of two DPSs, which are both listed as threatened under the ESA: the Okhotsk DPS in the Sea of Okhotsk and the Beringia DPS encompassing the remainder of the subspecies' range (77 FR 76740; December 28, 2012). Only the Beringia DPS is found in U.S. waters, and this portion is recognized by NMFS as the only Alaska stock (Muto et al. 2018). The ESA listing determination and related status review of the bearded seal identified ongoing and projected reductions in the extent and timing of sea ice stemming from climate change as the principal threat to the persistence of the Beringia DPS (Cameron et al. 2010; 77 FR 76740, December 8, 2012).

Reliable abundance estimates are not available for the entire Beringia DPS or for the Alaska stock (Cameron et al. 2010, Muto et al. 2018). However, as summarized by Muto et al. (2018), using a very limited sub-sample of the data collected from the U.S. portion of the Bering Sea in 2012, Conn et al. (2014) calculated an estimate of approximately 299,174 (95 percent confidence interval: 245,476 to 360,544) bearded seals in these waters.

Bearded seals inhabit seasonally ice-covered waters over the continental shelf of the Bering, Beaufort, and Chukchi Seas, where they use ice as a haul-out platform, particularly during whelping, rearing of pups, and molting (Cameron et al. 2010). Bearded seals have been reported to prefer moving ice that produces natural openings and areas of open water and they usually avoid areas of continuous, thick, shorefast ice (e.g., Burns and Frost 1979, Nelson et al. 1984, Kingsley et al. 1985). To remain associated with their preferred ice habitat, bearded seals generally move north in late spring and summer as the ice melts and retreats, and then move south in the fall as sea ice forms (Burns and Frost 1979, Burns 1981, Frost et al. 2008, Boveng and Cameron 2013, Breed et al. 2018). However, acoustic recordings indicate that at least some male bearded seals occur in the Beaufort and Chukchi Seas nearly year-round (MacIntyre et al. 2013, MacIntyre et al. 2015, Frouin-Mouy et al. 2016). A small number of bearded seals, primarily juveniles, remain near the coasts of the Bering and Chukchi Seas during summer and early fall and have been observed in small and bays and some rivers (Burns 1981, Nelson 1982, Huntington 2000a).

Bearded seals feed primarily on benthic organisms, including a variety of epifaunal and infaunal invertebrates and demersal fishes (Cameron et al. 2010). They are also able to switch their diet to include schooling pelagic fishes when advantageous (Finley and Evans 1983, Antonelis et al. 1994, Quakenbush and Citta 2009).

Additional information on bearded seal biology and habitat is available at:

<https://www.fisheries.noaa.gov/species/bearded-seal>

<https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-species-stock>

Bearded seals may be affected by pollutants associated with mixing zones authorized under the MZR primarily through consumption of exposed prey items and/or due to small localized reductions in prey quantity and/or quality that may be associated with some mixing zones. However, we expect that any such effects would be very small and we consider them to be insignificant for the following reasons:

- The mobility of bearded seals makes it unlikely that these seals would be present within the vicinity of a mixing zone for more than very minimal length of time, thus any exposure would be transient.
- Mixing zones authorized under the MZR are expected to overlap with a very small portion of the overall habitat used by these seals.
- Application of the provisions of the MZR, including those sections identified in Section 2.3 generally serve to moderate the impacts of mixing zones.

### 4.1.3 Arctic Subspecies of Ringed Seal

Arctic ringed seals have a circumpolar distribution and are found in all seasonally ice-covered seas of the Northern Hemisphere, including the U.S. Beaufort, Chukchi, and Bering Seas, where they are found as far south as Bristol Bay in years of extensive ice coverage (Frost 1985, Kelly 1988, Kelly et al. 2010b). The ESA listing determination and related status review of the ringed seal identified ongoing and projected reductions in sea ice, and in particular on-ice snow cover, stemming from climate change as the principal threat to the persistence of the Arctic ringed seal (Kelly et al. 2010a; 77 FR 76706, December 28, 2012).

NMFS proposed critical habitat for the Arctic ringed seal in the northern Bering, Chukchi, and Beaufort Seas off of Alaska on December 9, 2014 (79 FR 73010). The proposed rule discussed the following PBFs essential to the conservation of Arctic ringed seals: (1) sea ice habitat suitable for the formation and maintenance of subnivean birth lairs; (2) sea ice habitat suitable as a platform for basking and molting; and (3) primary prey resources to support Arctic ringed seals, which were defined to be Arctic cod, saffron cod, shrimps, and amphipods.

Reliable estimates of abundance are not available for the entire Arctic ringed seal population or for the U.S. portion of the seals' distribution, which is recognized as the Alaska stock (Kelly et al. 2010b, Muto et al. 2018). As summarized by Muto et al. (2018), using a very limited subsample of the data collected from the U.S. portion of the Bering Sea in 2012, Conn et al. (2014) calculated an estimate of 170,000 ringed seals in these waters. According to Muto et al. (2018), this estimate did not account for availability bias and did not include ringed seals in the shorefast ice zone, which was surveyed using a different method; therefore, the actual number of ringed seals in the U.S. Bering Sea is likely much higher, perhaps by a factor of two or more.

Arctic ringed seals occur in both shorefast and pack ice and show a strong affinity for ice-covered waters throughout their range (Kelly 1988, Kelly et al. 2010b). Most ringed seals that winter in the Bering and Chukchi seas are thought to migrate northward in spring as the seasonal ice melts and retreats and spend summer in the pack ice of the northern Chukchi and Beaufort seas, as well as in nearshore ice remnants (Burns 1970, Frost 1985, Crawford et al. 2012). Ringed seals are also dispersed in areas of the Bering, Chukchi, and Beaufort Seas during the open-water period (79 FR 73010; December 9, 2014).

As discussed by Kovacs (2014), Arctic ringed seals appear to favor landfast ice as whelping habitat (e.g., Smith and Stirling 1975, Lydersen and Gjertz 1986). However, there is some evidence indicating that ringed seal densities are low in water depths of less than 3 meters (m) (10 ft) (Moulton et al. 2002, Richardson and Williams 2004). Ringed seal whelping has also been observed on both nearshore and offshore drifting pack ice (e.g., Lentfer 1972, Finley et al. 1983, Wiig et al. 1999). As noted by Reeves (1998), nearly all research on Arctic ringed seal reproduction has been conducted on landfast ice, and the potential importance of stable but drifting pack has not been adequately investigated.

During the open water season, when ringed seals forage most intensively, some seals may remain in nearshore waters to feed, while others travel extensively and feed farther offshore (Frost 1985, Gjertz et al. 2000, Freitas et al. 2008, Kelly et al. 2010a, Harwood et al. 2012, Von Duyke et al.

2017). Arctic ringed seals eat a wide variety of prey spanning several trophic levels, and regional and seasonal differences in diet have been reported (Kelly et al. 2010b).

Additional information on ringed seal biology and habitat is available at:

<https://www.fisheries.noaa.gov/species/ringed-seal>

<https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-species-stock>

Arctic ringed seals may be affected by pollutants associated with mixing zones authorized under the MZR primarily through consumption of exposed prey items and/or due to small localized reductions in prey quantity and/or quality that may be associated with some mixing zones. However, we expect that any such effects would be very small and we consider them to be insignificant for the following reasons:

- The mobility of ringed seals makes it unlikely that these seals would be present within the vicinity of a mixing zone for more than a very minimal length of time, thus any exposure would be transient.
- Mixing zones authorized under the MZR are expected to overlap with a very small portion of the overall habitat used by these seals.
- Application of the provisions of the MZR, including those sections identified in Section 2.3 generally serves to moderate the impacts of mixing zones.

#### 4.1.4 Listed Sea Turtles

Four species of sea turtles have been detected in Alaska: green (*Chelonia mydas*), loggerhead (*Caretta caretta*), olive ridley (*Lepidochelys olivacea*), and leatherback turtles (*Dermochelys coriacea*) (Parker Hodge and Wing 2000). Although there is no recent published information available regarding occurrence of sea turtles in Alaskan waters, Parker Hodge and Wing (2000) summarized infrequent reports of turtles in Alaskan waters from 1960 through 1998. Green, loggerhead, and olive ridley are hard shell sea turtles, which rarely stray into cold waters (Mrosovsky 1980, Eckert 1993). The few sightings of hard shell turtles (green, loggerhead, and olive ridley) reported by Parker Hodge and Wing (2000) involved individuals that were either cold-stressed, likely to become cold-stressed, or already deceased. Thus, Parker Hodge and Wing (2000) suggested that these species were straying beyond their normal range. In contrast, leatherback sea turtles are cold-tolerant (Parker Hodge and Wing 2000). More than half of the limited sightings of sea turtles in Alaska compiled by Parker Hodge and Wing (2000) were leatherbacks, and the authors suggested that this species was ranging into marginal habitat that may not be consistently used from year to year.

Threats to these species include, among others, loss and degradation of foraging and nesting habitats, fisheries interactions (e.g., bycatch and vessel strikes), harvest (the principal cause of the historical declines in these species), and other anthropogenic factors (e.g., entrainment in intake channels and ingestion of marine debris) (NMFS 2013, NMFS 2014; 81 FR 20058, April 6, 2016; 76 FR 58868, September 22, 2011).

Additional information on the biology and habitat of green, loggerhead, olive ridley, and leatherback turtles is available at:



<https://www.fisheries.noaa.gov/species/green-turtle>  
<https://www.fisheries.noaa.gov/species/loggerhead-turtle>  
<https://www.fisheries.noaa.gov/species/olive-ridley-turtle>  
<https://www.fisheries.noaa.gov/species/leatherback-turtle>

Given that green, loggerhead, olive ridley, and leatherback turtles are mobile species that are uncommon in Alaskan waters, it is very unlikely that these turtles would experience adverse effects from the proposed action. In addition, given the mobility of this species, any exposure to mixing zones would be transient. We therefore conclude that any such effects are insignificant and discountable.

#### **4.1.5 Southern DPS of North American Green Sturgeon**

Two DPSs of the North American green sturgeon are recognized based on significant genetic differences: the northern DPS, ranging from spawning populations from the Eel River north to the Klamath and Rogue Rivers, and the southern DPS, which only spawns in the Sacramento River basin (NMFS 2015). NMFS listed the southern DPS of green sturgeon as threatened under the ESA in 2006 due to loss of spawning habitat, overharvest, and entrainment threats (71 FR 17757; April 7, 2006).

Juvenile green sturgeon spend 1 to 4 years in fresh and estuarine waters before they leave for saltwater (Adams et al. 2007). They then disperse widely in the ocean. Subadult and adult movements in the ocean are not well known, but green sturgeon have been captured in marine waters from Baja California to the Bering Sea. They typically remain in waters less than 100 m deep (Lindley et al. 2008). North American green sturgeon make a long-distance seasonal migration along the continental shelf of North America (Lindley et al. 2008). This includes a northward migration in fall, overwintering north of Vancouver Island, British Columbia, and south of Southeast Alaska, and southward return in the spring. NMFS (2018b) discussed that green sturgeon are long-lived and show spawning site fidelity in natal streams (Poytress et al. 2011). After maturity is reached at about 15 years of age, adults of the Southern DPS typically return to spawn in their natal streams every 3 to 4 years (Brown 2007, Poytress et al. 2012, NMFS 2018b). These sturgeon do not spawn in Alaska (NMFS 2018b).

NMFS (2015) discussed that anecdotal sightings and fisheries observer data indicate green sturgeon are observed infrequently in Alaskan waters and noted that telemetry data and genetic analyses suggested that Southern DPS green sturgeon generally occur seasonally (overwintering) south from Graves Harbor, Alaska. Lindley et al. (2008) tagged 213 sub-adult and adult Northern and Southern DPS green sturgeon from Oregon, Washington, and California and observed only one tagged green sturgeon taken in a commercial gillnet fishery in southeast Alaska, providing further evidence that green sturgeon occur infrequently in Alaskan waters. The tagged green sturgeon was later confirmed as belonging to the Southern DPS (NMFS 2015).

Additional information on the biology and habitat of green sturgeon can be found at:

<https://www.fisheries.noaa.gov/species/green-sturgeon>

Green sturgeon occur infrequently in Alaskan waters and it is therefore very unlikely that these fish would experience adverse effects from the proposed action. In addition, given the mobility



of this species, any exposure to mixing zones is very likely to be transient. Application of the provisions of the MZR, including those sections identified in Section 2.3, also generally serve to moderate the impacts of mixing zones. Consequently, we expect any such effects of the proposed action on listed green sturgeon would also be immeasurably small. Therefore, we conclude that effects of the proposed action on the Southern DPS of green sturgeon are insignificant and discountable.

#### **4.1.6 Listed Salmonids**

Eleven ESUs of Pacific salmon and six DPSs of steelhead listed under the ESA may occur in Alaskan waters (Table 1). As discussed in the listing determinations, there are a number of factors that contributed to declines in many West Coast salmonid stocks and led to NMFS's listing under the ESA of 28 of these stocks, including: overfishing, loss of freshwater and estuarine habitat, hydropower development, poor ocean conditions, and hatchery practices. Salmon and steelhead from the listed stocks are potentially present in Alaska waters strictly as juveniles or older age classes because their spawning and larval life stages occur only in freshwater streams in the Pacific Northwest.

NMFS (2016a) described the early ocean migration patterns of Pacific Northwest salmonids as follows. In general, sockeye, chum, and spring Chinook salmon move rapidly north varying distances along the continental shelf, as far north as Alaska; fall Chinook remain in local waters; and coho salmon display two general patterns: some move rapidly north along the coastal shelf, while others remain in local waters during the first summer before moving north (Myers et al. 1996, Burke et al. 2013, Fisher et al. 2014, Hayes and Kocik 2014). Steelhead generally exhibit a unique marine migration pattern and move directly offshore and apparently west across the North Pacific Ocean (Myers et al. 1996, Daly et al. 2014). There can also be large variation within these general groups. There is limited stock-specific information available on the ocean life history and ecology of Pacific Northwest salmonids beyond the end of their first ocean year of life until they return to coastal waters of the Pacific Northwest to spawn (e.g., Northwest Fisheries Science Center 2017).

Additional information on the biology and habitat of ESA-listed salmonids can be found in the five-year status reviews, the listing determinations (see Table 1), and recovery plans for these stocks. Key aspects of the life phases of chum, coho, sockeye, and Chinook salmon in Cook Inlet are also discussed in Section 4.2.5.2 of this opinion.

Although the presence of listed salmonid stocks in Alaskan waters has been documented in a number of studies via recovery of tagged fish and analysis of genetic data (e.g., Crane et al. 2000, Templin and Seeb 2004, Morris et al. 2007, Tucker et al. 2012, Beacham et al. 2014, Fisher et al. 2014, Tucker et al. 2015), these studies suggest that they comprise a small percentage of the salmon and steelhead, particularly of sockeye salmon, that occur within the action area. In addition, it is expected that any exposure to mixing zones would very likely be transient given the mobility of juvenile and older age classes of salmon and steelhead. Mixing zones authorized under the MZR are expected to overlap with a very small portion of the coastal action area (EPA 2006c) and provisions of the MZR, including those sections identified in Section 2.3, would generally serve to moderate the impacts of mixing zones. The effects of the

proposed action on listed salmonid stocks are therefore expected to be immeasurably small, and thus we consider any such effects of the proposed action on listed salmonids to be insignificant.

## **4.2 Status of Cook Inlet Beluga Whales and Critical Habitat**

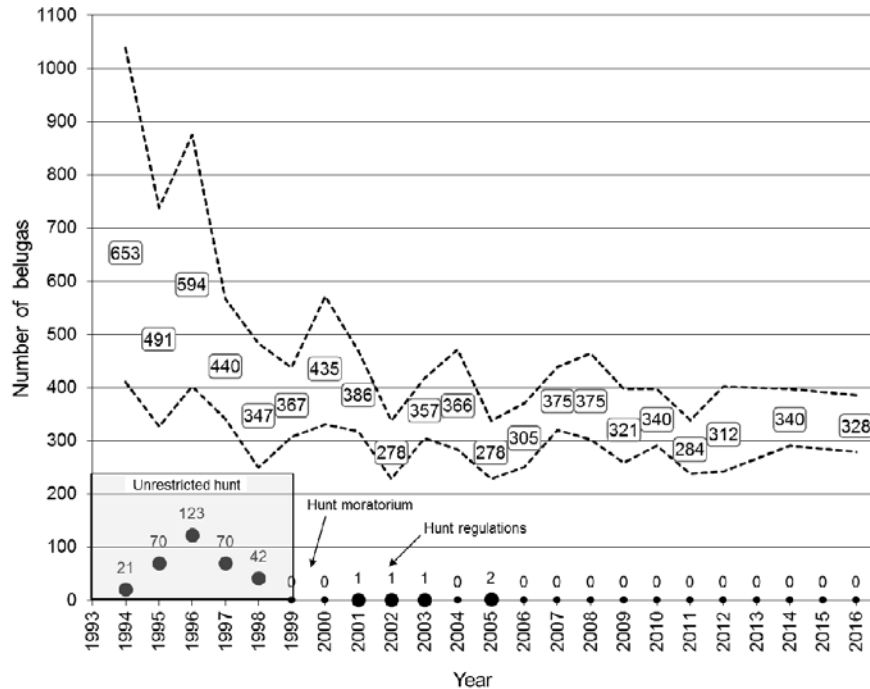
The 2010 opinion determined that the proposed action is not likely to jeopardize the continued existence of the Cook Inlet beluga whale. This conclusion remains valid and is unchanged. Nevertheless, we include here an updated examination of the status of the endangered Cook Inlet beluga whale to help inform our analysis of the effects of the proposed action on the species' critical habitat. The status is determined by the level of extinction risk that the Cook Inlet beluga whale faces, based on parameters considered in documents such as the species' most recent stock assessment report (Muto et al. 2018), conservation plan (NMFS 2008), recovery plan (NMFS 2016b), and listing decision (73 FR 62919; October 22, 2008). This section of the opinion also examines the condition of critical habitat throughout the designated area, and discusses the current function of the essential PBFs that help to form the conservation value for the Cook Inlet beluga whale.

In the summaries that follow, we focus on aspects of Cook Inlet beluga whale biology and ecology that are relevant to the effects of the proposed action. More detailed information regarding Cook Inlet beluga whale status and trends, and their biology and ecology, is available from the NMFS website at: <https://www.fisheries.noaa.gov/species/beluga-whale#overview>.

### **4.2.1 Population Status**

Beluga whales inhabiting Cook Inlet are one of five distinct stocks found in Alaska (Muto et al. 2018). The Cook Inlet stock is the most isolated of the five stocks; it is separated from the others by the Alaska Peninsula and resides throughout the year in Cook Inlet (Laidre et al. 2000, Goetz et al. 2012) north of a line from Cape Douglas to Cape Elizabeth (72 FR 19854; April 20, 2007).

The best available historical abundance estimate of the Cook Inlet beluga whale population was from a survey in 1979, which resulted in an estimate of 1,293 whales (Calkins 1989). NMFS began conducting comprehensive and systematic aerial surveys of the beluga population in 1993. These surveys documented a decline in beluga abundance from 653 whales in 1994 to 347 whales in 1998, a decline of nearly 50 percent (Hobbs et al. 2000). In response to this decline, on May 31, 2000, NMFS designated the Cook Inlet beluga whale population as depleted under the Marine Mammal Protection Act (65 FR 34590). After measures were established in 1999 to limit subsistence harvests, NMFS expected the population to grow at an annual rate of 2 to 6 percent. However, abundance estimated from the 1999 to 2008 aerial surveys showed the expected population growth did not occur (Figure 3). This lack of population growth led NMFS to list the Cook Inlet beluga whale as endangered under the ESA on October 22, 2008 (73 FR 62919). Although only five Cook Inlet belugas have been harvested since 1999 and none since 2005, the population has continued to decline (NMFS 2016b). The most recent (2016) population estimate is 328 (range: 279 to 386 whales) Cook Inlet belugas, with the trend for the last 10 survey years (2006 to 2016) showing a rate of decline of -0.5 percent per year (Shelden et al. 2017).



**Figure 3. Abundance estimates for beluga whales in Cook Inlet with 95 percent confidence intervals for coefficients of variation (dashed lines). The annual rate of decline was -13.7 percent per year from 1994 to 1998 when harvest was unrestricted. The 10-year trend from 2006 to 2016 was -0.5 percent per year. The reported annual number of beluga whales reported harvested for subsistence uses is indicated along the x-axis. Figure from Shelden et al. (2017).**

#### 4.2.2 Natural History

The beluga whale is a small, toothed (Odontocete) whale in the family Monodontidae, a family shared with only the narwhal. Beluga whales are known as “white whales” because the adults are white. Beluga calves are born dark to brownish gray and lighten to white or yellow-white with age. Adult Cook Inlet belugas average 3.6 to 4 m (12 to 14 ft) in length (NMFS 2008), although Alaska Native hunters have reported some may grow to 6 m (20 ft) (Huntington 2000b).

Beluga whales are long-lived and have a relatively slow reproductive cycle, giving birth to a single calf every two or more years. Most calving in Cook Inlet has been assumed to occur from mid-May to mid-July (e.g., Calkins 1989). However, a beluga photo-identification study conducted in Cook Inlet from late spring to early fall of 2005 to 2016 documented observations of beluga newborns beginning in mid-July and ending in mid-October (McGuire et al. 2016, McGuire et al. 2017). Young beluga whales are nursed for at least a year, and likely longer in some cases (NMFS 2016b).

Beluga whales are extremely social and often travel and interact in close, dense groups. Groups of 200 or more beluga whales have been observed in the Susitna Delta area (Beluga River to Little Susitna River) between mid-July and early August, when salmon runs were underway (McGuire and Stephens 2017, McGuire et al. 2017). Beluga whales are among the most vocal of

the cetaceans, making a wide variety of sounds that they use to communicate, navigate, and locate prey.

Although beluga whales remain year-round in Cook Inlet, they demonstrate seasonal movements within the Inlet. In the spring, beluga whales in Cook Inlet appear to feed extensively on concentrations of spawning eulachon. These fish first enter the upper Inlet in April, with two major spawning migrations occurring in the Susitna River in May and June (Barrett et al. 1984, Calkins 1989). Cook Inlet belugas then shift to foraging on salmon as eulachon runs diminish and adult salmon return to spawning streams (NMFS 2016b). Beluga whales also feed on other prey that occur in shallow coastal waters, such as saffron cod (Hobbs et al. 2008). During summer and fall, beluga whales are concentrated in the Susitna Delta area, Knik Arm, Turnagain Arm, and Chickaloon Bay (Hobbs et al. 2005, Goetz et al. 2012, Shelden et al. 2015, McGuire and Stephens 2017, McGuire et al. 2017). As noted in the recovery plan for Cook Inlet belugas (NMFS 2016b), in northern Cook Inlet the whales likely benefit from the tendency of anadromous prey species to be concentrated by shallow water and the time required to transition from salt water to fresh as they enter the stream mouths, which presumably makes these prey easier to capture. Beluga whales have also been observed in the Kenai River Delta, albeit more sporadically and in fewer numbers, likely feeding on eulachon or adult salmon (NMFS 2016b, McGuire and Stephens 2017). Beluga activity was documented on numerous occasions in the lower Kenai River during late March through April 2018, with the greatest number of sightings occurring upriver more than 9.7 km (6 miles) (NMFS unpublished data).

In the fall, as anadromous fish runs begin to decline, beluga whales return to consuming the fish species found in nearshore bays and estuaries. These species include cod, as well as other bottom-dwellers, such as Pacific staghorn sculpin, and flatfishes, such as starry flounder and yellowfin sole (NMFS 2008). Data from beluga whales tagged with satellite transmitters documented that during winter, the whales tended to disperse into deeper waters in the mid-Inlet and made deep feeding dives (NMFS 2016b). The narrowing of the Inlet in this area and the presence of Kalgin Island just south of the Forelands may result in upwelling and eddies which concentrate nutrients and may provide a still-water refuge area for several migrating anadromous fishes (Calkins 1983, 1989). The Kalgin Island area may also be rich in biological productivity; for instance, crustaceans are known to occur south of the island (Calkins 1983). Available information also indicates beluga whales occasionally traveled into the upper Inlet in winter, including the upper ends of Knik and Turnagain Arms (Shelden et al. 2015). Winter distribution does not appear to be associated with river mouths, as it is during the warmer months.

Beginning in 1993, aerial surveys to determine abundance and distribution of beluga whales in Cook Inlet have been conducted annually or biennially in June or July by NMFS (Shelden et al. 2017). In addition, NMFS conducted surveys in the upper Inlet in August 2005 to 2012 to document calving rates (Hobbs et al. 2015). Historic aerial surveys for beluga whales also were completed in the late 1970s and early 1980s (see review in Shelden et al. 2015). Survey results, records of opportunistic sightings, and traditional ecological knowledge indicate that before the 1990s, beluga whales used areas throughout the upper, mid, and lower Inlet during the spring, summer, and fall (Huntington 2000b, Rugh et al. 2000, 2008, Rugh et al. 2010). The distribution has since contracted northeastward into upper Cook Inlet, which is especially evident in the summer (NMFS Rugh et al. 2000, Speckman and Piatt 2000, Hobbs et al. 2008, 2008, Rugh et al. 2010, Shelden et al. 2017) (Figure 4). This distributional shift and contraction coincided with the

decline in beluga whale abundance (Moore et al. 2000, NMFS 2008, Goetz et al. 2012, NMFS 2016b, Sheldon et al. 2017). It is unknown whether this change in distribution is due to habitat changes (e.g., changes in prey availability), predator avoidance, or reflects use of preferred habitats by the reduced beluga population (NMFS 2016b). Threats to Cook Inlet belugas are discussed in Section 5, where we describe the environmental baseline for the proposed action.

### **4.2.3 Diet**

Beluga whales are opportunistic feeders, preying on a variety of organisms that they swallow whole. The whales are known to feed on prey that concentrate, including shrimp and schooling or spawning fish (e.g., Quakenush et al. 2015). Quakenush et al. (2015) reported that for non-empty stomachs of Cook Inlet belugas sampled from 2002 to 2010 (March to November;  $n = 27$ ), fish were identified in all stomachs and invertebrates in half of the stomachs. Salmon, cod, smelt, and flounder were the most prevalent fish species identified in individual stomachs. Salmon that could be identified to species included coho, chum, and Chinook. Cod species included saffron cod, walleye pollock, and Pacific cod. Eulachon was the only smelt identified, and yellowfin sole and starry flounder were the only flounders. Stomach samples from Cook Inlet belugas are lacking for the winter months of December to February. It is thought that during the winter Cook Inlet belugas feed on such prey as flatfish, sculpin, cod, and pollock (NMFS 2008).

### **4.2.4 Contaminants Found in Cook Inlet Beluga Whales**

Determining the potential impact of the proposed action on the Cook Inlet beluga population involves assessing exposure to contaminants as well as possible effects of exposure (see Section 6). Information on the current contaminant load of Cook Inlet belugas, as well as specific sources of those contaminants, is limited. Analysis for contaminants in Cook Inlet beluga tissues have primarily been from those collected through the Alaska Marine Mammal Tissue Archival Project (AMMTAP). AMMTAP samples from 10 male and 10 female Cook Inlet belugas taken during subsistence hunts from 1992 to 1997 were compared to beluga whales from other North American locations, including two other Alaskan stocks, for polychlorinated biphenyls (PCBs) and organochlorine pesticides; and samples from ten of the Cook Inlet belugas (6 males and 4 females) were compared for other selected elements, including heavy metals (Becker et al. 2000). Among Alaskan beluga stocks, the Cook Inlet animals had lower concentrations of PCBs and chlorinated pesticides, cadmium, hepatic total mercury, selenium, vanadium, and silver, similar levels of methylmercury, and substantially higher levels of copper (Becker et al. 2000). The results for copper are discussed in more detail in the 2010 opinion.

More recently, AMMTAP samples collected from Cook Inlet belugas collected from 1992 to 1996 and from belugas in the eastern Alaskan Chukchi Sea from 1989 to 2000 were analyzed for perfluorinated compounds (PFCs) (Reiner et al. 2011), PCBs, organochlorine pesticides,

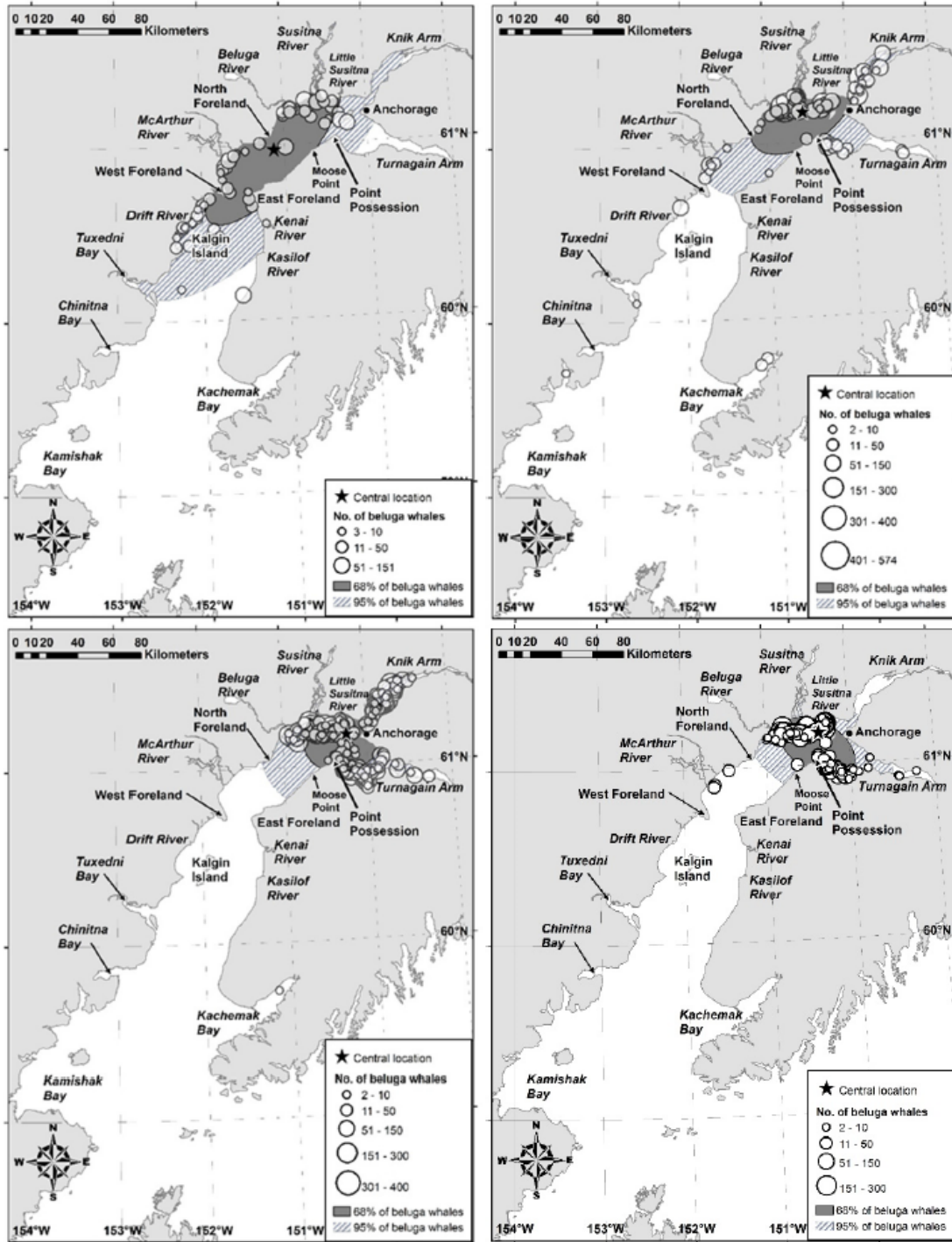


Figure 4. Summer range contraction of Cook Inlet beluga whales over time as indicated by ADF&G and NMFS aerial surveys (from Sheldon et al. 2017). The distribution of beluga whales (shaded regions) was calculated around the central location indicated by a different point symbol for each period at 1 and 2 standard deviations (capturing 68 and 95 percent of the whales, respectively) in 1978 to 1979 (upper left map), 1993 to 1997 (upper right map), 1998 to 2008 (lower left map), and 2009 to 2016 (lower right map).

polybrominated diphenyl ethers (PBDEs), hexabromocyclododecanes (HBCDs), and mercury (Hoguet et al. 2013). Samples from more than 10 males and 10 females were used in these analyses. As was indicated in previous findings, concentrations of PCBs, chlorinated pesticides, and mercury were significantly lower in the Cook Inlet belugas than in the eastern Chukchi Sea animals. However, concentrations of the PBDEs (a class of flame retardants) in the Cook Inlet animals were significantly higher than in the eastern Chukchi Sea belugas. Nine PFCs were determined in the livers of the belugas from both regions; but two compounds, perfluorooctane sulfonate (PFOS) and perfluorooctane sulfonamide (PFOSA), dominated in both the Cook Inlet and eastern Chukchi Sea animals. The Cook Inlet belugas had higher concentrations of most PFCs compared to the eastern Chukchi Sea animals, but had a lower median concentration of one particular type of PFC, specifically, PFOSA. There was no temporal increase evident in the concentrations of PCBs chlorinated pesticides, or mercury across sample years. However, there was a temporal trend toward increasing concentrations of PBDEs, HBCDs, and most PFCs in both populations. The Cook Inlet animals tended to have smaller annual increases as compared to the eastern Chukchi Sea belugas, which the authors suggested may have reflected a decrease of PFC inputs from local sources in the Cook Inlet region.

Finally, Wetzel et al. (2010) provided information on concentrations of total polycyclic aromatic hydrocarbons (PAHs) in archived Cook Inlet beluga blubber and liver samples. The most prevalent PAHs identified in the liver samples were fluorenes, anthracenes, and phenanthrenes; and in the blubber were naphthalenes, fluorenes, anthracenes, and fluoranthracenes. A small amount of benzo(a)pyrene was detected in one blubber sample.

The small population of beluga whales in the St. Lawrence Estuary in eastern Canada provides another basis for comparisons to be made with Cook Inlet beluga whales with respect to contaminants. The St. Lawrence Estuary has been exposed to extreme industrial effluent contamination and offers an example of possible adverse effects of contaminants on beluga whales in the wild. Although this beluga whale population has been completely protected since 1979, only a few hundred animals currently remain from around 5,000 to 10,000 animals in the late 1800s (Committee on the Status of Endangered Species in Canada [COSEWIC] 2014). A host of contaminants were found in St. Lawrence belugas, some of which can compromise immune function (Martineau et al. 1994, De Guise et al. 1998), the most prominent included organochlorines, heavy metals, and PAHs (of which benzo(a)pyrene is of most concern because it is a known carcinogen), which are of special interest because of their abundance and known toxicity. The high concentrations of organochlorines, which include pesticides such as dichlorodiphenyltrichloroethane (DDT), chlordane, mirex and dieldrin, as well as PCBs, and heavy metals in tissues of these animals suggest the importance of exposure to industrial contaminants in the decreasing population (Martineau et al. 1988). The frequency of dystocia (difficulty calving) and postpartum complications documented in stranded dead adult female St. Lawrence belugas (19 percent) examined from 1983 to 2012 is the highest reported in wild cetaceans (Lair et al. 2016). In addition, the incidence of infectious, degenerative, hyperplastic, or neoplastic lesions, and evidence of immune-suppression, found in dead stranded St. Lawrence belugas is considerably higher than found in marine mammals elsewhere or in other species of marine mammals from the same waters (De Guise et al. 1995, Lair et al. 2016), and cancer is the second-most frequent cause of mortality (after infectious disease) documented in these whales (Lair et al. 2016). Though the subject of debate, one hypothesis proposed to explain the high

frequency of cancer is the exposure to carcinogenic contaminants, such as PAHs (benzo(a)pyrene) (COSEWIC 2014, Lair et al. 2016).

Concentrations of organochlorines, including PCB's, DDT, toxaphene, chlordane, dieldren, hexachlorobenzene (HCB), hexachlorohexane (HCH) and mirex were all found to be substantially lower in Cook Inlet beluga whale tissues than those of St. Lawrence belugas (Becker et al. 2000). With respect to tissue concentrations of heavy metals, in comparison to St. Lawrence belugas, Cook Inlet belugas had lower levels of mercury and selenium, higher levels of zinc and cadmium (though cadmium concentrations for both populations were relatively low), and significantly higher levels of copper (Becker et al. 2000). It is not possible to make a direct comparison with respects to PAHs in that the presence of this contaminant was not reported in comparable ways for the two populations. There are differences between the two populations that necessitate a measure of caution in making direct comparisons, primarily involving sample collection. Regarding the St. Lawrence beluga population, samples were collected from accessible dead animals found stranded along the shore (Béland et al. 1988, Béland 1996, Lair et al. 2016), many of which may have died from the associated pathology. Regarding Cook Inlet belugas, AMMTAP tissue samples were predominantly collected from healthy animals taken during subsistence hunting and would likely not show levels of contaminants resulting in pathology or adverse effects. Of 164 known dead-stranded Cook Inlet belugas between 1988 and 2013, necropsies were performed on 38 (Burek-Huntington et al. 2015). Although no tumors were reported for these animals, the authors noted that the majority were in a moderate to advanced state of decomposition, which limited the diagnostic options.

#### **4.2.5 Cook Inlet Beluga Whale Critical Habitat**

NMFS designated critical habitat for the Cook Inlet beluga whale on April 11, 2011 (76 FR 20180). The critical habitat (Figure 5) includes two specific areas of marine habitat, both of which are located within the action area:

- Area 1 includes all marine waters of Cook Inlet north of a line from the mouth of Threemile Creek (61°08.5' N., 151°04.4' W.) connecting to Point Possession (61°02.1' N., 150°24.3' W.), including waters of the Susitna River south of 61°20.0' N., the Little Susitna River south of 61°18.0' N., and the Chickaloon River north of 60°53.0' N.
- Area 2 includes all marine waters of Cook Inlet south of a line from the mouth of Threemile Creek (61°08.5' N., 151°04.4' W.) to Point Possession (61°02.1' N., 150°24.3' W.) and north of 60°15.0'N., including waters within 2 nautical miles seaward of mean high water (MHW) along the western shoreline of Cook Inlet between 60°15.0' N. and the mouth of the Douglas River (59°04.0' N., 153°46.0' W.); all waters of Kachemak Bay east of 151°40.0' W.; and waters of the Kenai River below the Warren Ames bridge at Kenai, Alaska.

The PBFs of this critical habitat that are essential to the conservation of the Cook Inlet beluga whale are:

1. Intertidal and subtidal waters of Cook Inlet with depths less than 30 ft (MLLW) and within 5 miles of high and medium flow anadromous fish streams;



2. Primary prey species consisting of four species of Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole;
3. Waters free of toxins or other agents of a type and amount harmful to Cook Inlet beluga whales;
4. Unrestricted passage within or between the critical habitat areas; and
5. Waters with in-water noise below levels resulting in the abandonment of critical habitat areas by Cook Inlet beluga whales.

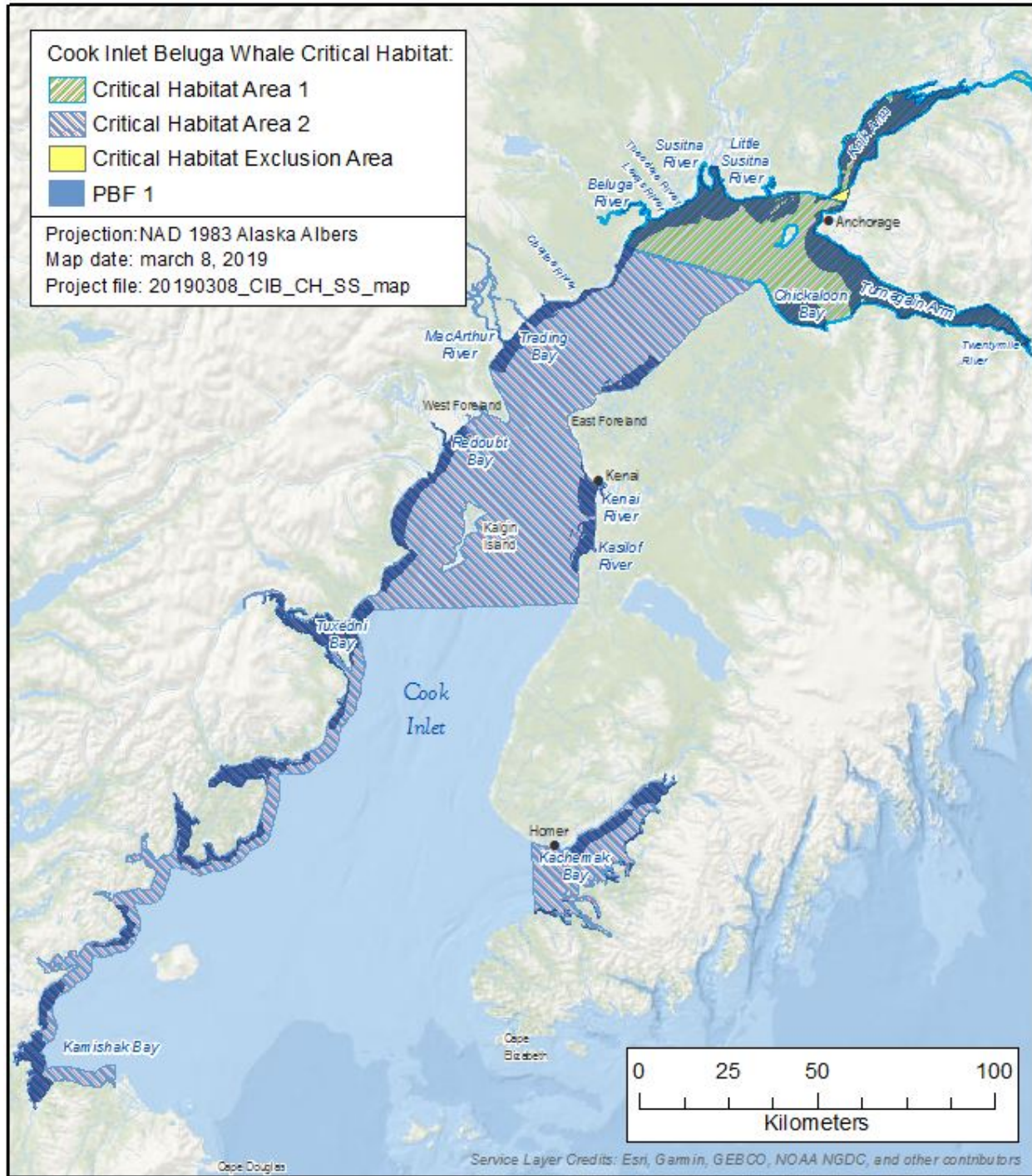
Area 1 during spring and summer months for these purposes (Figure 4). Area 1 also has the highest concentrations of belugas from spring through fall (approximately March through October), as well as the greatest potential for adverse impact from anthropogenic stressors due to the high seasonal concentrations of belugas and the biological importance of the area to the conservation of the species.

Critical habitat Area 2 was designated for the area's importance to Cook Inlet beluga fall and winter feeding and transit, and for less concentrated spring and summer use by belugas. Area 2 is located south of Area 1, and includes both near and offshore waters of the mid and upper Inlet, and nearshore waters along the west side of the lower Inlet (Figure 5). Area 2 also includes a portion of Kachemak Bay on the east side of lower Cook Inlet. Based on dive behavior and analysis of samples of stomach contents from Cook Inlet belugas, it is assumed that Area 2 habitat is an active feeding area during fall and winter months when the spatial dispersal and diversity of winter prey likely influences the wider beluga winter range in the absence of fish runs (NMFS 2008). However, tagging data indicate use of Area 2 by belugas in all months except April and May, and the indicated absence of use of Area 2 in these two months is based upon tagging data from only one beluga whale (Shelden et al. 2018).

The Cook Inlet beluga whale recovery plan (NMFS 2016b) discussed that "most of the beluga habitat in Cook Inlet is not degraded to the point that adverse effects to [Cook Inlet] belugas are apparent." The recovery plan also noted that anthropogenic activities in Cook Inlet are concentrated in the coastal zone and are often seasonal and concurrent with increasing anthropogenic activities in Cook Inlet. Consequently, contraction of the range of Cook Inlet belugas into the upper Inlet has resulted in increased proximity to developing and developed areas near Anchorage.

Critical habitat Area 1, which is located in northern Cook Inlet (Figure 5), contains shallow tidal flats, river mouths, and estuarine areas. Many rivers in Area 1 habitat support large eulachon and salmon runs. Area 1 is important as foraging and calving habitat, and belugas are concentrated in

The following discussion summarizes the status of each of the PBFs of Cook Inlet beluga whale critical habitat.



**Figure 5. Cook Inlet beluga whale designated critical habitat. Also illustrated are the approximate geographic areas within the critical habitat that meet the definition of PBF 1.**

#### **4.2.5.1 PBF 1: Intertidal and subtidal waters of Cook Inlet with depths less than 30 feet (MLLW) and within 5 miles of high and medium flow anadromous fish streams**

PBF 1 is important beluga feeding habitat because of the shallow depths and bottom structure, which act to concentrate prey and aid in feeding efficiency by belugas. This habitat also supports other biological needs such as predator escape, calving, and molting. Within the designated critical habitat, about 38 percent of intertidal and subtidal waters meet the definition of PBF 1 (Figure 5). Currently, the majority of coastal development in Cook Inlet is concentrated near Anchorage. As a result, much of the intertidal and subtidal critical habitat within 8 km (5 miles) of anadromous fish streams is generally intact and relatively undisturbed.

#### **4.2.5.2 PBF 2: Primary prey species consisting of four species of Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole**

Four species of Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole constitute the most important food sources for Cook Inlet belugas based on scientific research results and traditional knowledge. All these species are harvested commercially, and some are also subject to subsistence and recreational harvest.

The primary prey species of Cook Inlet belugas use freshwater and/or marine habitats for multiple life history phases. Below we summarize the status and life history of each of the primary prey species of Cook Inlet belugas, with a focus on information that is relevant to the effects of the proposed action on these species. Unless otherwise noted, for Pacific salmon, we used information available in the “Essential Fish Habitat and Habitat Areas of Concern” appendix to the *Fishery Management Plan for the Salmon Fisheries in the EEZ of Alaska* (North Pacific Management Council 2012). Additional information on the marine residence of juvenile salmon in Cook Inlet can be found in the *Review of Literature on Fish Species and Beluga Whales in Cook Inlet* (Rodrigues et al. 2006). Similarly, for Pacific eulachon, Pacific cod, walleye Pollock, and yellowfin sole, unless otherwise noted, we used information available in the “Life History Features and Habitat Requirements of Fishery Management Plan Species” appendix to the *Fishery Management Plan for Groundfish of the Gulf of Alaska* (North Pacific Management Council 2017).

##### **4.2.5.2.1 Chinook, Sockeye, Chum, and Coho Salmon**

The Cook Inlet region is a migratory corridor and early life rearing area for all of Alaska's five species of Pacific salmon. Chinook salmon runs are the first to return to Cook Inlet each year, beginning in late April and May, and coho salmon arrive the latest, beginning in July (Rodrigues et al. 2006). The largest salmon runs in Cook Inlet enter the Kenai, Kasilof, and Susitna Rivers (Shields and Frothingham 2018). The Cook Inlet beluga whale recovery plan (NMFS 2016b) summarized the historical mean in-river abundance of salmon runs for major rivers flowing into Cook Inlet (Figure 6). Sockeye salmon are the dominant species that spawn in the Kenai and Kasilof Rivers, and significant numbers of Chinook, coho, and pink salmon also spawn in the Kenai River. The Susitna River drains the largest watershed entering Cook Inlet and supports substantial runs of all five Pacific salmon species. The Little Susitna River supports moderately

sized runs of pink, chum, and coho salmon. Additionally, the Chuitna, Beluga, Theodore, and Lewis Rivers support relatively small runs of Chinook salmon and somewhat larger runs of coho salmon, and numerous small streams along Knik and Turnagain Arms support relatively small runs of all five salmon species.

Although belugas may not currently be frequenting critical habitat in and near the Kenai River during the peak periods of large salmon runs (see Figure 4), they make heavy use of salmon runs elsewhere in upper Cook Inlet, most notably waters near the mouth of the Susitna and Beluga Rivers, and rivers feeding into Knik Arm and Chickaloon Bay (Goetz et al. 2012, McGuire and Stephens 2017). Little information is available on salmon returns to those drainages that have been most heavily exploited by Cook Inlet belugas in recent years. However, since the early 1970s run sizes, indexed as catches and escapements into major river systems, show general increases in sockeye and coho salmon return abundances, an odd/even year cycle in pink salmon abundances, and a decline in chum salmon abundances (NMFS2016b).

Cook Inlet sockeye salmon run sizes increased primarily because of recent larger returns to the Kenai and Kasilof Rivers. Susitna River sockeye salmon stocks were designated as of yield concern beginning in 2008 (Shields and Frothingham 2018). Yield concern means “a concern arising from a chronic inability, despite the use of specific management measures, to maintain specific yields, or harvestable surpluses, above a stock’s escapement needs... (5 AAC 39.222(f)(42)).” Shields and Frothingham (2018) reported that within the Susitna River drainage, sockeye salmon production in some lakes appears to be stable, whereas others are producing fewer adults than they once did, and sockeye salmon are no longer present in some previously productive lakes. The authors noted that factors affecting sockeye salmon production in this drainage include alteration and loss of habitats as a result of urbanization and natural processes, as well as introduction of invasive northern pike.

For over a decade Chinook salmon returns have been declining in Alaska, including in Cook Inlet, coincident with reductions in age and size (Lewis et al. 2015). Chinook salmon stocks throughout Cook Inlet are currently experiencing a period of lower abundance (Shields and Frothingham 2018). Since 2011, the Chuitna, Theodore, and Lewis River Chinook stocks on the west side of Cook Inlet have been designated as stocks of management concern; and Alexander Creek and Willow Creek in the Susitna River drainage have been designated as stocks of management concern and yield concern, respectively (Shields and Dupuis 2017, Shields and Frothingham 2018). Management concern means “a concern arising from a chronic inability, despite the use of specific management measures, to maintain escapements for a salmon stock within the bounds of the SEG [sustainable escapement goal], BEG [biological escapement goal], OEG [optimal escapement goal], or other specified management objectives for the fishery... (5 AAC 39.222(f)(21)).” Additionally, in the Susitna River drainage, Sheep Creek and Goose Creek (which was designated as a stock of yield concern in 2011) have been designated as stocks of management concern since 2014 (Shields and Frothingham 2018). Management of the commercial and other fisheries in Cook Inlet is discussed in Section 5.5.

The generalized life cycle of Pacific salmon includes phases of incubation of fertilized eggs and hatching of embryos in the gravel bed of a stream or shoreline of a lake; freshwater emergence of juveniles, and initial rearing of juveniles in fresh water; migration to the ocean for feeding and growth; and adult migration from the ocean to natal freshwater streams and lakes for completion

of maturation and spawning, followed by death within a few weeks. Depending on the species and other factors, juvenile Pacific salmon may spend from a few days or weeks (pink and chum salmon) to, in general, a year or more (Chinook, sockeye, and coho salmon) in fresh water before undergoing smoltification and beginning their downstream migration. In the Cook Inlet Region, the majority of the smolt outmigration occurs from late April through July (ADEC et al. 2017). Smolt normally rear for a variable period of time in estuaries of rivers and nearshore marine areas before migrating beyond coastal areas, where most remain for a year or more before returning to fresh water to spawn. For each of the primary salmon prey species of Cook Inlet belugas, below we briefly summarize key aspects of these life phases.

### **Chinook Salmon**

Chinook salmon are the least abundant and largest of the Pacific salmon species, with the weights of individual adult fish often exceeding 13.6 kilograms (kg) (30 pounds [lb]) (ADF&G 2008). Adult chinook salmon typically remain at sea for 1 to 6 years before returning to Cook Inlet tributaries in early May through July to spawn (ADF&G 2018b). Chinook salmon fry hatch in late winter or early spring, and (in Alaska) most juveniles spend at least a year in fresh water, feeding primarily on larval and adult insects, before they out-migrate toward the sea during spring. Juvenile Chinook salmon remain in estuarine and nearshore marine areas for weeks to months, where they feed on prey such as zooplankton and forage fish (e.g., sand lance) before continuing toward the open ocean. They may be present in estuarine waters from spring through early autumn, and in nearshore marine waters from spring to as late as January or February of the following year.

### **Sockeye Salmon**

Adult sockeye salmon may spend 1 to 4 years at sea before returning to Cook Inlet tributaries in early May through August to spawn (ADF&G 2018b), typically in freshwater drainages with at least one lake. Sockeye salmon fry hatch during late winter through spring, and in systems with lakes, they make use of lake rearing habitat for 1 to 3 years before they out-migrate toward the sea, generally during spring and summer. However, some populations rear in streams, in which case outmigration typically occurs the same year as hatching. In fresh water, juvenile sockeye salmon feed primarily on zooplankton. Depending on the stock, juvenile sockeye salmon may reside in the estuarine or nearshore environment feeding on zooplankton and insects during spring and summer before migrating toward the open ocean.

### **Chum Salmon**

Adult chum salmon remain at sea for about 1 to 6 years before returning to Cook Inlet tributaries beginning in mid-July to spawn (ADF&G 2018b), often in the lower reaches of coastal streams. After chum salmon fry hatch in late winter through spring, juveniles spend from days to a few weeks in fresh water as they out-migrate downstream to estuaries, where for several months they tend to feed in intertidal wetlands and along the shore before moving into channels toward more open water areas and the open ocean. Juvenile chum salmon feed on a variety of prey including zooplankton and insects, and additionally, on organisms such as fish and squid as they mature.

### **Coho Salmon**

Most coho salmon spend about 18 months at sea before returning as adults to Cook Inlet tributaries beginning in mid-July to spawn (ADF&G 2018b). After coho salmon fry emerge in the spring, they usually spend 1 to 2 years in fresh water streams, lakes, as well as estuaries,

before migrating toward the sea. During summer, the most productive freshwater rearing habitats for juvenile coho salmon are located in smaller streams with low-gradient alluvial channels, various types of pools, and structural habitat elements such as large woody debris and undercut banks. During their first summer, juveniles may alternatively use estuarine waters, in which case they migrate back upstream to fresh water to overwinter. During their seaward migration, juvenile coho salmon may be present in estuaries from late spring through summer, and they also may spend up to 4 months in coastal waters before migrating toward the open ocean. While in fresh water and in estuaries, juvenile coho salmon feed on invertebrates, and as they grow larger, on other fishes.

### **Pacific Eulachon**

Pacific eulachon is a small (up to about 25.4 cm [10 inches] in total length) anadromous schooling species that spends several years in the open ocean (primarily in waters less than 300 m [984 ft]) before returning to fresh water to spawn in spring or early summer. Eulachon have high oil-content (17 to 21 percent of the wet weight; Payne et al. 1999) and migrate in dense schools in the spring, making them an important food source for Cook Inlet belugas at a time when their energy reserves are low, as evidenced by a thin blubber layer (Huntington 2000b). Eulachon begin returning to spawning areas in Cook Inlet from mid-May to mid-June (Shields and Frothingham 2018). They spawn on coarse sandy river bottoms, and most die after their first spawning. Eulachon eggs, which adhere to the bottom substrate, hatch after an incubation period that is temperature-dependent, varying from a few weeks to more than a month (Gustafson et al. 2010). Eulachon larvae are carried downstream by currents to the ocean and develop in coastal marine waters. However, Hay and McCarter (2000) indicated that larval eulachon may remain in low-salinity surface waters of estuaries for several weeks or longer before entering the ocean. NMFS (2014) indicated that the residence time of larval eulachon in the estuary before entering the ocean is unknown. Eulachon larvae and juveniles feed primarily on phytoplankton, copepods, larvae, and euphausiids; and adults feed primarily on copepods and euphausiids.

Large eulachon runs in Cook Inlet are known to occur in the Susitna River and at Twentymile River in Turnagain Arm. In the Susitna River and Twentymile River, the eulachon spawning migration peaks in late May to early June and is largely completed by mid-June (Barrett et al. 1984, Spangler et al. 2003). Consistent with this timing, eulachon was the fourth most abundant species caught (14 percent of total catch) in surface tow net surveys conducted in upper Cook Inlet in the vicinity of the Susitna River and southwest to the Forelands in 1993, but these fish were present for only a brief time in June (Moulton 1997). The 2016 spawning biomass of eulachon in the Susitna River watershed was estimated to be about 48,000 metric tons (53,000 tons) (Shields and Frothingham 2018).(Shields and Frothingham 2018)

### **Pacific Cod**

Pacific cod is a transoceanic demersal species that prefers soft sediment and occurs at depths ranging from very shallow waters near the shoreline to 500 m (1,640 ft). Adult Pacific cod are known to migrate seasonally from shallower summer feeding grounds (less than 100 m [328 ft]) to deeper winter to early spring spawning aggregation areas along the continental shelf and slope. Pacific cod eggs, which sink to the bottom and are adhesive, hatch in about 15 to 20 days. Larvae are epipelagic and move downward and shoreward as they grow. Juvenile Pacific cod reside in nearshore coastal areas and bays at depths of 60 to 150 m (197 to 492 ft). Juvenile



Pacific cod initially feed on small invertebrates and transition as they grow to feeding on fish and crustaceans.

The 2017 stock assessment of the Pacific cod stock in the Gulf of Alaska reported that the 2017 survey estimates for Pacific cod abundance and biomass dropped 71 percent and 58 percent, respectively, compared to the 2015 estimates (Barbeaux et al. 2017). The biomass and abundance

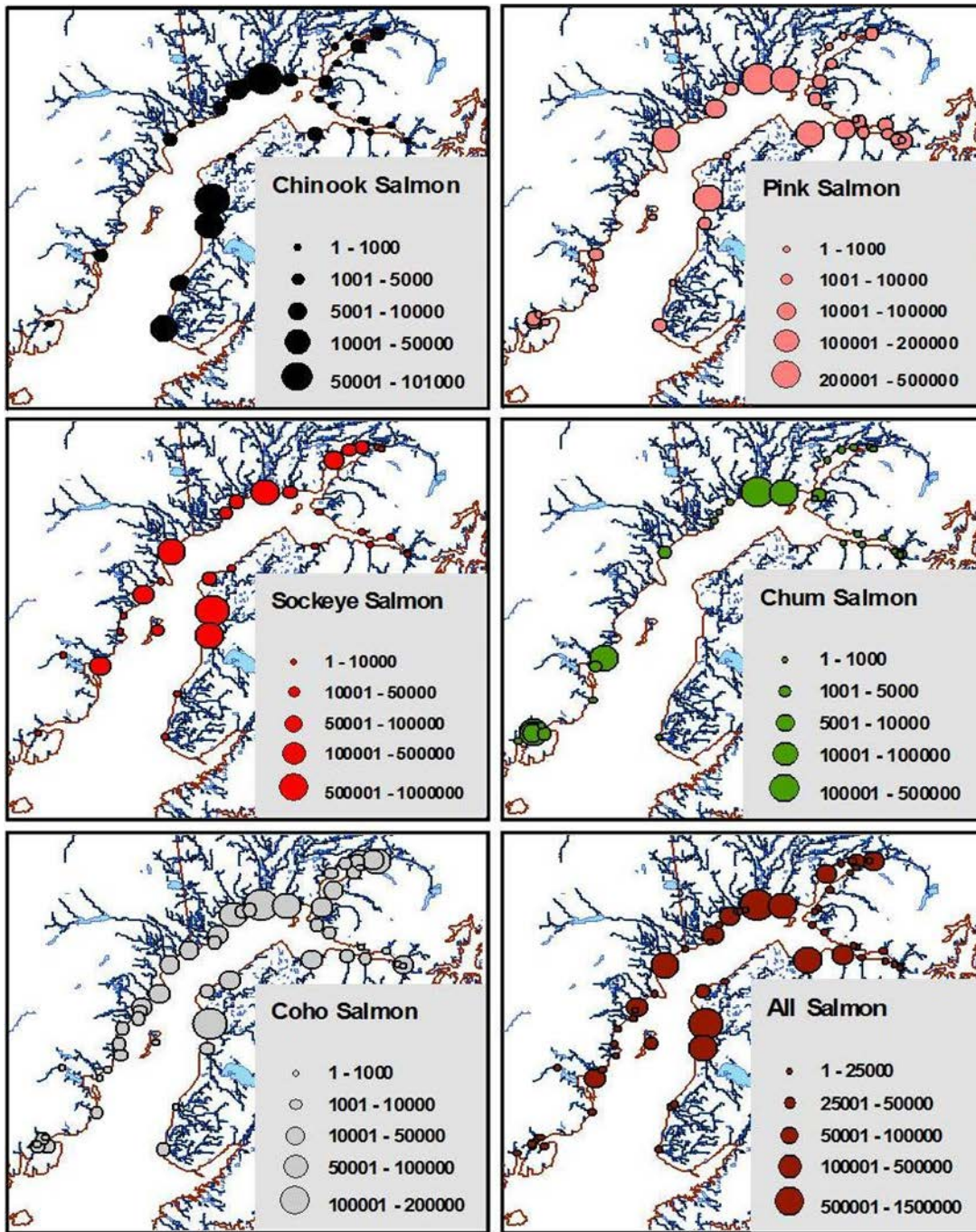


Figure 6. Historical mean in-river abundance of Chinook, sockeye, coho, pink, and chum salmon runs entering the major rivers flowing into Cook Inlet (from NMFS 2016b).

estimates both showed a declining trend after 2009, and the 2017 estimates were the lowest values in the time series dating back to 1984. The declines are thought to be the result of anomalously warm conditions in the Pacific Ocean in 2014 through 2016.

The limited information available on the abundance and distribution of Pacific cod within Cook Inlet is primarily from surveys conducted more than 10 years ago. Very few Pacific cod were caught during limited trawl surveys conducted in Cook Inlet during April and October 2012 at sites located from Kalgin Island to the Forelands (Saupe et al. 2014). Pacific cod were also rare or not caught during surface tow net and beach seine surveys conducted in Knik Arm in May to early June 1983, July through November 2004, and April through July 2005 (Dames & Moore 1983, Moulton 1997, Houghton et al. 2005). They comprised less than one percent of the fishes collected during mid-water trawl surveys conducted in the mid- to late 1990s near Chisik Island in lower Cook Inlet (Fecchelm et al. 1999, Abookire and Piatt 2005), but were a relatively common occurrence there in beach seine catches in 1996 (Robards et al. 1999). In Kachemak Bay, Pacific cod were commonly caught in small-mesh trawl and beach seine surveys conducted during the summer in the early to mid-1990s (Robards et al. 1999, Abookire et al. 2001), but the species comprised only about 3 percent of the total catch there during a small-mesh survey conducted in May 2000 (Gustafson and Bechtol 2005).

### **Walleye Pollock**

Walleye pollock are found throughout the water column to depths of at least 300 m (984 ft), and are widely distributed throughout the shelf regions of the Gulf of Alaska. Adult pollock seasonally migrate from overwintering areas along the outer shelf to shallower waters (100 to 200 m [328 to 656 ft] depth in the Gulf of Alaska), where spawning aggregations occur in late winter to early spring. The principal location for pollock spawning in the Gulf of Alaska is Shelikof Strait, where spawning peaks in late March. Pollock eggs develop throughout the water column, and in the Gulf of Alaska they hatch in roughly 2 weeks. Juvenile pollock appear to be initially pelagic, then become increasingly demersal with age. Pollock primarily feed on pelagic crustaceans, copepods and euphausiids as juveniles, and on fish and pelagic crustaceans as adults.

The 2017 stock assessment of the walleye pollock stock in the Gulf of Alaska indicated that this stock is currently at relatively high abundance, although increased uncertainty regarding future abundance is evident in light of divergent trends in the 2017 survey data and unusual patterns in some stock characteristics (Dorn et al. 2017). Similar to Pacific cod, the limited information available on the abundance and distribution of walleye pollock within Cook Inlet is primarily from surveys conducted more than 10 years ago (Dames & Moore 1983, Moulton 1997, Fecchelm et al. 1999, Robards et al. 1999, Abookire and Piatt 2005, Houghton et al. 2005, Saupe et al. 2014). Pacific cod were generally absent or accounted for a very small proportion of fish caught during Cook Inlet surveys, with the exception of some locations sampled during trawl surveys conducted in October 2012 from Kalgin Island to the Forelands (Saupe et al. 2014), and in small-mesh shrimp trawl surveys conducted in Kachemak Bay in 2001 (Gustafson and Bechtol 2005).

### **Saffron Cod**

There is limited information available on the life history and seasonal habitats of saffron cod. Saffron cod are demersal fish that occur in nearshore waters, typically less than 60 m deep, and



also in rivers and streams within areas with tidal influence (Mecklenburg et al. 2002). Saffron cod spawn in winter in relatively shallow coastal waters in areas with sand/pebble bottom substrate (Logerwell et al. 2015, Food and Agriculture Organization 2018). Saffron cod eggs are demersal and larvae hatch out in the spring (Wolotira 1985). The larvae are planktonic and descend to the bottom after developing for several months. Juvenile saffron cod remain in shallow water throughout the year, whereas adults primarily spend the winter in nearshore waters and migrate somewhat farther offshore during the summer (Love et al. 2016, Food and Agriculture Organization 2018). Around Kodiak Island and in Prince William Sound, juvenile saffron cod (and Pacific cod) were often associated with eelgrass beds (Laurel et al. 2007, Johnson et al. 2009). In Prince William Sound, most juvenile saffron cod left nearshore waters by late summer or early fall (Johnson et al. 2009). Diet information available primarily for saffron cod occurring in Arctic waters indicates that juvenile saffron cod feed on zooplankton, whereas larger fish consume a wide variety of prey including fishes and crustaceans (Wolotira 1985, Love et al. 2016).

Similar to Pacific cod and walleye pollock, the limited information available on the abundance and distribution of saffron cod within Cook Inlet is primarily from surveys conducted more than 10 years ago. Few saffron cod were caught during limited trawl surveys conducted in April and October 2012 at sites located from Kalgin Island to the Forelands (Saupe et al. 2014). Similarly, saffron cod comprised less than 2 percent of the total catch during surface tow net surveys conducted in upper Cook Inlet during the summer of 1993 (Moulton 1997). In contrast, saffron cod were found to be relatively common (nearly 13 percent of the total catch) in beach seine catches in Knik Arm conducted during certain ice-free months in 2004 and 2005, and they were also reported as one of the more abundant species caught there by beach seines in late spring of 1983 (Dames & Moore 1983, Houghton et al. 2005). Johnson et al. (2009), who reported a dramatic increase in the abundance of saffron cod in the nearshore waters of Prince William Sound, noted that in lower Cook Inlet the frequency of occurrence of saffron cod in beach seine catches increased from less than 2 percent in 1979 to 73 percent in 2008. Saffron cod were for the most part not observed during trawl surveys conducted in lower Cook Inlet (Fecchelm et al. 1999, Abookire and Piatt 2005, Gustafson and Bechtol 2005), although a small number of juvenile saffron cod were caught during small-mesh trawl surveys for juvenile groundfishes conducted in Kachemak Bay during the summer of 1994 through 1999 (Abookire et al. 2001) and in beach seine catches there in 1995 and 1996 (Robards et al. 1999).

### **Yellowfin Sole**

Yellowfin sole are demersal shallow-water fish that live on soft, sandy bottom substrates and occur at depths of up to (600 m [1,968 ft]), but usually at depths less than 150 m (492 ft) (Mecklenburg et al. 2002). Adult yellowfin sole migrate annually in the spring from over-winter habitat near the shelf margins onto the inner shelf to spawn, primarily in shallow waters. The spawning period is variable and extends from late May through August, occurring primarily in shallow water. Juvenile yellowfin sole remain in shallow water for a period of time. Yellowfin sole juveniles and adults feed on prey such as polychaetes, amphipods, and bivalves.

Similar to Pacific cod, walleye pollock, and saffron cod, the limited information available on the abundance and distribution of yellowfin sole within Cook Inlet is primarily from surveys conducted more than 10 years ago. With the exception of the small numbers of yellowfin sole caught during mid-water trawl surveys conducted in lower Cook Inlet near Chisik Island in

August of 1997 (Fecchelm et al. 1999) and during small-mesh trawl surveys conducted in Kachemak Bay in May 2000 (Gustafson and Bechtol 2005), yellowfin sole were not reported in the catch for Cook Inlet surveys (Dames & Moore 1983, Moulton 1997, Robards et al. 1999, Abookire and Piatt 2005, Houghton et al. 2005, Saupe et al. 2014)

#### **4.2.5.3 PBF 3: Waters free of toxins or other agents of a type and amount harmful to Cook Inlet beluga whales**

There is little information on the potentially deleterious effects of contaminants on Cook Inlet belugas, but it is likely that chronic exposure to contaminants may compromise an individual whale's health, with the potential for population-level effects (NMFS 2016b). The Cook Inlet region is the most populated and industrialized region of the state. Its waters receive various pollutant loads through activities that include runoff from urban, mining, and agricultural areas, oil and gas activities (e.g., discharges of drilling muds and cuttings, production waters, treated sewage effluent discharge, deck drainage), municipal sewage treatment effluents, oil and other chemical spills, fish processing, and other regulated discharges (Moore et al. 2000, NMFS 2014) (also see Section 5.4). Many of these pollutants are regulated by either EPA or ADEC, who may authorize certain discharges under the NPDES/APDES program.

An integrated environmental monitoring project was undertaken in Cook Inlet in 2008 and 2009 in which several different studies sampled Inlet waters and sediments at more than 50 sites, including sites located within the primary area of Cook Inlet oil and gas activities. Sediment concentrations of DDTs, PCBs, and chlordanes were found to be relatively low, but total HCH concentrations were relatively high at a number of locations in Trading Bay and Kachemak Bay. The sources for the HCH in sediments were attributed to atmospheric origin. Metals in sediments were found to be for the most part at "background" levels or were lower than the minimum sediment quality guidelines (Long et al. 1995), although a few metals were above those levels in some locations due to natural physical and chemical processes (Trefy et al. 2012).

Concentrations of dissolved metals in Cook Inlet water samples were also found to be for the most part at "background" levels, with the exception of elevated lead concentrations in Trading Bay that were described as likely due to input from area rivers (Trefy et al. 2012). Sediment PAH levels were found to be low, with some localized anthropogenic inputs (Savoie et al. 2012). Wetzel et al. (2010) similarly reported that PAH levels in sediments sampled in several known feeding areas of Cook Inlet belugas were low compared to other urban areas known to have environmental concerns due to PAH contamination. An earlier assessment of coastal bays and estuaries in southcentral Alaska that included several sampling sites in Cook Inlet reported measurements of several standard parameters in samples of the water column and sediments that were lower than the "Effects Range Low" values identified (the lower threshold bioeffects limit based on the NOAA National Status and Trends program guidelines and criteria), with the exception of nickel levels in sediment samples from a few locations (Saupe et al. 2005).

The CWA mandates that each state develop a program to monitor and report on the quality of its surface and ground waters and prepare a report describing the status of its water. Section 305(b) of the CWA requires that the quality of all waterbodies be characterized, and section 303(d) requires that states list any waterbodies that do not meet WQS. Generally, waterbodies are assigned to categories by the degree to which water quality goals are attained. In the most recent water quality assessment report for Alaska that has been approved by EPA, a few streams that

are tributaries to Cook Inlet (most in the vicinity of Anchorage), including the lower portion of Ship Creek in Anchorage, are listed as impaired for fecal coliform bacteria. Ship Creek is also listed for petroleum hydrocarbons and oil and grease (ADEC 2010). In addition, the draft water quality assessment report for 2014 to 2017 (ADEC 2017b) identified 8.5 miles of the Little Susitna River, 1.6 river km (1 river mile) upstream of the public boat launch and 12.1 river km (7.5 river miles) downstream of the boat launch, where petroleum hydrocarbon levels have exceeded Alaska WQS during the month of August. The report noted that an action made effective in January of 2017 to limit fishing from motorized boats to certain motor sizes is expected to improve water quality there. Cook Inlet waters within the Anchorage watershed, which includes most of Turnagain Arm and the eastern part of Knik Arm, are listed as Category 3 in Alaska's section 303(d) list of impaired water bodies, indicating that there is insufficient or no data or information to determine whether the Alaska WQS for any designated water use are attained (ADEC 2010).

#### **4.2.5.4 PBF 4: Unrestricted passage within or between the critical habitat areas**

Certain actions may have the effect of reducing or preventing Cook Inlet beluga whales from freely accessing the habitat areas necessary for their survival. Dams and causeways may create physical barriers, whereas noise and other disturbance or harassment might cause a behavioral barrier, whereby the whales reach these areas with difficulty or, in a worst case, abandon the affected habitat areas altogether due to such stressors. Within Cook Inlet, potential barriers that could restrict beluga whale movement include port facilities, vessel traffic, and noise. Port facilities are located along the coastline in a number of locations in Cook Inlet, and large cargo ships, and commercial and recreational fishing boats pass through the Inlet. Noise from construction, oil and gas platforms, and other coastal activities also have the potential to restrict the movements of Cook Inlet belugas. The majority of disturbing anthropogenic noise is found in upper Cook Inlet near Anchorage. Currently, passage within or between the critical habitat areas is unrestricted in Cook Inlet.

#### **4.2.5.5 PBF 5: Waters with in-water noise below levels resulting in the abandonment of critical habitat areas by Cook Inlet beluga whales**

Beluga whales are among the most adept users of sound of all marine mammals, and use sound rather than sight for many important functions, especially in the highly turbid waters of upper Cook Inlet. In Cook Inlet, belugas must compete acoustically with natural and anthropogenic sounds. Man-made sources of sounds in Cook Inlet include large and small vessels, aircraft, oil and gas drilling, marine seismic surveys, pile driving, and dredging.

### **4.3 Climate Change**

One factor affecting the rangewide status of listed species and their critical habitat at large is climate change. The Fifth Assessment Synthesis Reports from the Working Groups on the Intergovernmental Panel on Climate Change (IPCC) conclude that climate change is unequivocal (IPCC 2013, 2014). Oceans have warmed, with ocean warming the greatest near the surface (e.g., the upper 75 m have warmed by 0.11°C per decade over the period 1971 to 2010) (IPCC 2013, 2014). Global mean sea level rose by 0.19 m between 1901 and 2010, and the rate of sea level rise since the mid-nineteenth century has been higher than the mean rate during the

previous 2 millennia (IPCC 2013) The IPCC projects a rise of the world's oceans from 0.26 to 0.98 m by the end of the century, depending on the level of greenhouse gas emissions (Doney et al. 2012). Additional consequences of climate change include increased ocean stratification, decreased sea-ice extent, altered patterns of ocean circulation, and decreased ocean oxygen levels (IPCC 2013, 2014). Further, ocean acidity has increased by 26 percent since the beginning of the industrial era (IPCC 2013), and this rise has been linked to climate change (Murray et al. 2014, Okey et al. 2014, Secretariat of the Convention on Biological Diversity 2014, U.S. Government Accountability Office 2014, Andersson et al. 2015). Climate change is also expected to increase the frequency of extreme weather and climate events including, but not limited to, cyclones, heat waves, and droughts (IPCC 2014) In addition, climate change is expected to result in the expansion of low oxygen zones in the marine environment (Gilly et al. 2013).

Climate change has the potential to impact species abundance, geographic distribution, migration patterns, timing of seasonal activities (IPCC 2014), and species viability into the future (Bellard et al. 2012). Though predicting the precise consequences of climate change on highly mobile marine species, such as Cook Inlet belugas, is difficult (Simmonds and Isaac 2007), recent research has indicated a range of consequences are already occurring.

Marine species ranges are expected to shift as they align their distributions to match their physiological tolerances under changing environmental conditions (Doney et al. 2012). These shifts have implications throughout the food web. Hazen et al. (2012) examined top predator distribution and diversity in the Pacific Ocean in light of rising sea surface temperatures using a database of electronic tags and output from a global climate model. The authors predicted up to a 35 percent change in core habitat area for some key marine predators in the Pacific Ocean, with some species predicted to experience gains in available core habitat and some species predicted to experience losses. Macleod (2009) estimated, based upon expected shifts in water temperature, that 88 percent of cetaceans would be affected by climate change, with 47 percent likely to be negatively affected.

Species that are shorter-lived, of larger body size, or generalist in nature are likely to be better able to adapt to climate change over the long term versus those that are longer-lived, smaller-sized, or rely upon specialized habitats (Purvis et al. 2000, Brashares 2003, Cardillo 2003, Cardillo et al. 2005, Isaac 2009, Silber et al. 2017). Climate change is most likely to have its most pronounced effects on species whose populations are more vulnerable because of certain ecological and life history traits, e.g., those with limited ranges and/or specialized habitat requirements (Isaac 2009, Silber et al. 2017). As such, we expect the risk of extinction to listed species to rise with the degree of climate shift associated with global warming. The limits to acclimatization or adaptation capacity are presently unknown. But mass extinctions occurring during much slower rates of climate change in Earth history suggest that evolutionary rates in some organisms may not be fast enough to cope (IPCC 2014).

Acevedo-Whitehouse and Duffus (2009) also proposed that the rapidity of environmental changes, such as those resulting from global warming, can harm immunocompetence and reproductive parameters in wildlife to the detriment of population viability and persistence. Additionally, altered ranges can result in the expansion or shift in range of competing species or novel diseases to new areas (Simmonds and Elliott 2009). It has also been suggested that

increases in harmful algal blooms could be a result of increases in sea surface temperature (Moore et al. 2008).

## 5 Environmental Baseline

For the reasons explained above, effects of the proposed action on Cook Inlet beluga critical habitat are the focus of this opinion. Therefore, this section describes baseline conditions in Cook Inlet that are relevant to our analysis of effects on this critical habitat, rather than throughout the action area. The “environmental baseline” includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in-progress (50 CFR 402.02).

This section focuses on existing natural and anthropogenic stressors within the action area and their influences on Cook Inlet beluga critical habitat. Cook Inlet is the most human-populated and fastest growing region in Alaska (Hunsinger et al. 2018). Human activity, especially within upper Cook Inlet, has produced a number of anthropogenic stressors that affect the critical habitat, including: coastal development, oil and gas development, natural and anthropogenic noise, water pollution, fisheries harvest, and research. The critical habitat is also affected by climate and environmental change, as well as natural sources of noise. Cook Inlet beluga critical habitat may be affected by multiple stressors at any given time, compounding the impacts of individual stressors (NMFS 2016b).

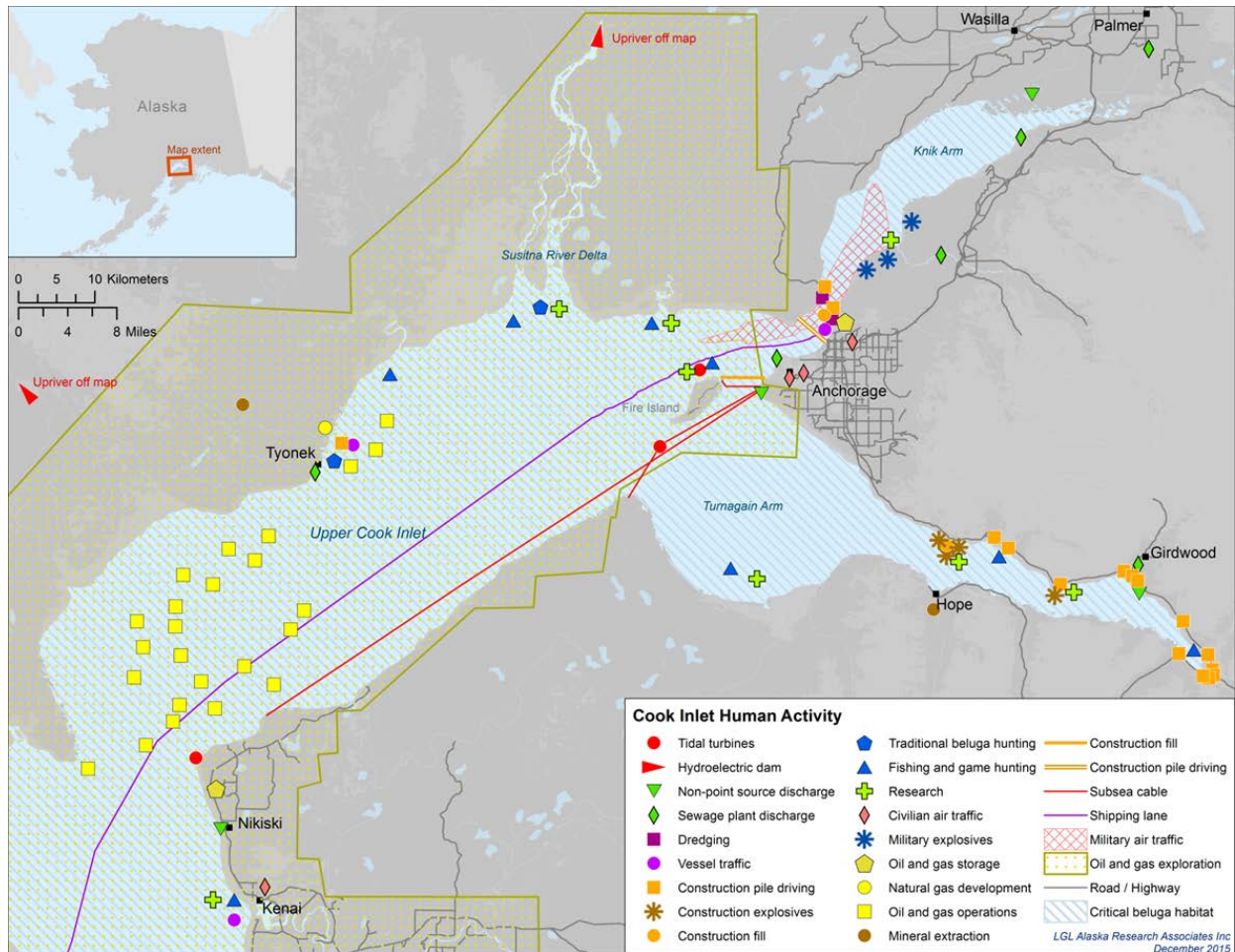
The following discussion addresses individually the principal natural and anthropogenic stressors that affect Cook Inlet beluga critical habitat. For additional information on all stressors affecting Cook Inlet belugas and their habitat, please refer to the following documents:

- Marine mammal stock assessment reports for the Cook Inlet stock of beluga whales (most recently, Muto et al. 2018); available online for the Alaska Region at: <https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region>
- Cook Inlet Beluga whale recovery plan; available from the NMFS website at: <https://www.fisheries.noaa.gov/resource/document/recovery-plan-cook-inlet-beluga-whale-delphinapterus-leucas>
- Cook Inlet beluga whale endangered species listing determination and supporting documents; available from the NMFS website at: <https://www.fisheries.noaa.gov/action/listing-cook-inlet-beluga-whale-under-esa>

### 5.1 Coastal Development

An estimated 62 percent of Alaska's human population (737,080) resides within the Anchorage and Matanuska-Susitna region (401,649) and the Kenai Peninsula Borough (58,024) in the Cook Inlet region (Hunsinger et al. 2018). Coastline development can lead to both direct habitat loss from construction of roads, housing or other shoreline developments, and indirect loss associated with bridges, boat traffic, in-water noise, and discharges that affect water quality.

The overwhelming majority of Cook Inlet shoreline is undeveloped, but there are municipalities, port facilities, airports, domestic WWTFs, roads, mixing zones, and railroads that occur along or close to the shoreline, particularly in upper Cook Inlet within areas designated as Cook Inlet beluga critical habitat (Figure 7). Knik Arm supports the largest port and military base in the state. Construction in Cook Inlet associated with coastal development includes dredging (e.g., at the Port of Alaska [POA]), road improvements (e.g., highway improvements along Turnagain Arm) and pile driving (e.g., at the POA, Ship Creek boat launch, Port MacKenzie, Seward Harbor, and several small projects in the Kachemak Bay area). In this section, we describe the physical aspects of development; noise aspects of development are discussed in Section 5.3.



**Figure 7. General geographic distribution of current and proposed human activities in upper Cook Inlet as of December 2015 (from NMFS 2016b).**

### 5.1.1 Road Construction

The Alaska Department of Transportation undertook Seward Highway improvements from Mile 75 to 107 (along Turnagain Arm) beginning in 2015. These activities included geophysical and geotechnical testing, on-shore blasting, pile removal and installation at stream crossings, fill placed into Turnagain Arm to facilitate roadway straightening, and construction of a boat ramp at Windy Point.

During marine mammal monitoring efforts for this project at Twentymile Bridge in April 2015, belugas were observed on 15 of the 16 days of monitoring. Even though no in-water activities occurred at night (at Twentymile Bridge), roadway flaggers present throughout the night indicated they could hear belugas at the bridge site during nighttime hours. Eighteen observations of beluga groups, ranging in size from 3 to 30 individuals, were recorded. Shutdowns typically occurred when belugas were at the mouth of Twentymile River to ensure the animals did not enter the harassment zone during in-water activities (HDR 2015). No takes of belugas were reported to have occurred during project activities, although project operations were shut down over a dozen times.

### **5.1.2 Port Facilities**

Cook Inlet has port facilities at Anchorage, Point Mackenzie, Nikiski, Kenai, Homer, Seldovia, and Port Graham; barge landings are present at Tyonek, Drift River, and Anchor Point. Anchorage has a small boat ramp near Ship Creek, which was renovated in 2017. It is the only hardened public access boat ramp in upper Cook Inlet. However, numerous other boat launch sites (e.g., beach launch at Tyonek, Captain Cook State Recreation Area, City of Kenai boat launch, multiple boat launch locations near the mouth of the Kenai River, and Kasilof River State Recreation Site) provide access to small boats in Cook Inlet.

#### **5.1.2.1 Port of Alaska**

The POA, located in upper Cook Inlet in Anchorage, is Alaska's largest seaport and provides 90 percent of the consumer goods for about 85 percent of all of Alaska (POA 2018). Operations began at the POA in 1961 with a single berth. Since then, the POA has expanded to a total of four bulk carrier berths and two petroleum berths that handle more than 3.5 million tons of fuel and cargo each year (POA 2018). It also has two railway spurs, and a small craft floating dock, and 89 hectares (220 acres) of land facilities. During 2016, there were 846 cargo vessel calls at the POA (U.S. Department of Transportation 2017).

The POA is in the process of further updating the facilities, including increasing the number and size of berths and making changes to accommodate larger vessels (e.g., deeper draft, longer berths). During 2016, the POA conducted a test-pile program to evaluate sound attenuation devices for potential use on the many piles they plan to drive during future port expansion efforts.<sup>7</sup>

Maintenance dredging at the POA began in 1965, and is an ongoing activity from May through November in most years, affecting about 40.5 hectares (100 acres) of substrate per year. Dredging at the POA does not seem to be a source of re-suspended sediments (U.S. Army Corps of Engineers 2008), and belugas often pass near the dredge.

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<sup>7</sup>The POA had plans to begin construction of a petroleum-cement terminal in 2018, but this project has been delayed until 2019.



### 5.1.2.2 Port MacKenzie

Port MacKenzie is located along western lower Knik Arm. Coastal development at this site began in 2000 with the construction of a barge dock. Additional construction and bulkhead repair activity has occurred since then. Port MacKenzie currently consists of a 152-meter (500-foot) bulkhead barge dock, a 366-meter (1,200-foot) deep draft dock with a conveyor system, a landing ramp, and more than 3,642 hectares (9,000 acres) of adjacent uplands (Matanuska-Susitna Borough 2018). Current operations at Port MacKenzie may include dry bulk cargo movement and storage, depending on the current state of the port and existing demand for its facilities. The seawall to this port has failed twice (in the winters of 2015 to 2016 and 2016 to 2017), necessitating emergency pile driving and other repair measures to avoid additional loss of fill and damage to sheet piles.

### 5.1.2.3 Other Ports

The Drift River facility in Redoubt Bay is used primarily as a loading platform for shipments of crude oil. The docking facility there is connected to a shore-side tank farm and is designed to accommodate tankers in the 150,000 deadweight-ton class. The Drift River Terminal had an original storage capacity of up to 6 million gallons of crude oil. In 2009, a volcanic eruption of Mount Redoubt forced the evacuation of the terminal and a draw-down of oil stored on-site (Alaska Journal of Commerce 2009). Hilcorp Alaska bought the facility in 2012 and, after numerous improvements, partially reopened the facility to oil storage and tanker loading operations. In June 2018, an application was submitted to the State of Alaska Regulatory Commission for approval to permanently discontinue use of and to remove or abandon the facility (Boettger 2018).

Nikiski is home to several privately owned docks. Activity at Nikiski includes the shipping and receiving of anhydrous ammonia, dry bulk urea, liquefied natural gas, sulfuric acid, petroleum products, caustic soda, and crude oil (NMFS 2008). In 2014, the Arctic Slope Regional Corporation expanded and updated its Rig Tenders Dock in Nikiski, in anticipation of increased oil and gas activity in Cook Inlet and to accommodate oil and gas development in the Chukchi and Beaufort seas (ASRC Energy Services 2014).

## 5.2 Oil and Gas Development

Cook Inlet has a long history of oil and gas activities. Activities occurring during the initial phases of oil and gas exploration and development include marine seismic exploration, geological and geophysical surveys, and exploratory drilling. Subsequent phases include development, production, and decommissioning activities, including installing on- and off-shore oil and gas pipelines, installing platforms and processing facilities, drilling production and service wells, and producing oil and gas. Increased vessel and air traffic occur in association with many of these activities.

Today, there are 17 offshore oil and gas platforms in Cook Inlet. These platforms and most of the associated infrastructure is more than 40 years old. Furie intends to drill up to five new wells in state waters of Cook Inlet in the Kitchen Lights Unit, which is located north of the East Foreland and south of the village of Tyonek (Figure 8). In 2017, NMFS completed ESA section 7



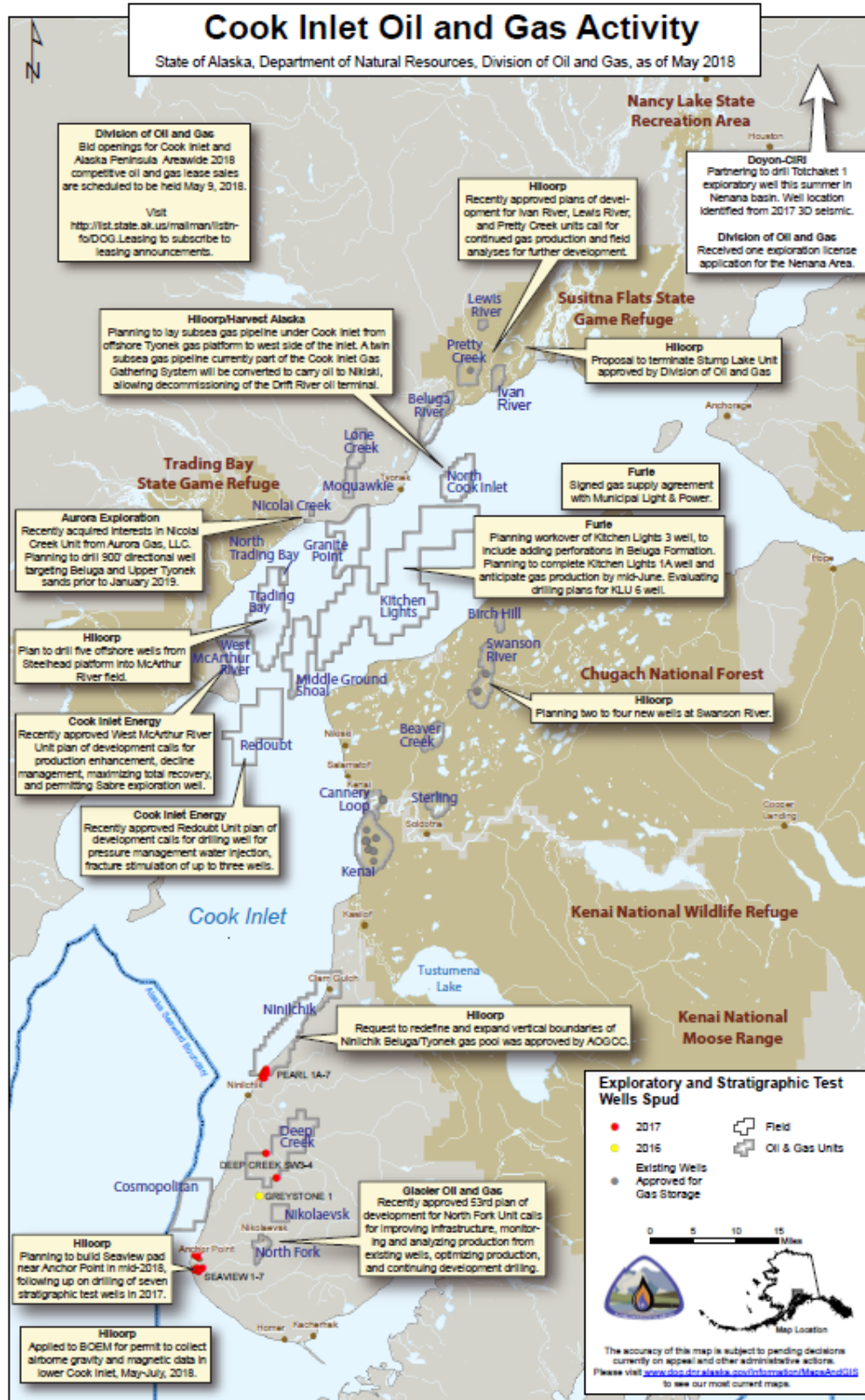


Figure 8. Oil and gas activity in Cook Inlet as of May 2018 (from ADNR 2018b).

consultation on Furie's plans to drill up to nine wells between 2017 and 2021 (NMFS 2017). Active oil and gas leases in Cook Inlet as of August 2018 total 209 leases encompassing approximately 182,875 hectares (451,895 acres) of state-leased land of which 125,505 hectares (310,129 acres) are offshore (Alaska Department of Natural Resources [ADNR] 2018a). Hilcorp was the only company that responded, submitting bids on 14 of 224 tracts/blocks offered, encompassing 12,547 hectares (31,005 acres) (Bureau of Ocean Energy Management 2018). Cook Inlet is estimated to have 500 million barrels of oil and over 538 billion cubic meters (19 trillion cubic feet [ft<sup>3</sup>]) of natural gas that are undiscovered and technically recoverable (Wiggin 2017).

Within the Kitchen Lights Unit (Figure 8), Furie intends to drill up to nine wells between 2017 and 2021. Actions associated with this proposed activity include transport of a jack-up rig by up to three tugs to the drilling sites, high-resolution geophysical surveys, pile driving at each drilling location, drilling operations, vessel and air traffic associated with rig operations, fuel storage, and well completion activities. The noise produced by these activities has the potential to affect Cook Inlet belugas and their designated critical habitat. NMFS completed formal ESA section 7 consultation on this action in 2017 (NMFS 2017). The action was subsequently modified to further reduce impacts to ESA listed species, and NMFS completed informal ESA section 7 consultation on Furie's drilling operations in 2018 covering the period 2018–2021.

Pipelines are an integral part of oil and gas activities in Cook Inlet. As of 2013, there were approximately 365 km (227 miles) of undersea pipelines in Cook Inlet, including 126 km (78 miles) of oil pipelines and 240 km (149 miles) of gas pipelines (ADNR 2015). ESA section 7 consultation was completed in April 2018 on issuance of a U.S. Army Corps of Engineers permit and incidental harassment authorization (IHA) for Harvest's Cook Inlet cross-inlet pipeline extension project (NMFS 2018a).

The existing Kenai LNG liquefaction and terminal complex adjacent to the coast of Cook Inlet began operating in 1969. Until 2012, it was the only facility in the United States authorized to export liquefied natural gas (LNG) produced from domestic natural gas. But with LNG shipments from the terminal declining, the terminal's owner announced in mid-2017 that it would put the plant in long-term shutdown (Brehmer 2017). The facility was sold in 2018 to the owner of the Kenai Refinery in Nikiski, which was also acquired by this owner in 2017.

The Alaska LNG project is being designed to carry natural gas from the North Slope to southcentral Alaska. Proposed infrastructure includes an approximately 1,287-kilometer (800-mile) long, large diameter pipeline from the North Slope that may cross Cook Inlet north of the Forelands and terminate at a liquefaction terminal proposed in the Nikiski area on the Kenai Peninsula. The proposed Alaska LNG terminal could eventually ship up to 68 million cubic meters (2.4 billion ft<sup>3</sup>) of LNG per day (U.S. Energy Information Administration 2017). The Federal Energy Regulatory Commission set a timeline for environmental review of the Alaska LNG project to receive its final environmental impact statement by December 2019.

Based on existing active leases and estimates of undeveloped oil and gas resources, oil and gas development will likely continue in Cook Inlet; however, the overall effects on Cook Inlet belugas are unknown (NMFS 2008). Potential impacts from oil and gas development on Cook Inlet beluga critical habitat include increased noise from seismic surveys, vessel traffic, air

traffic, drilling, discharge of wastewater and drilling muds, habitat loss from the construction of oil and gas facilities, and contaminated food sources resulting from an oil spill or natural gas blowout (NMFS 2008). In-water noise and water quality and pollution are addressed individually in Sections 5.3 and 5.4, respectively.

### **5.3 In-Water Noise**

Because PBF 5 of Cook Inlet beluga critical habitat pertains to in-water noise, this opinion considers noise as a separate category of the environmental baseline, although it is generally attributable to other factors in the baseline, such as coastal development and oil and gas development.

Underwater sound levels in Cook Inlet arise from many sources, including physical noise, biological noise, and human-caused noise. As discussed in the Cook Inlet beluga recovery plan (NMFS 2016b), the acoustic environment of Cook Inlet is naturally noisy, complex, and dynamic. Physical noise sources in Cook Inlet are particularly abundant in the hearing range of belugas and include: bottom substrate being transported by high currents, sand and mud bars generating breaking waves during low tide/high current periods, river mouths becoming rapids at low tide periods, and fast and pancake ice being formed during winter months and under continuous mechanical stress by high tide oscillations and currents (NMFS 2016b). Biological noise includes sounds produced by marine mammals, fishes, and invertebrates. Anthropogenic noise consists of sounds from vessel motor sounds, oil and gas operations, maintenance dredging, aircraft overflights, and construction. Most sources of anthropogenic noise are seasonal and occur during the ice-free months, although some sources are present year-round.

The PBFs of Cook Inlet beluga critical habitat include primary prey species (PBF 2), which could be exposed to human-caused noise. Recent literature reviews on the effects of sound on fish (Popper and Hastings 2009) conclude little is known about these effects and that it is not yet possible to extrapolate from one experiment to other signal parameters of the same noise, to other types of noise, to other effects, or to other species. Recently, McCauley et al. (2017) reported on the impacts of seismic exploration on zooplankton, effects which can be passed on through disruption of a cornerstone of marine food webs. However, it is unknown how seismic effects to local zooplankton populations may affect their availability as food in a system like Cook Inlet, which is subject to extreme tidal action and fairly rapid turnover of water (on the order of a few weeks) due to a net outflow of water resulting from freshwater inputs throughout the basin (see Section 5.8).

#### **5.3.1 Vessel Noise**

Cook Inlet is a regional hub of marine transportation throughout the year, and is used by various classes of vessels, including containerships, bulk cargo freighters, tankers, commercial and sport-fishing vessels, and recreational vessels. Vessel traffic density in Cook Inlet is concentrated along the eastern margin of the Inlet between the southern end of the Kenai Peninsula and north to Anchorage (Figure 9). Oil produced on the western side of Cook Inlet is transported by tankers to refineries on the east side of the Inlet. Refined petroleum products are then shipped elsewhere. LNG is also transported via tankers once it is processed (ADNR 2015). As noted in

Section 5.1.2, there are plans to decommission the Drift River Terminal, which would eliminate one substantial source of tanker traffic in Cook Inlet.

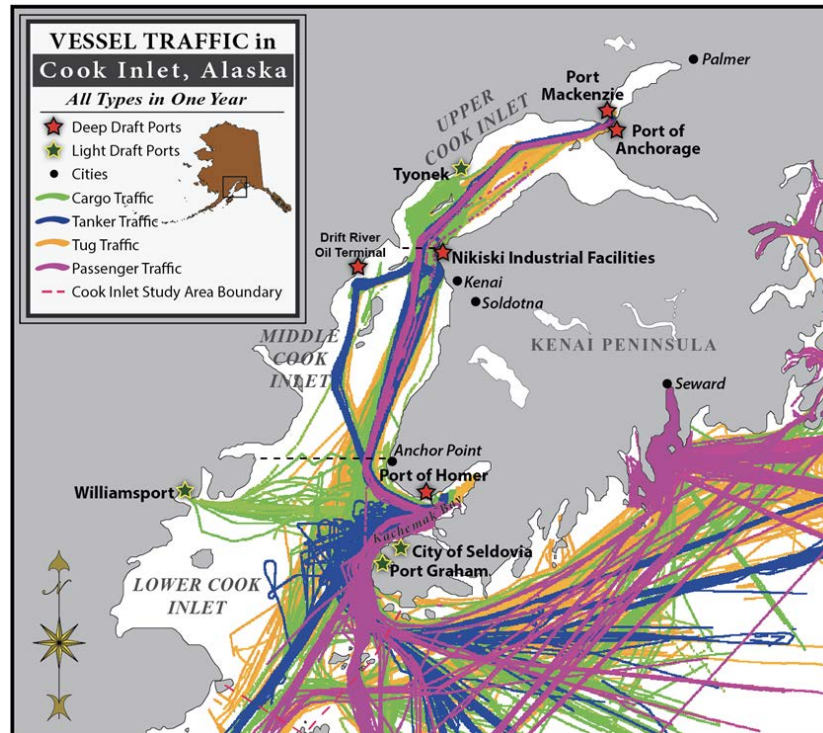


Figure 9. Annual vessel traffic in Cook Inlet by vessel type (from Cape International 2012).

## 5.3.2 Oil and Gas Operations

### 5.3.2.1 Seismic Survey Noise

Seismic surveys use high energy, low frequency sound in short pulse durations to characterize subsurface geology (Richardson et al. 1995), often to determine the location of oil and gas reserves. Geophysical seismic activity has been described as one of the loudest underwater anthropogenic sources of noise (Broad 2012), with the potential to harass or harm marine mammals, including belugas.

From 2004 to 2014, some 1,167 line kilometers (725 line miles) of 2D seismic and 1,709 square kilometers (660 square miles) of 3D seismic were collected in the Cook Inlet area (Wiggin 2017). Seismic surveys were also conducted in upper Cook Inlet in 2015 by SAE and in 2016 for the Alaska LNG project. In the past, large airgun arrays of greater than 3,000 cubic inches (in<sup>3</sup>) were used for seismic exploration in Cook Inlet; these arrays can produce source noise levels exceeding 240 dB re 1  $\mu$ Pa rms.<sup>8</sup> However, smaller arrays are now being used in Cook Inlet

<sup>8</sup> Sound pressure is the sound force per unit micropascals ( $\mu$ Pa), where 1 pascal (Pa) is the pressure resulting from a force of one newton exerted over an area of one square meter. Sound pressure level is expressed as the ratio of a measured sound pressure and a reference level. The commonly used reference pressure level in acoustics is 1  $\mu$ Pa and the units for underwater sound pressure levels are decibels (dB) re 1  $\mu$ Pa. Root-mean-square (rms) is the square root of the arithmetic average of the squared instantaneous pressure values.

because of the generally shallow-water environment and the increased use of ocean-bottom cable and ocean-bottom node technology (Borman 2012).

### **5.3.2.2 Oil and Gas Drilling and Production Noise**

Blackwell and Greene (2003) recorded underwater noise produced at Phillips A oil platform (now the Tyonek platform) at distances ranging from 0.3 to 19 km (0.2 to 12 miles) from the source. The highest recorded sound pressure level was 119 dB re 1  $\mu$ Pa rms at a distance of 1.2 km (0.75 miles). The noise from the platform was operating, not drilling noise. Much of the sound energy associated with the platform noise was below the hearing thresholds for beluga whales; however, some noises between 2 to 10 kHz were measured as high as 85 dB re 1  $\mu$ Pa rms as far away as 19 km (12 miles) from the source. Although audible to belugas, these frequencies are not within their most sensitive hearing range. Jack-up drilling rigs with the platform and generators located above the sea are relatively quiet compared to drill ships or semi-submersible drill rigs (Richardson et al. 1995).

### **5.3.3 Aircraft Noise**

The airspace above Cook Inlet receives significant levels of aircraft traffic. Ted Stevens Anchorage International Airport is directly adjacent to lower Knik Arm and receives high volumes of commercial air traffic. It is also the second largest air cargo hub in the United States. Joint Base Elmendorf-Richardson (JBER) also has runways near lower Knik Arm. Lake Hood in Anchorage is the world's largest and busiest seaplane base and the only seaplane base in the United States with primary airport status (Federal Aviation Administration 2016). Other small public runways are found at Birchwood, Goose Bay, Merrill Field, Girdwood, Kenai Municipal Airport, Ninilchik, Homer, and Seldovia. Oil and gas development projects (see Section 5.2) often involve use of helicopters and fixed-winged aircraft, and aircraft are used for surveys of natural resources, including Cook Inlet belugas.

For an overhead sound source, such as an aircraft, most sound at angles more than 13 degrees from vertical is reflected and does not penetrate the water, especially in calm conditions (Richardson et al. 1995). Consequently, aircraft noise is primarily transmitted from air into the water within a narrow band centered on the flight path. Thus, a beluga below the surface would need to be nearly under an aircraft flight path to be exposed to elevated in-water noise from the aircraft.

### **5.3.4 Construction and Dredging Noise**

Pile driving and dredging are the primary sources of construction noise in Cook Inlet. The POA is dredged annually and is in need of extensive renovation. Corroding piles and decades of damage from Cook Inlet ice have weakened Terminal 1, where in summer 2017, a 25,855-kilogram (57,000-pound) fender fell off the dock while a cruise ship was in port. The renovations will entail driving many new piles to support new port structures. The POA has recently undertaken an outreach campaign to inform the public about the need for repairs. Port Mackenzie, located just 3.2 km (2 miles) away from the POA across Cook Inlet, has also undergone recent renovations requiring pile driving, including removal and installation of sheet piles.

The majority of such construction activities have taken place near Anchorage; therefore, most of the studies documenting construction noise in Cook Inlet have occurred in this part of the upper Inlet. Moreover, these studies have focused almost exclusively on pile driving because of the concerns of potential harassment to belugas from this activity. As a result there is very little to no documentation of noise levels from other construction activity in Cook Inlet. Only a few studies have recorded dredging noise near the POA (Dickerson et al. 2001, URS 2007).

Small and/or private docks also may utilize pile driving as a part of their expansions or repairs, (e.g., the Offshore Systems Kenai dock in Nikiski was approved to be upgraded and expanded in 2012). Repair of sewage lines and construction of dock facilities occurred during the time that this project took place, which introduced noise to the marine environment, but there was no documentation of noise levels from this repair work.

## **5.4 Water Quality and Water Pollution**

The area surrounding Cook Inlet is the most populated and industrialized region of Alaska. Therefore, its waters are influenced by urban (and a small amount of agricultural) runoff, oil and gas activities (accidental spills, discharges of drilling muds and cuttings, production waters, deck drainage), effluent from municipal sewage treatment facilities, oil and other chemical spills, offal from seafood processing, and other regulated discharges (NMFS 2016b). Many of these pollutants are regulated by either EPA or ADEC, which may authorize certain discharges under the NPDES/APDES program.

The Cook Inlet beluga whale recovery plan (NMFS 2016b) indicates that the threat posed to Cook Inlet belugas from known and tested contaminants is in general of low relative concern. Lower trophic levels, including the primary prey species of Cook Inlet belugas (PBF 2) are exposed to pollutants in Cook Inlet. It is possible that the quality of prey items of the Cook Inlet belugas could be affected as a result of contamination. Exposure to pollutants may also affect the prey species themselves in terms of impacts on survival and reproduction.

### **5.4.1 Wastewater Discharges**

#### **5.4.1.1 Municipal Wastewater**

Ten communities currently discharge treated municipal wastewater into Cook Inlet. Wastewaters entering these plants may contain a variety of organic and inorganic pollutants, metals, nutrients, sediments, bacteria and viruses, and other emerging pollutants of concern (EPOCs) (Norman et al. 2015). A brief description of EPOCs is provided in Section 5.4.6. Wastewater from the Municipality of Anchorage, Nanwalek, Port Graham, Seldovia, and Tyonek receive primary treatment, wastewaters from Homer, Kenai, and Palmer receive secondary treatment, and wastewaters from Eagle River and Girdwood receive tertiary treatment (Norman et al. 2015). Primary treatment is defined at 40 CFR 128.58(r) as screening, sedimentation, and skimming adequate to remove of at least 30 percent of the biochemical oxygen demanding material and of the suspended solids in the treatment works influent, and disinfection where appropriate. Secondary treatment involves adding a biological component to remove the remaining biodegradable organic material. Advanced treatment involves both primary and secondary

treatment as well as additional processes to increase the water quality of the discharge (EPA 2004).

The Anchorage John M. Asplund WWTF is the largest wastewater facility in Alaska and is located in upper Cook Inlet, with an outfall within Area 1 of Cook Inlet beluga critical habitat (in waters that meet the definition of PBF 1 of the critical habitat). Asplund WWTF provides primary treatment only and removes a monthly average of 78 percent of total suspended solids (TSS) and 34 percent of biochemical oxygen demand (BOD) constituents before discharge (CH2MHILL 2011). The facility was built in 1972, was upgraded in 1982, and was expanded and upgraded again in 1989 (design average flow of 58 million gallons per day [mgpd]). EPA issued a CWA section 301(h) waiver of secondary treatment and allows the direct discharge of wastewater from the Asplund WWTF into Cook Inlet near Point Woronzof after the wastewater has undergone primary treatment. Once the sediment is removed from the wastewater, the sludge is incinerated.

The outfall for the City of Kenai WWTF, which is one of the other larger municipal water treatment plants discharging into Cook Inlet (design flow of 1.3 mgpd and an average daily flow of 0.54 mgpd), is located within Area 2 of Cook Inlet beluga critical habitat near mouth of the Kenai River, a significant watershed for Pacific salmon (EPA 2016b). The City of Kenai has been taking steps to address ammonia effluent limits stipulated in the 2015 APDES permit for the facility, which are lower than discharge concentrations reported during the previous 5 years (ADEC 2015b, Alaska Office of Management and Budget 2015).

In addition, the Palmer WWTF, which discharges into the northernmost channel of the Matanuska River, is being upgraded to address numerous permit violations for pollutants including ammonia, fecal coliform, pH, BOD, and TSS, after Alaska reached a settlement agreement with EPA in 2017 (EPA 2017).

#### **5.4.1.2 Seafood Processing Waste**

There are a number of seafood processing facilities that are authorized to discharge effluents into Cook Inlet. For example, there are several seafood processing facilities with outfalls located in the lower Kenai River (see Section 6.2.2 for additional information). Discharged seafood processing wastes and wastewater may contain the waste fluids, heads, organs, flesh, fins, bones, skin, chitinous shells, stickwater (liquid pressed out of cooked fish) produced by the conversion of aquatic animals from a raw to marketable form, wash-down water including disinfectants; sanitary wastewater, and other wastewater. Major pollutants of concern include ammonia, BOD, nonpetroleum fats, oil, and grease, nutrients, and solids (NMFS 2016b).

#### **5.4.1.3 Oil and Gas**

As discussed in Section 5.2, Cook Inlet has a long history of oil and gas exploration and development. Many of the discharges from oil and gas facilities are currently covered under general permits, and a few are authorized under individual permits. In recent years, EPA and ADEC have been working toward dividing EPA's 2007 general permit for Cook Inlet oil and gas activities into separate general permits for Federal and state waters. The agencies replaced the exploration components of the 2007 general permit with two separate general permits in 2015



(ADEC) and 2016 (EPA). The development and production components of the 2007 general permit have been administratively extended to remain in effect until a general permit is issued by ADEC for these activities in Cook Inlet.

Areas covered under the EPA and ADEC general permits for oil and gas exploration in Cook Inlet are illustrated in Figure 10. A number of areas are excluded from coverage, including Cook Inlet waters within 4 km of: (1) a coastal marsh, river delta, or river mouth; (2) a State Game Refuge, State Game Sanctuary, or State Critical Habitat Area; and (3) parts of Chinitna, Kamishak, and Tuxedni Bays, as well as an area near Port Graham/Nanwalek. Oil and gas related discharges to these areas would require authorization under an individual permit.

The types of oil and gas discharges authorized under general or individual permits may include, but are not limited to, drilling fluids and drill cuttings, deck drainage, sanitary wastes, domestic wastes, desalination unit wastes, blowout preventer fluid, boiler blowdown, fire control system test water, non-contact cooling water, uncontaminated ballast water, bilge water, water flooding discharges, produced water and produced sand, completion fluids, workover fluids, well treatment fluids, test fluids, mud, cuttings, and cement at seafloor, and storm water runoff from onshore facilities. Effluent is discharged either directly into Cook Inlet or piped from a platform to a shore-based facility, which then either discharges directly into Cook Inlet or sends treated effluent back to the platform.

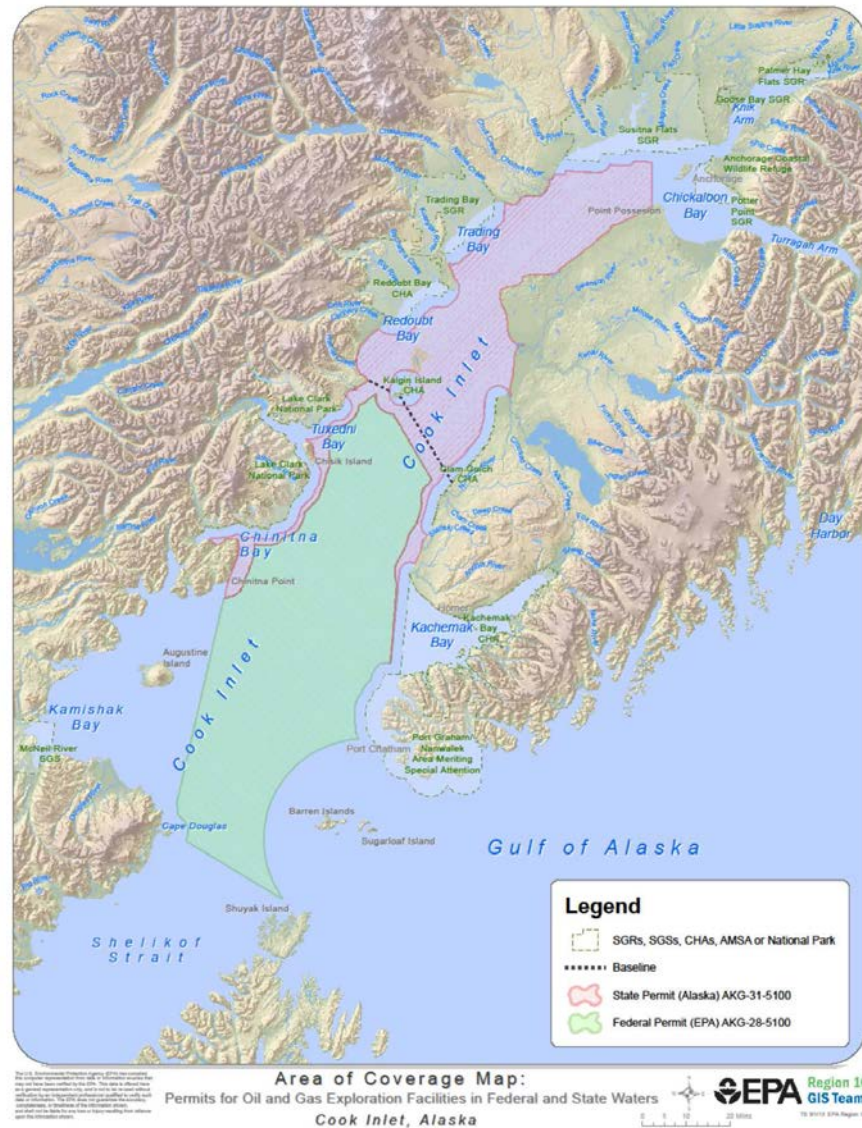
Potential spills associated with these facilities are also a concern with respect to offshore oil and gas production, petroleum product shipment, and general vessel traffic (see Section 5.4.5).

#### **5.4.1.4 Mixing Zones**

As explained in Section 2.1, in some but not all cases, a discharge permit may authorize a mixing zone within which specified WQC may be exceeded, but in waters beyond which all applicable WQC must be met. Based on information provided by ADEC to EPA (EPA 2016b), and supplemented by permit information obtained by NMFS, mixing zones are currently authorized within state waters of Cook Inlet and its tributaries under approximately 48 permits for discharges associated with oil and gas facilities, municipal WWTFs, seafood processing facilities, and other industrial facilities. Under these permits, there are multiple mixing zones authorized for some of these facilities and some seafood processing vessels are authorized to discharge into mixing zones in multiple locations. It should be noted that there may also be mixing zones associated with placer mining located in typically remote streams within the Cook Inlet watershed that were not included in the above summary. The statewide general permit for mechanical placer mining allows for mixing zones to be authorized in individual permits for turbidity (ADEC 2015a).

The Asplund WWTF, which discharges a large volume of effluent into Cook Inlet after primary treatment, is operating under an EPA-issued NPDES permit that is currently undergoing substantial reanalysis by EPA in response to a request by ADEC to renew the 301(h) waiver of secondary treatment requirements under the CWA (EPA 2016b). Therefore, the mixing zone associated with the Asplund WWTF is included in the baseline, but is not considered an aspect





**Figure 10. Areas of general permit coverage for oil and gas exploration discharges in Cook Inlet (EPA 2016a).**

of the proposed action that is the subject of this consultation. The regulatory mixing zone (“zone of initial dilution” in the discharge permit) for this facility is sizeable, with a radius of 649 m (2,130 ft) centered 30.5 m (100 ft) shoreward of the outfall, which is located 245 m (804 ft) from shore off Point Woronzof in water with a depth of 4.6 m (15 ft) MLLW (CH2MHILL 2011). Initial dilution was described in the permit as rapid, normally completing within several minutes after discharge. According to the *Fact Sheet* for the permit (EPA 2000b), modeling indicated discharge plumes are generally long and narrow; only at slack tides do they spread out, and then switch quickly when tidal directions change. The longest plumes to reach the criterion set out for completion of initial dilution were about 649 m (which was used as the radius for the mixing zone authorized in the discharge permit). For most hours during the day, the width of the plume is less than about 50 m (165 ft). However, during slack tide, plume widths reached over 200 m (656 ft) for the maximum discharge rate.

### **5.4.2 Stormwater Runoff**

Stormwater pollutants may include street and aircraft deicer, oil, pesticides and fertilizers, heavy metals, and fecal coliform bacteria. The Municipality of Anchorage Watershed Management Service and the Alaska Department of Transportation and Public Facilities (DOT&PF) are responsible for identifying, monitoring, and controlling pollutants in stormwater within the Municipality of Anchorage and in State of Alaska rights-of-way owned or operated by DOT&PF. Stormwater from other communities in the action area (e.g., Kenai) may also contribute to pollutants that enter Cook Inlet. The effects of stormwater on the Cook Inlet beluga have not been studied and are unknown (NMFS 2008).

Numerous releases of petroleum hydrocarbons have been documented from the POA, JBER, and the Alaska Railroad Corporation. The POA transfers and stores petroleum oils, as well as other hazardous materials, and since 1992, all significant spills and leaks have been reported. Past spills have been documented at each of the bulk fuel facilities within the POA and also on JBER's property (JBER 2015).

JBER is listed on the National Priorities List under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, because of known or threatened releases of hazardous substances, pollutants, or contaminants. Spills have also been reported at the Alaska Railroad Corporation rail yard. In 1986, petroleum seeped into Ship Creek from the nearby rail yard, and several oil spills occurred in 2001 (JBER 2015). Freight handling activities have historically caused numerous surface stains and spills at the rail yard.

### **5.4.3 Aircraft De-icing**

Airport-based deicing contributes to the levels of pollutants found in Cook Inlet. Deicing and anti-icing of aircraft and airfield surfaces are required by the Federal Aviation Administration to ensure the safety of passengers. Deicing and anti-icing chemicals are used from October through May and may be used on aircraft, tarmacs, and runways (NMFS 2008). Depending on the application, deicing material is composed of different chemicals. Ethylene glycol and propylene glycol are used on aircraft for anti-icing and deicing purposes, whereas potassium acetate and urea are used to deice tarmacs and runways (NMFS 2008). Much of the deicing material or their breakdown products eventually enter Cook Inlet. No studies exist analyzing the potential impacts on beluga whales from these deicing agents.

The Ted Stevens Anchorage International Airport and JBER airport are the largest airports in Cook Inlet. Other smaller airports exist throughout the Cook Inlet watershed, including Merrill Field, Lake Hood, and Lake Spenard.

### **5.4.4 Ballast Water Discharges**

Discharges of wastes from vessels are regulated by EPA and the U.S. Coast Guard. Potential discharges include oily waste, sewer water, gray water (e.g., shower water), ballast water that may contain invasive marine species, and garbage. Gray water and sewer water, provided that they are free from oil waste, may be discharged in the open sea. However, by law, no discharges of any kind are allowed within 3 miles of land.

Ships can potentially release pollutants and non-indigenous organisms into Cook Inlet through the discharge of ballast water. It is a recognized worldwide problem that aquatic organisms picked up in ship ballast water, transported to foreign lands, and dumped into non-native habitats are responsible for significant ecological and economic perturbations costing billions of dollars. The National Ballast Information Clearinghouse reported that more than 5 million metric tons of ballast water were released in Cook Inlet, from Homer to Anchorage, between 1999 and 2003 (JBER 2015). Invasive species were found just off the POA in a 2004 survey by the Smithsonian Environmental Center (JBER 2015). The effects of discharged ballast water and possible invasive species from such discharges on Cook Inlet belugas and their designated critical habitat are unknown. In order to try to protect Alaska's waters, ADF&G developed an aquatic nuisance species management plan (Fay 2002).

#### **5.4.5 Point Source Contaminant Spills/Releases**

Given the amount of oil and gas production, vessel traffic, and coastal development, particularly in upper Cook Inlet, contaminant spills, in particular petroleum spills, are a source of concern for Cook Inlet belugas and their critical habitat. ADEC maintains a record of all spills of harmful substances. From 1994 to 2011, there were 255 events in or near Cook Inlet releasing more than 378.5 liters (L) (100 gallons) or 45.4 kg (100 lb) of reportable substances (ADNR, Division of Oil and Gas, 2011, unpublished data, as cited in NMFS 2016b). These spills included 90 events releasing a total of 318,713 L (84,195 gallons) of various types of oils (diesel, hydraulic, gasoline, engine lube, aviation fuel, and natural gas); 48 events releasing a total of 96,165 L (25,404 gallons) and 11,364,847 kg (25,055,199 lb) of hazardous materials (bases or alkaline substances, drilling muds, glycols, and urea); and 73 events releasing 110,332 kg (243,241 lb) and 5,958 L (1,574 gallons) of extremely hazardous substances (anhydrous ammonia, hydrochloric acid, and sulfur dioxide). According to the ADEC oil spills database (see ADEC 2018), oil spills to marine waters consist mostly of harbor and vessel spills, and spills from platform and processing facilities. Effects of these spills on listed species are unknown.

Research indicates cetaceans are capable of detecting oil, but they do not seem to avoid it (Geraci 1990). Related effects to Cook Inlet belugas associated with these events could include death or injury from swimming through oil (skin contact, ingestion of oil, respiratory distress from hydrocarbon vapors), contamination of food sources, or displacement from foraging areas (NMFS 2008). The paucity of data on oiled belugas makes it difficult to predict effects of spills on the whales. Oil spills that occur in or upstream of Cook Inlet beluga habitat could result in the whales experiencing direct contact with the oil, with possible effects to skin and/or respiratory systems. Cook Inlet belugas could be affected through residual oil from a spill, even if they were not present during the oil spill, because of the highly mobile nature of oil in water and the extreme tidal fluctuations in Cook Inlet (NMFS 2008). Prey contamination is also likely, but the effect of contaminated prey on belugas remains unknown. Spill clean-up efforts could also result in displacement of whales from essential feeding areas.

As discussed in Section 4.2.4, exposure to PAHs, a class of chemicals found in petroleum products, combined with a variety of other contaminants, has been associated with unusually high occurrence of cancer and other pathologic conditions in St. Lawrence beluga whales, and are otherwise a concern with respect to the conservation and recovery of Cook Inlet belugas.

### 5.4.6 Emerging Pollutants of Concern

Certain pollutants are regulated by the Alaska WQS; however, substances that are not specified in the Alaska WQS may be contained in authorized discharges within mixing zones, including endocrine disruptors, pharmaceuticals, personal care products, and prions (proteins that may cause an infection), amongst other bacterial and viral agents that are found in wastewater and biosolids. A brief description of these types of unregulated pollutants is provided below based on URS (2010). Data are limited or lacking on the occurrence and concentrations of these unregulated contaminants, particularly for those that may be found in mixing zone discharges into Cook Inlet and in the nearshore surface waters of Cook Inlet. Moreover, very little is known about unregulated compounds and their potential effects on Cook Inlet belugas and their critical habitat.

#### Pharmaceuticals and Personal Care Products

A variety of pharmaceuticals and personal care products are used by individuals for personal health or cosmetic reasons. Pharmaceuticals include over-the-counter medication (e.g., aspirin, acetaminophen, and pseudoephedrine) as well as medications prescribed by a physician (e.g., opioids, statins, amoxicillin). Most ingested pharmaceuticals are only partially metabolized, so a portion is excreted, unmetabolized, in urine or feces. Metabolized and unmetabolized pharmaceuticals are discharged in domestic sewage.

Personal care products include chemicals such as soaps, detergents, shampoo, cosmetics, sunscreen products, fragrances, insect repellants, and antibacterial compounds. An example of a personal care product is triclosan, a potent wide-spectrum antibacterial and antifungal agent. Personal care products enter domestic wastewater from bathing, laundry, and household cleaning.

#### Steroids and Hormones

Steroids and hormones include both naturally occurring compounds and synthetic analogues that are structurally related to one another. Hundreds of distinct steroids are found in plants and animals. Sterols, which are steroid-based alcohols, are the most abundant of the steroids. The most common sterol in vertebrates is cholesterol, which is found in cell membranes, and also serves as a central intermediate in the biosynthesis of many biologically active steroids, including bile acids, corticosteroids, and sex hormones.

Hormones are intercellular chemical messengers. They are synthesized and secreted from a cell and act in low concentrations by binding to a stereospecific target-cell receptor to activate a response. Some hormones are classified by chemical structure as steroids. Steroid hormones include the sex hormones, which are, among others, natural estrogens, synthetic estrogens such as EE2 (17 alpha-ethinyl estradiol), progesterone, and testosterone. Other hormones are polypeptides or amino acid-derived compounds.

#### Alkylphenols and Alkylphenol Ethoxylates

Alkylphenol ethoxylates (APEs) are synthetic surfactants used in some detergents and cleaning products. The most common APEs are nonylphenol ethoxylates, derived from nonylphenol, which is an alkylphenol. Octylphenol ethoxylates, derived from octylphenol, are also common.

## **Bisphenol**

Bisphenol A (BPA), also known as 4,4'-isopropylidenediphenol, is an organic compound used primarily to make polycarbonate plastic and epoxy resins. Polycarbonate is used in eyeglass lenses, medical equipment, water bottles, compact disks, digital versatile disks, and many other consumer products. Among the many uses for epoxy resins are can coatings, industrial floorings, automotive primers, and printed circuit boards.

## **Polybrominated Diphenyl Ethers**

Polybrominated Diphenyl Ethers (PBDEs) are structurally similar to polychlorinated biphenyl. PBDEs are major components of commercial formulations often used as flame retardants in furniture foam (e.g., pentaBDE), plastics for television cabinets, consumer electronics, wire insulation, back coatings for draperies and upholstery (e.g., decaBDE), and plastics for personal computers and small appliances (e.g., octaBDE). These chemicals slow ignition and rate of fire growth.

## **Perfluoroalkyl and Polyfluoroalkyl Substances**

Perfluoroalkyl and polyfluoroalkyl substances (PFAS) are a class of chemicals that resist heat, grease, and water. These substances have been used over the past several decades on fabric, food packaging, nonstick cookware, and in fire-fighting foam. Recently, PFAS and related compounds such as perfluorooctane sulfonate and perfluorooctanoic acid, have fallen out of favor as they have been linked with birth defects, various forms of cancer, and immune system dysfunction. Some firefighting agencies across the country, as well as military departments, have been curtailing their use for that reason. These chemicals are persistent, and resist degradation in the environment and for decades were disposed of in watersheds because they were unregulated. They also bioaccumulate, meaning their concentration increases over time in the blood and organs.

## **Pesticides**

Pesticides are any of a large number of unrelated chemicals that are used to prevent, destroy, or repel a living organism that occurs where it is not wanted (i.e., a pest). Pesticides are often referred to according to the type of pest they control (e.g., insecticides, rodenticides, fungicides). Pesticides include organochlorines, organophosphorus compounds, triazine, and pyrethroid pesticides.

## **5.5 Fisheries**

Commercial, personal use, recreational, and subsistence fisheries all occur within Cook Inlet. Fish harvested include, but are not limited to, all five Alaska Pacific salmon species, halibut and other groundfish species, and eulachon. Commercial harvest of salmon in Cook Inlet is substantial, averaging 3.5 million salmon per year in 2007 to 2016 (Shields and Frothingham 2018). Within that same time period, personal use salmon fisheries in the Kenai River, Kasilof River, and Fish Creek resulted in a total estimated annual harvest of about 460,000 fish (ADF&G 2018a). Fall et al. (2014) reported the historical average estimated subsistence harvest of salmon in the Cook Inlet area (1981 to 2011) at about 5,400 fish. Annual sport harvest of non-land-locked salmon within the Northern Cook Inlet sport fish management area in 2005 to 2015 averaged about 97,000 fish (Oslund et al. 2017). Estimated annual personal use harvest of eulachon from the Knik Arm and Westside Susitna River management units in 2005 to 2015

averaged about 2,500 fish and ranged from 71 to 6,763 fish (Oslund et al. 2017). Annual commercial harvest of eulachon (referred to as smelt in Shields and Frothingham 2018) in 2007 to 2017 averaged about 75.8 tons.

The operation of watercraft near the mouths and deltas of rivers entering Cook Inlet, Turnagain Arm, and Knik Arm can hinder belugas from using these waters in pursuit of eulachon and salmon. Belugas made regular use of the Kenai River during late March through April 2018, often traveling upriver more than 9.7 km (NMFS unpublished data). However, in recent years observations of belugas have not been reported in the Kenai River during time periods when salmon runs were strong and fishing activity (commercial, recreational, and personal use) was high (Shelden et al. 2015, Castellote et al. 2016).

There is a strong indication that these whales are dependent on access to relatively dense concentrations of high value prey species throughout the summer months (Norman et al. 2015). A significant reduction in the amount of available prey, or in their ability to reach or utilize feeding habitat, may diminish the conservation value of Cook Inlet beluga critical habitat, and may impact the whales' ability to accumulate sufficient food energy, with subsequent potential impacts on both survival and productivity, which may delay or preclude recovery (NMFS 2016b). The effects of the existing levels of fisheries harvest in Cook Inlet remain undetermined.

### **5.5.1 Subsistence, Personal Use, and Recreational Fisheries**

Alaska residents may participate in subsistence and personal use fisheries. Personal use salmon gillnet fishing occurs near the Kasilof River. Personal use dipnet fisheries for salmon in Cook Inlet occur in the Kenai and Kasilof Rivers and in Fish Creek in upper Cook Inlet. Subsistence fisheries in and near Cook Inlet are open to all Alaska residents, and occur near Tyonek, Seldovia, and Port Graham. Popular recreational fishing streams within the action area include anadromous streams along the west coast of Cook Inlet (Oslund et al. 2017). Eulachon harvest locations include areas from the Chuitna north to the Susitna and Little Susitna Rivers, including the waters of Turnagain Arm (Oslund et al. 2017). Groundfish (e.g., halibut, lingcod, and rockfish) are also harvested within the action area.

Potential impacts on the Cook Inlet beluga critical habitat from subsistence, personal use, and recreational fishing include the operation of small watercrafts in the mouths of streams and in shallow waters, displacement from important habitat, ship strikes, and reductions in the amount of available beluga prey (NMFS 2008). The overall impacts from subsistence, personal use, and recreational fishing on the recovery of the Cook Inlet population is thought to be low (NMFS 2008).

### **5.5.2 Commercial Fisheries**

There are several commercial fisheries in Cook Inlet, all of which require permits. ADF&G has management responsibility for most of the commercial fisheries in Cook Inlet, with the exception of halibut and a few federally managed fisheries in lower Cook Inlet. The state-managed commercial fisheries in Cook Inlet are divided into two management units: Upper Cook Inlet (UCI) and Lower Cook Inlet (Shields and Frothingham 2018). The UCI consists of all waters north of Anchor Point Light and is further divided into the Northern (north of the Forelands) and

Central districts (south of the Forelands to Anchor Point Light). Species commercially harvested in the UCI management unit include all five Pacific salmon species (drift and set gillnet), eulachon (dipnet), Pacific herring (gillnet), and razor clams; sockeye salmon are the most economically valuable species harvested (Shields and Frothingham 2018). The largest fisheries in Cook Inlet, in terms of participant numbers and landed biomass, are the state-managed salmon drift and set gillnet fisheries concentrated in the Central and Northern districts.

In 2017, approximately 2.6 million salmon were harvested commercially in the UCI management unit which was less than the average annual harvest for 1966 to 2017 (4.1 million fish) and for 2007 to 2016 (3.5 million fish) (Shields and Frothingham 2018). Even though all five Alaska species of Pacific salmon are caught in the UCI management unit, sockeye salmon is the primary target of the salmon commercial fisheries. Times of operation change depending upon management requirements, but in general the drift fishery operates from late June through August, and the set gillnet fishery during June through September. Salmon fishery effort varies between years, and within-year effort can be temporally and spatially directed through salmon management regulations. Although the number of permits fished in the UCI management unit salmon gillnet fisheries has been relatively constant, the actual number of fish caught has fluctuated greatly during the past 20 years (ranging from a high of 5.7 million in 2004 to a low of 2.0 million in 1998) (Shields and Frothingham 2018).

As noted in Section 4.2.5.2, Chinook salmon returns throughout much of Alaska have declined precipitously in recent years. Returns of these salmon in Cook Inlet have been hard-hit, leading to closures to both sport and commercial fisheries beginning in 2011 and 2012. Susitna River sockeye salmon were first designated as a stock of yield concern in 2008 (see Section 4.2.5.2). As a result, ADF&G and the Board of Fisheries developed restrictive management measures in those fisheries harvesting Susitna River sockeye salmon. However, even with the reduction in harvest, Susitna sockeye salmon warrant continued concern and they have remained a stock of yield concern (Shields and Frothingham 2018).

The herring fisheries are located in four subdistricts of the UCI management unit (Upper, West, Kalgin Island, and Chinitna Bay subdistricts); however, the Upper subdistrict fishery is the most productive one. In 2017, approximately 28.3 tons of herring were commercially harvested (Shields and Frothingham 2018). There are no overall commercial harvest limits for the razor clam fishery on the west side of Cook Inlet, which has historically occurred between the Crescent River and Redoubt Creek, though management of this fishery is intended to yield a maximum harvest of 158,757 to 181,437 kg (350,000 to 400,000 lb) (in the shell) annually (Shields and Frothingham 2018). The 2017 harvest, which was taken primarily from the Polly Creek and Crescent River areas, was approximately 80,286 kg (177,000 lb) in the shell (Shields and Frothingham 2018).

There was a sporadic fishery for eulachon in Cook Inlet from 1978 to 1999. NMFS made recommendations to the Alaska Board of Fisheries to discontinue this fishery effective in 2000, in part due to the lack of data on the eulachon runs into the Susitna River and the absence of any evaluation of the effect of this fishery on belugas in terms of disturbance/harassment or competition for these fish. Additionally, it was noted that belugas may be heavily dependent on the oil-rich eulachon early in the spring (preceding salmon migrations) and that large eulachon runs may occur in only a few upper inlet streams. The commercial fishery for eulachon was

reopened in 2005, but was restricted to hand-operated dip nets in salt water between the Chuit and Little Susitna Rivers, with a total harvest of 100 tons or less. This harvest cap was increased to 2,000 tons at the 2017 Alaska Board of Fisheries meeting. Subsequently, in 2017 it was estimated that approximately 9.3 tons of eulachon were commercially harvested (Shields and Frothingham 2018). Shields and Frothingham (2018) noted that it is possible that the estimated eulachon harvest, which was considerably lower than the annual estimated harvest in the previous 10 years (range: 39.1 to 107.0 tons), may have been due to much of the eulachon migration occurring before the arrival of harvesters.

## **5.6 Research**

Research is a necessary endeavor to assist in the recovery of the Cook Inlet beluga population; however, research activities can also affect Cook Inlet beluga whale critical habitat. Beluga surveys and research sometimes require boats, adding to the vessel traffic, noise, and pollution within Cook Inlet. Aerial surveys can also introduce noise into the water column. Deployment and retrieval of passive acoustic monitoring devices requires a boat, which temporarily increases noise in the immediate area. Although research may affect the critical habitat of Cook Inlet belugas, it is anticipated that research will continue to increase because there are many remaining data gaps on Cook Inlet beluga biology and ecology (NMFS 2016b). However, managers apply a precautionary approach to research, and strive to ensure that permitted research minimizes risks and impacts to Cook Inlet belugas and their critical habitat and maximizes the information gained toward recovery of the population.

## **5.7 Climate and Environmental Change**

Overwhelming data indicate the planet is warming (IPCC 2014), which poses a threat to most Arctic and sub-Arctic marine mammals. In Alaska, average annual air temperatures have warmed at a rate more than twice that of other U.S. states over the past 60 years (Chapin et al. 2014), as well as more than twice that of the global rate over the past 50 years (U.S. Global Change Research Program 2017).

Cook Inlet is a very dynamic environment that experiences continual change in its physical and structural composition; there are extreme tides, strong currents, and a tremendous volume of silt input from glacial scouring. Climate-driven changes in glacial melt are presumed to have profound effects on seasonal streamflow within the Cook Inlet basin, affecting both anadromous fish survival and reproduction in unpredictable ways. Changes in glacial outwash will also likely affect the chemical and physical characteristics of Cook Inlet's estuarine waters, possibly changing the levels of turbidity in the inlet. In addition, more rapid melting of glaciers might significantly alter the silt deposition in the Susitna River Delta, potentially altering habitat for prey (NMFS 2016b). Whether such a change disproportionately benefits or harms marine mammals, their prey, or their predators is unknown.

Cook Inlet beluga critical habitat may be affected by climate change and other large-scale environmental phenomena including Pacific Decadal Oscillation (a long-lived El Niño-like climate variability that may persist for decades) and ecological regime shifts. Climate change can potentially affect prey availability, glacial output and siltation, and salinity and acidity in downstream estuarine environments (NMFS 2016b). Pacific Decadal Oscillation may influence



rainfall, freshwater runoff, water temperature, and water column stability. Ecological regime shifts, in which species composition is restructured in association with abrupt changes in the climate, have been identified in the North Pacific (Hollowed and Wooster 1992, Anderson and Piatt 1999, Hare and Mantua 2000) and are believed to have affected prey species availability in Cook Inlet and the North Pacific. These events may result in seasonal and spatial changes in prey abundance and distribution and could affect the conservation value of designated critical habitat for Cook Inlet belugas. Reductions in seasonal ice in Cook Inlet may also result in increased vessel activity, with an associated increase in noise and pollution.

The extent to which such changes may impact the conservation value of designated critical habitat for Cook Inlet belugas is unknown. However, these impacts are likely to be most important if they affect the temporal availability of energy-rich prey such as Pacific salmon and eulachon (NMFS 2016b). Changes that result in decreases in specific runs or changes in the availability of prey (e.g., changes in fish schooling patterns or shallow nearshore terrain) may also leave temporal gaps in prey availability that could be detrimental to Cook Inlet belugas (NMFS 2016b). The whales may compete with other predators (e.g., harbor seals, harbor porpoise, sea otters, etc.) for available prey resources, and changes to the prey resources and distributions of these competitors as a result of climate change could also increase such competition.

## **5.8 Hydrodynamics of Cook Inlet**

Cook Inlet is a tidal estuary approximately 290 km long and 97 km wide (180 miles and 60 miles, respectively) at its mouth, with a general northeast-southwest orientation. Cook Inlet is divided into the upper and lower Inlet by the East and West Forelands, where the Inlet is approximately 16 km (10 miles) wide (Science Applications International Corporation 2001). Upper Cook Inlet is approximately 27 to 30 km (17 to 19 miles) wide and has relatively shallow water depths.

### **5.8.1 Currents and Tides**

The movement of water through Cook Inlet provides important context for understanding the potential effects of mixing zones on beluga critical habitat. It should be noted that much of what is known about the physical dynamics in Cook Inlet, some of which is summarized in this opinion, relates to ice-free conditions during late spring through early autumn, and considerably less is known about the physical dynamics of the Inlet during other parts of the year. Water circulation in Cook Inlet is characterized by variable tidal, seasonal, annual, and interannual timescales (Musgrave and Statscewich 2006). Tides in Cook Inlet are classified as mixed, having strong diurnal and semi-diurnal components, and are characterized by two unequal high and low tides occurring over a period of approximately one day, with the mean range increasing northward (Minerals Management Service [MMS] 2003). The region has the fourth largest tidal range in the world, and the circulation in Cook Inlet is dominated by tidally driven flows, with current speeds up to 3 meters/second (m/s) (6 knots) (Musgrave and Statscewich 2006). Knowledge of the tidal and subtidal currents in Cook Inlet is essential for determining and predicting transport pathways as they play a critical role in affecting potential pollutants and the fate of contaminants (Musgrave and Statscewich 2006).

The lunar semidiurnal tide is the principal tidal influence in Cook Inlet. Due to the size, shape, and bathymetry of the Cook Inlet basin, a funneling effect and tidal resonance create some of the highest tidal amplitudes in the world. Tidal ranges vary within Cook Inlet, from 4.9 m (16 ft) near Seldovia in Kachemak Bay to 8.2 m (27 ft) near Anchorage (Richardson and Schmalz 2012). This large tidal exchange within Cook Inlet causes strong tidal currents which drive the circulation in the broader Cook Inlet area (Bureau of Ocean Energy Management 2016). Tidal forces have a strong influence on salinity gradients as well. The general circulation pattern of lower and middle Cook Inlet is characterized by denser, saltier water that flows northward along the eastern shore and fresher, silty outflowing water moving southward along the western shore (Figure 14). Satellite imagery suggests that horizontal current speeds in Cook Inlet have large and frequent fluctuations, routinely near banks and shoals (Haley et al. 2000). These fluctuations create zones of divergence marked by upwelling where water appears to boil on the surface. Tidal currents are strongly polarized in the north-south direction, consistent with local bathymetry and the orientation of Cook Inlet (Musgrave and Statscewich 2006). Magnitudes are generally greater and more polarized in the middle portion of the inlet than near the shorelines. Subtidal current speeds are significantly weaker than tidal currents, but they may dominate transport processes at time scales which are longer than the dominant tidal periods (Musgrave and Statscewich 2006).

Oceanic water tends to travel up the eastern side of the inlet (EPA 2016b). It appears that the paths of incoming oceanic water and outgoing turbid water cross (at least at the surface) north of the Forelands (Figure 11). Convergence zones, known as tidal rips, are formed when the tidal and freshwater flows interact with the bathymetry. Cook Inlet's rip currents are strong and well-known. They appear to be well defined in the middle Inlet and weak or obscure in the upper Inlet. However, the rip currents that pass between the Forelands appear to be well-established on both flood tides and ebb tides (Figure 12) (EPA 2016b).

Upper Cook Inlet currents are predominantly tidally driven, with speeds primarily a function of the tidal range and orientation to bathymetric contours. The area near Tuxedni Bay and along the west side of Cook Inlet exhibits mean southward baroclinic<sup>9</sup> flow, whereas the area near Anchor Point and along the east side of Cook Inlet exhibits a weaker northward mean flow. There is a mean southward baroclinic flow between the Forelands (Okkonen et al. 2009). Johnson (2008) calculated tidal velocities using drifting buoys deployed northeast of Kalgin Island. Mean north-south tidal velocity was measured at 4.7 centimeters/second (cm/s) flowing southward, whereas the mean west-east velocity was measured at 3 cm/s towards the west (Johnson 2008). Musgrave and Statscewich (2006) utilized high frequency radar systems near the mouth of the Kenai River in upper Cook Inlet to measure surface currents. A persistent southward current was observed proximate to the northeast side of Kalgin Island at speeds up to 25 cm/s.

Lower Cook Inlet is influenced by the Alaskan Stream and by a parallel current in the western Gulf of Alaska called the Kenai Current or the Alaska Coastal Current (MMS 2003). The ACC flows along the inner shelf in the western Gulf of Alaska and enters Cook Inlet and Shelikof Strait (Royer 1981a, 1981b, Schumacher and Reed 1986). The current is narrow (less than 30 km [18.6 miles]) and high-speed (20 to 175 cm/s) with flow that is driven by fresh water discharge

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<sup>9</sup> Baroclinic denotes the depth-dependent part of the flow. The baroclinic component of the flow results from the density distribution of the fluid that varies due to different temperature and salinity waters.

and inner-shelf winds (MMS 2003). Peak velocities of 175 cm/s occur in September through October (Johnson et al. 1988). The Alaska Coastal Current transports volume ranging from 0.1 to 1.2 million cubic meters per second and varies seasonally in response to fresh water runoff fluctuations, regional winds, and atmospheric pressure gradients (Luick et al. 1987, Schumacher et al. 1989).

Oey et al. (2007) used a wetting and drying algorithm for the Princeton Ocean Model to model Cook Inlet baroclinic three-dimensional ocean circulation. The model showed upwelling and down-welling cells with strong horizontal and vertical velocities within the central portion of Cook Inlet due to fronts produced by convergence of salt water from lower Cook Inlet through the deep center channel with more fresh water from the upper Cook Inlet (Oey et al. 2007).

### 5.8.2 Freshwater Inputs

River discharge into the upper and western side of Cook Inlet greatly contributes to the freshwater inputs. The ACC and these freshwater inputs may account for most of the non-tidal influence on circulation in upper and middle Cook Inlet, except on the west side (Whitney 2002). The fresher water from the upper Inlet flows south along the west side and it eventually meets with the westward-moving ACC near Augustine Island (Figure 11).

Near the mouths of major rivers, such as the Susitna River in upper Cook Inlet, currents may locally influence both the current speed and direction by the large volume of fresh water inflow (Science Applications International Corporation 2001). Freshwater discharge measurements from the Susitna River show maximum discharge in May with seasonal variability associated with rainfall. Discharge decreases from June through August and begins to drastically reduce in September (Okkonen et al. 2009).

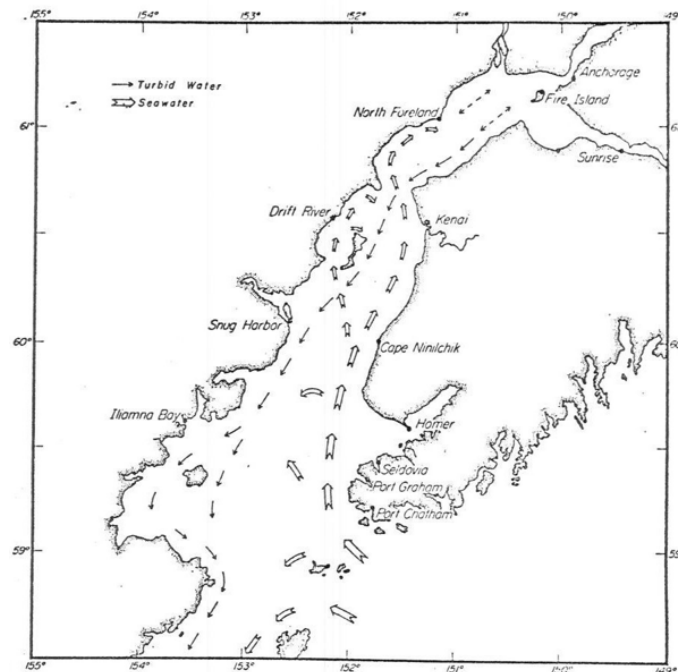


Figure 11. Net surface circulation in Cook Inlet (from Burbank 1977).

Oxygen isotope measurements in late summer show that glacial meltwater may provide much of the total fresh water runoff into the ACC (Kipphut 1990). The northern edge of the ACC generally follows the 100-meter [656-foot] isobath around the mouth of Cook Inlet. The southward flowing water along the western boundary is generally trapped by the ACC. Most of the freshwater flow out of Cook Inlet narrows to a few kilometers in width as it passes Cape Douglas at the southern end of Cook Inlet (Okkonen et al. 2009).

As described in Section 5.8.1, tidal rips, are formed when the tidal and freshwater flows interact with the bathymetry. These tidal rips often delineate strong gradients in water properties (e.g., temperature, salinity, and suspended sediments) as well as the speed of the current (Li et al. 2005, Okkonen 2005). There are three main rips evident in central Cook Inlet (Figure 12). They extend from the vicinity of the Forelands to beyond the southern tip of Kalgin Island. During the stages of the tidal cycle when the rips are strongest, they can accumulate debris, ice, and spilled oil along their axes. This material can become submerged and resurface downstream. The movement of material from one side of the rip to the other is inhibited (Whitney 2002). Both anecdotal reports and scientific observations (Funk et al. 2005) indicate that rip currents tend to aggregate forage fishes (herring, sand lance, sand fish, various smelt species, and juveniles of those and many other species) and, therefore, predators, including larger fish species, birds, and marine mammals.

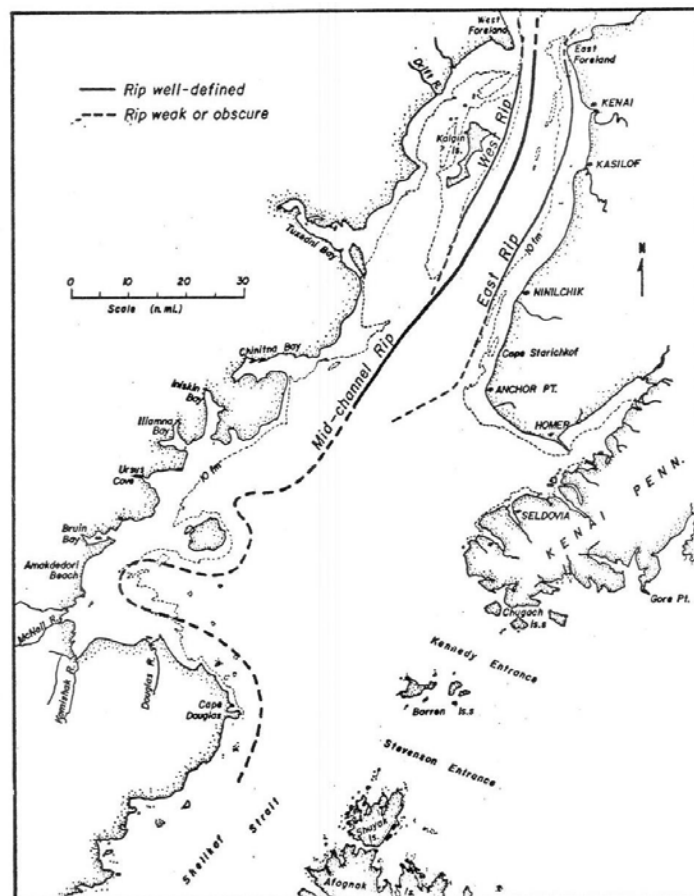
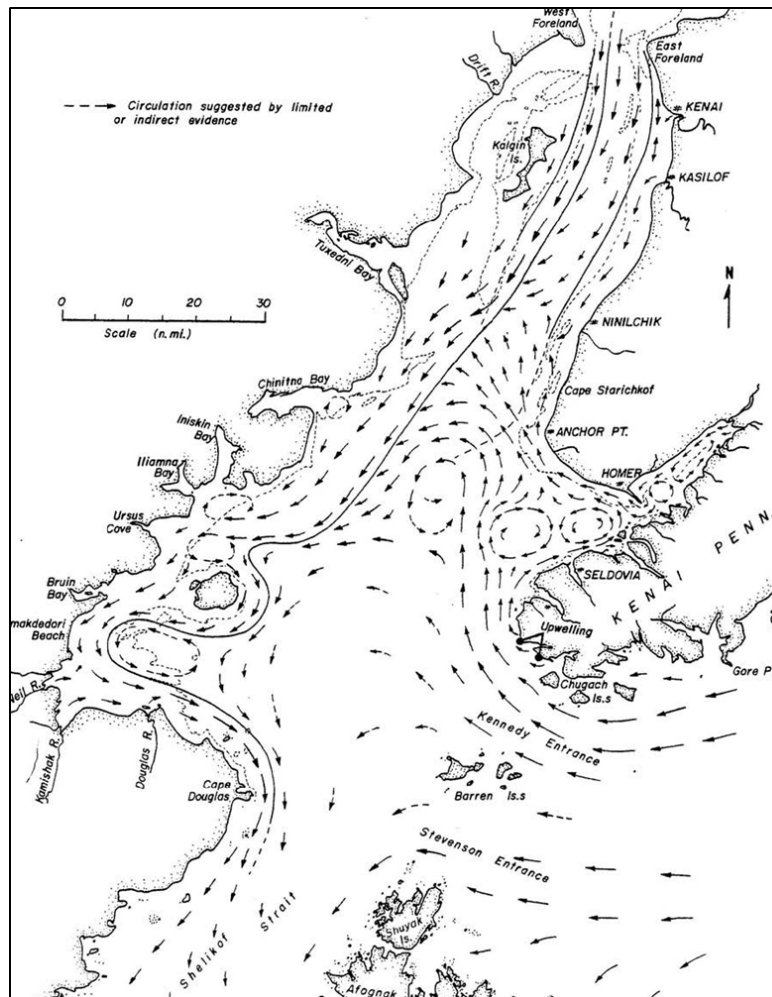


Figure 12. Major tidal rips in lower Cook Inlet (from Burbank 1977).

### 5.8.3 Flushing Time

Flushing time is defined as the approximate time that a parcel of water spends in a system. A short flushing time implies lower potential for retention of waterborne pollutants discharged to the system than a long flushing time. For example, a body of water such as a lake with inflow only sufficient to replace evaporation would have an infinite flushing time and thus pollutants could eventually build up to a concentration equal to the discharge concentration. In contrast, the non-tidally influenced portions of a river with flowing “clean” water upstream of any points of discharge would have a relatively short flushing time and the concentration of discharged pollutants in those portions of the river would eventually approach zero.



**Figure 13. Net surface circulation pattern in lower Cook Inlet during spring and summer (from Burbank 1977).**

One method to estimate flushing time is based on the volume of water in the system and the net volumetric flow rate through the system (e.g., due to tidal or river inflows). Zimmerman and Prescott (2014) determined the volume of Cook Inlet at MHW and calculated the tidal exchange volume from MHW to MLLW. From these calculations, the mean volume of Cook Inlet is

approximately 974.25 cubic kilometers (km<sup>3</sup>) or 3.441 x 10<sup>13</sup> ft<sup>3</sup>. The net volumetric flow rate (i.e., the net total

volumetric flow rate of water leaving the Inlet) calculated by Kinney et al. (1970) is approximately 1.32 x 10<sup>6</sup> ft<sup>3</sup>/second for the entire Cook Inlet. Using the above estimates, the mean flushing time for Cook Inlet is approximately:

$$\frac{3.441 \times 10^{13} \text{ ft}^3}{1.32 \times 10^6 \text{ ft}^3/\text{second}} = 26,064,631.84 \text{ seconds} \times \frac{1 \text{ day}}{86,400 \text{ seconds}} = 301.67 \text{ days}$$

Kinney et al. (1970) calculated the approximate time for an introduced pollutant in Cook Inlet to be reduced to 10 percent of its original concentration by flushing to be about 10 months (approximately 300 days), similar to the flushing time calculated above.

Longer flushing times are likely to occur in certain areas near the natural gyres of Cook Inlet, whereas shorter flushing times are likely to occur near tidal rips. Figure 13 provides a detailed surface current map of lower Cook Inlet and the locations of gyres.

## 6 Effects of the Action

“Effects of the action” means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

The action that is the subject of this consultation is EPA's proposed approval of the MZR. In the BE, EPA noted that the MZR does not propose or authorize any particular mixing zones, nor does it specify the number, location, timing, frequency, and magnitude of mixing zones that may be considered for authorization. EPA expressed the view that consistent with this, its action pertains to the substance of the MZR itself, not the proposed authorization of actual mixing zones or the past authorization of mixing zones under the previously approved version of the mixing zone provision. However, EPA approval of the MZR will allow the State of Alaska to implement the regulation, so any environmental changes caused by mixing zones will be a direct result of EPA's action. Therefore, the underlying question with respect to effects of the action on Cook Inlet beluga critical habitat is whether the MZR, and consequently the presence of mixing zones, as regulated by the State of Alaska under the MZR, is likely to destroy or adversely modify critical habitat. In the 2010 opinion, we analyzed the effects of the action on Cook Inlet beluga whales. As discussed in Section 1.2, we maintain our previous determination that the action is not likely to jeopardize the continued existence of Cook Inlet beluga whales, and effects of the action on these whales are not further analyzed here.

This section addresses our analysis of the effects of mixing zones, as authorized by the State of Alaska in accordance with the MZR, on critical habitat designated for Cook Inlet belugas. The primary analysis presented in EPA's BE focused on assessing whether the MZR contains provisions that, if implemented consistent with their wording, would prevent or minimize effects on Cook Inlet beluga whale critical habitat. To further inform its effects analysis, EPA also included in the BE an evaluation of a small subset of discharges to Cook Inlet beluga whale

critical habitat for which mixing zones have been authorized, and this evaluation was further limited to a small subset of pollutants that may be discharged into mixing zones at concentrations exceeding WQC. Our analysis draws from information provided in the BE, but is substantially supplemented by additional information on representative discharges and pollutants for which mixing zones may be authorized and the potential effects of these pollutants on the PBFs of the critical habitat.

In general, within state waters of Cook Inlet and its tributaries the number of point source discharges with mixing zones authorized and the characteristics of those discharges have not changed appreciably since EPA submitted its previous effects analysis for this action in 2006 (EPA 2016b). Therefore, to inform our analysis of the effects of the proposed action, we focus primarily on information available for mixing zones that are currently authorized within state waters of Cook Inlet and its tributaries (described in more general terms as part of the environmental baseline described in Section 5.4). Although the existing mixing zones were authorized pursuant to a version of the mixing zone provisions that was previously approved by EPA, the fundamental concepts in these two versions are similar (EPA 2016b). In the absence of projections for new or increased mixing zone authorizations under the MZR, and in view of the general similarity between mixing zones currently authorized and those considered in EPA's previous effects analysis for this action (EPA 2006c), we find it reasonable to assume that the characteristics of these mixing zones are generally representative of mixing zones that may be authorized within Cook Inlet beluga whale critical habitat under the MZR.

EPA indicated in the BE that existing authorized regulatory mixing zones occupy approximately 2 percent or less of the area designated as Cook Inlet beluga whale critical habitat, and explained that there are several factors that could affect the accuracy of a 2 percent estimate for beluga whale critical habitat potentially impacted by mixing zones in the future under the MZR. These factors, as identified in the BE, include the extent to which future development results in request to ADEC for new or increased mixing zones and the extent to which adverse effects to the PBFs of the critical habitat that may be affected by mixing zones are authorized under the ESA (see MZR provisions at 18 AAC 70.240(c)(F)). EPA stated in the BE that attempting to predict either would be conjecture and, therefore, EPA did not attempt to do so. Although our analysis is therefore focused on consideration of potential overlap of mixing zones with 2 percent or less of the area designated as Cook Inlet beluga whale critical habitat, in evaluating the response of the PBFs of the critical habitat, we also consider such effects relative to a moderate increase in this overlap.

This biological opinion relies on the best scientific and commercial information available. We try to note areas of uncertainty, or situations where data are not available. In analyzing the effects of the action, NMFS gives the benefit of the doubt to the listed species by minimizing the likelihood of false negative conclusions (concluding that adverse effects are not likely when such effects are, in fact, likely to occur).

We organize our analysis of the effects of the proposed action using a stressor identification – exposure – response – risk assessment framework.

We conclude this analysis with an “Integration and Synthesis of Effects” (Section 8) that integrates information presented in the “Rangewide Status of the Species and Critical Habitat”

and “Environmental Baseline” sections of this opinion (Sections 4 and 5, respectively) with the results of our exposure and response analyses to estimate the probable risks the proposed action poses to Cook Inlet beluga whale critical habitat.

## **6.1 Factors to be Considered in Assessing Effects of the Action**

### **6.1.1 Assumptions**

Mixing zones are associated with various industrial activities as well as municipal WWTFs within state waters of Cook Inlet and its tributaries. The effects of the action, EPA's proposed approval of the MZR, are a function of the number, location, and regulated characteristics of authorized mixing zones, relative to impacts on Cook Inlet beluga critical habitat. Whether mixing zones have an effect on Cook Inlet beluga critical habitat depends upon the level to which the PBFs of the critical habitat are exposed to contaminants from regulated mixing zones and the consequences of that exposure. In determining the effects of mixing zones on Cook Inlet beluga critical habitat, NMFS made the following assumptions:

- The presumption with mixing zones within the action area is that dilution inside the perimeter of the mixing zone will allow for quick and even mixing to meet WQS and that contaminant concentrations outside the mixing zone will be reduced to levels that are not acutely or chronically toxic to aquatic life. For Cook Inlet, part of this presumption is based upon the hydrologic characteristics of the Inlet (described in Section 5.8), which appear to follow typical estuarine circulation, but are also complex and not well understood. As discussed in Section 5.8, there are many variables that influence the movement of substances throughout Cook Inlet and create a level of unpredictability. EPA (2016b) indicated that given the hydrodynamics of Cook Inlet (see Section 5.8), there could be uncertainty as to whether a particular mixing zone functions as intended, e.g., effluent plume behavior and the dilution that occurs may be different than modeled when a mixing zone is established. Freshwater discharges, for example, include seasonally changing inputs from large river systems in upper Cook Inlet. Furthermore, the interaction of tidal currents and bathymetry can result in convergence zones or fronts, which change with the tide, tend to accumulate debris and also organize plankton which subsequently attract marine birds and fish (Schumacher 2006). There are also local currents, including eddy systems, which also change with the tides. For the purposes of this consultation, it is assumed that all applicable WQS are met at the edge of both the acute and chronic mixing zones.
- This consultation is not intended to evaluate the Alaska WQS in and of themselves. Therefore, for the purposes of this consultation, it is assumed that the WQC set out in the Alaska WQS are sufficient in protecting a particular waterbody for the designated use of growth and propagation of fish, shellfish, other aquatic life, and wildlife (we refer to these criteria elsewhere in the analysis as the WQC for aquatic life and in short as the WQC).

### **6.1.2 Proximity of the Action and Distribution**

There is no readily available centralized database on mixing zones authorized within the action area. Therefore, for this analysis, we primarily relied on information provided in the BE



regarding active permits that authorize point source discharges with mixing zones in Cook Inlet, which EPA obtained from ADEC. EPA (2016b) noted that there were not always accurate coordinates available for the locations of the discharges authorized by these permits, in which case EPA mapped the discharge locations by starting with the low resolution coordinates indicated in selected permits, and adjusting the point locations manually based on aerial imagery and the available descriptive information regarding the associated facilities. We compiled similar information for a few mixing zones located in fresh water tributaries of Cook Inlet using ADEC's online water permit search interface (ADEC 2017c). Based on all of this information, there are currently approximately 48 active permits that authorize point source discharges with mixing zones within state waters of Cook Inlet and its tributaries including:

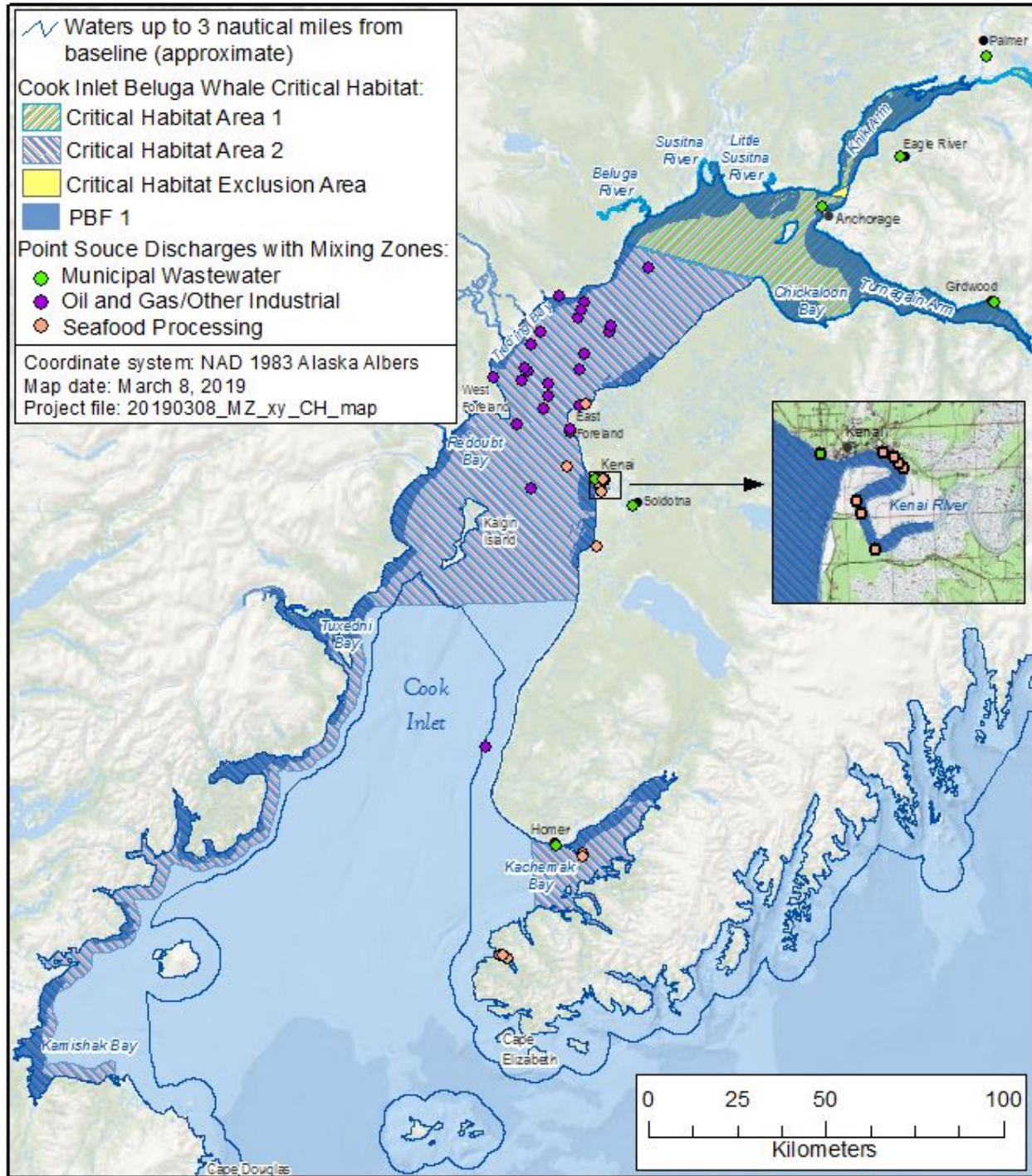
- 7 municipal WWTFs (2 permits in Cook Inlet beluga critical habitat Area 1, 2 permits in Area 2, and 3 permits in fresh water);
- 14 seafood processing facilities (14 permits within Cook Inlet beluga critical habitat Area 2);
- 25 oil and gas industry facilities (25 permits within Cook Inlet beluga critical habitat Area 2); and
- 2 other industrial facilities<sup>10</sup> (2 permits within Cook Inlet beluga critical habitat Area 2 for a nitrogen fertilizer production plant and a power generation plant).

There are multiple mixing zones authorized under some of these permits and some facilities (seafood processing vessels) are authorized to discharge into mixing zones in more than one place. Included in the above summary is the Asplund WWTF, which as explained in Section 5.4.1.1, is operating under an EPA-issued NPDES permit that is currently undergoing reanalysis by EPA in response to a request by ADEC to renew the 301(h) waiver of secondary treatment requirements under the CWA (EPA 2016b). Although the mixing zone associated with the Asplund WWTF is included in the baseline and the above total for municipal WWTFs, we do not consider it to be representative of mixing zones that may be authorized under the MZR. Therefore, information for this mixing zone was not used to identify stressors of the action or to inform the related exposure and response analyses.

In general, the locations, types of facilities, sizes, and pollutants for which mixing zones are authorized within the action area have not changed appreciably since NMFS issued its 2010 opinion on the effects of the proposed action on Cook Inlet belugas. Regarding future mixing zones, EPA (2006c) indicated that it is not possible to estimate the future number of facilities with authorized mixing zones, where they will be located, what specific pollutants will be granted mixing zones, or other details for mixing zones that may be authorized under the MZR. A primary related factor is the extent to which future development results in requests to ADEC for new or increased mixing zones (EPA 2016b). Aside from those associated with oil and gas platforms, current mixing zones are all located adjacent to the shore and it is likely that the future overall distribution of mixing zones will be similar.

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<sup>10</sup> The BE categorized the two other industrial facilities in terms of the Standard Industrial Classification codes as "water supply and wastewater related." For these purposes of the analyses in this opinion, we grouped the two industrial facilities with the oil and gas facilities based on similarity in some of the pollutants discharged.



**Figure 14. Approximate locations of point sources discharges with mixing zones in Cook Inlet based on information provided in EPA (2016b) and in discharge permits. Cook Inlet beluga whale critical habitat and approximate geographic areas within the critical habitat that meet the definition of PBF 1 are also illustrated.**

### 6.1.3 Duration, Frequency, and Intensity of Disturbance

Mixing zones are sustained, long-term chronic events. Although some oil and gas facilities are no longer operational, most of the facilities with mixing zones have been operational for many years on a continuous basis. The probability is high that this would be the case with new mixing zones. Potential effects are generally expected to be localized; however, the frequency and intensity of exposure to harmful pollutants and the resulting effects will depend on the characteristics of the discharge permitted and the timing of the discharge. For example, the frequency and intensity of exposure of a Pacific salmon (a component of PBF 2 of Cook Inlet beluga critical habitat) to harmful contaminants and consequent effects is a function of the size of a mixing zone, the concentration of contaminants contained within the mixing zone, the amount of time that the salmon occupies the mixing zone, the life stage potentially exposed, and activity type (e.g., feeding, transiting, spawning). Although it is not possible to predict the duration and disturbance frequency, the disturbance frequency as well as duration of that disturbance would most likely be greatest for beluga whale and prey species life history events that occur in the nearshore environment, e.g., summer congregation patterns.

Certain provisions of the MZR provide a basis for moderating such effects through permit conditions or denial of mixing zones (see Appendix A). For example the MZR allows for a mixing zone to be approved only if available evidence reasonably demonstrates that it will not result in a reduction in fish or shellfish population levels (18 AAC 70.240(c)(4)(D)), form a barrier to migratory species or fish passage (18 AAC 70.240(c)(4)(G)), or adversely affect threatened or endangered species except as authorized under the ESA (18 AAC 70.240(c)(F)). In addition, the MZR does not allow a mixing zone to be authorized in a spawning area of any of the five species of anadromous salmon found in the state, or to adversely affect the present and future capability of an area to support spawning, incubation, or rearing of these species (18 AAC 70.240(e)). In the BE, EPA also expressed the view that Cook Inlet beluga whale critical habitat can be protected as part of the designated uses for Cook Inlet and as an existing use under the provision at 18 AAC 70.240(c)(2) that "...designated and existing uses of the waterbody as a whole will be maintained and protected."

Under the MZR, the size of a mixing zone must be determined to be "as small as practicable" and comply with applicable size limitations (18 AAC 70.240(k)). For estuarine and marine waters, mixing zone size limitations (MZR at 18 AAC 70.240(k)(1)) include that at MLLW:

- The cumulative linear length of all mixing zones intersected on any given cross section of an estuary, inlet, cove, channel, or other marine water may not exceed 10 percent of the total length of that cross section; and
- The total horizontal area allocated to all mixing zones at any depth may not exceed 10 percent of the surface area.

For streams, rivers, and other flowing fresh waters, the length of a mixing zone may not extend beyond the computed point of complete mixing, as determined using a standard river flow mixing model or other methods accepted by ADEC (18 AAC 70.240(k)(3) and 18 AAC 70.240(k)(4)).

The specific size of a mixing zone authorized under a discharge permit depends on the physical parameters of the water body and the dilution ratio that is necessary for a pollutant to meet WQS outside the area of the mixing zone. For example, within Cook Inlet:

- A 150-meter-radius (492-foot-radius) chronic mixing zone for a municipal WWTF discharge is authorized in Cook Inlet for ammonia, copper, and zinc based on a dilution ratio of 18:1 (ADEC 2015b, EPA 2016b);
- 30-meter-radius (98-foot-radius) chronic mixing zones are authorized for several seafood waste processing facility discharges in the lower Kenai River (under the general permit for Alaska seafood processing facilities) for dissolved gas, oil and grease (non-petroleum), floating and suspended waste residues, color, turbidity, temperature, pH, fecal-coliform bacteria, and total residual chlorine based on a dilution ratio of 30:1 (EPA 2001, 2016b);
- A 1,863 by 22 m (6,112 by 72 ft) chronic mixing zone for an oil and gas platform discharge is authorized in Cook Inlet for total aromatic hydrocarbons (TAH<sup>11</sup>) and total aqueous hydrocarbons (TAqH<sup>12</sup>) based on a dilution ratio of 12:1 (EPA2006a, 2016b); and
- A 47 by 5 m (154 by 16 ft) chronic mixing zone for a municipal WWTF is authorized in fresh water in the Kenai River for pH, temperature, nutrients, dissolved oxygen (DO), total residual chlorine, and metals (EPA 2000a).

Our review of information for the permits considered in our analysis indicates that at least for Cook Inlet and its tributaries, chronic mixing zones authorized for the discharge of seafood processing waste are generally an area of 30-meter radius, but they tend to be larger for oil and gas discharges and municipal WWTFs, and as in the above case, are sometimes quite large for oil and gas discharges in particular.

Although the size of the regulatory mixing zone is fixed in an outfall's permit, its exact location changes with the tides and currents. For example, because Cook Inlet is tidal, during flood tides, the mixing zone would be oriented in the same direction as the incoming tidal current. When the tides changes, the mixing zone will move in the same direction as the outgoing current. Therefore, a mixing zone does not represent a fixed immobile volume of water where certain WQC are exceeded, but is a variable volume of water that potentially exceeds certain WQC and moves with the tides (or river flows).

## 6.2 Stressors of the Action

A stressor is defined as any physical, chemical, or biological entity that can induce an adverse response. In this opinion we are primarily concerned with the potential adverse effects on Cook Inlet belugas and their designated critical habitat of pollutants contained in effluent discharges that may be authorized to exceed WQC within mixing zones, as authorized by the State of

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<sup>11</sup> TAH is defined in the Alaska WQS as “the sum of the following volatile monoaromatic hydrocarbon compounds: benzene, ethylbenzene, toluene, and the xylene isomers, commonly called BETX [BTEX].”

<sup>12</sup> TAqH is defined in the Alaska WQS as “those collective dissolved and water-accommodated monoaromatic and polynuclear aromatic petroleum hydrocarbons that are persistent in the water column; [TAH] does not include floating surface oil or grease.”

Alaska in accordance with the MZR. As discussed in Section 6.1.3, it is not possible to project the specific locations or characteristics of mixing zones that may be authorized under the MZR in the future. Therefore, we focus our analysis primarily on the information available for existing authorized mixing zones within state waters of Cook Inlet and its tributaries to identify a representative range of the types of discharges and pollutants for which future mixing zones may be authorized under the MZR. As summarized in Section 6.1.2, within these waters, mixing zones are associated with discharges from: municipal WWTFs, seafood processing facilities, and oil and gas and other industrial facilities. Below we consider the chemical and physical stressors that may be associated with the mixing zones for these three categories of facilities. We note that EPA's BE was used to inform the analysis described in this opinion, and portions of the BE are incorporated herein. However, EPA's analysis of pollutants that may be associated with mixing zones did not address oil and gas discharges, and for WWTF discharges, focused primarily on ammonia as a representative pollutant for which one of the existing mixing zones in Cook Inlet was established. To address all potential effects, in this opinion we expand on EPA's analysis to consider a representative range of pollutants for which mixing zones may be established under the MZR (including ammonia) and we include consideration of mixing zones for oil and gas facilities and other industrial discharges.

### **6.2.1 Mixing Zones for Municipal Wastewater Treatment Facility Discharges**

Aside from the Asplund WWTF, within state waters of Cook Inlet there are three municipal WWTFs with mixing zones (Figure 14). These facilities serve the cities of Girdwood, Kenai, and Homer. There are also freshwater mixing zones for three municipal WWTFs within tributaries of Cook Inlet that are located in the northernmost channel of the Matanuska River, the Eagle River, and the Kenai River. These facilities serve the cities of Palmer, Eagle River, and Soldotna, respectively. Mixing zones are authorized for these facilities in individual permits for pollutants that across permits include nutrients, pH, DO, copper, silver, zinc, lead, ammonia, total residual chlorine, and fecal coliform bacteria (EPA 2000a, 2006b, , 2016 #26; ADEC 2013). The sizes of the mixing zones vary by facility, with chronic mixing zones ranging from 97 m by 136 m to 2.7 m by 600 m in Cook Inlet, and from 5 m by 47 m to 11 m by 1,600 m in Cook Inlet tributaries.

### **6.2.2 Mixing Zones for Seafood Waste Discharges**

As discussed in Section 5.4.1.2, mixing zones for offshore seafood processors in waters 0.5 to 3 nautical miles from shore are currently covered under a statewide general permit issued by ADEC, and those for seafood waste discharges from land-based facilities are currently covered under administrative extension of the statewide general permit issued by EPA in 2001. Certain areas are excluded from coverage under the general permits (e.g., certain state and Federal designated areas and areas with mean water depth less than 60 ft MLLW that have or are likely to have poor flushing). Mixing zones that are currently authorized for seafood processors within Cook Inlet are located in the Kenai and Kasilof Rivers, Kachemak and Port Graham Bays, and along the coast north of the Kenai River (Figure 14).

Under ADEC's statewide general permit for offshore seafood processing facilities (ADEC 2011), numeric effluent limitations are set only for the annual amount discharged at each single location (3.3 million pounds). A standard cylindrical mixing zone with a 100-foot radius extending from the sea surface to the seafloor may be authorized for seafood waste discharges for DO, oil and

grease, pH, temperature, color, turbidity, residues, fecal coliform bacteria, total residual chlorine, and the WQC of 40 CFR 131.41 for enterococci bacteria. In offshore marine waters covered under the general permit, ADEC may also authorize a zone of deposit (ZOD) of up to 4,047 square meters (1 acre) on the seafloor for settleable solid seafood processing waste residues. EPA (2016b) noted that although ZODs are not part of this consultation, a mixing zone allows for discharge of the waste that can settle into a ZOD if flows are not sufficient to disperse the waste material.

EPA's 2001 statewide general permit (which has been administratively extended) similarly sets numeric effluent limitations only for the annual amount discharged (4.5 million kilograms [10 million pounds]), BOD, and TSS (EPA 2001). The standard size of mixing zones and ZODs that may be authorized is the same as for ADEC's general permit. The pollutants for which mixing zones may be authorized are similar between ADEC's general permit for offshore seafood processing facilities and EPA's 2001 general permit, which currently covers other seafood processing facilities within Cook Inlet.

### **6.2.3 Mixing Zones for Oil and Gas and Other Industrial Discharges**

There are currently 25 oil and gas and other industrial facilities, primarily production platforms, with mixing zones authorized in Cook Inlet (Figure 14). In recent years, EPA and ADEC have been working toward dividing EPA's 2007 general permit for Cook Inlet oil and gas extraction activities into separate general permits for federal and state waters, and into separate general permits for exploration versus development and production activities. The agencies replaced the exploration components of the 2007 general permit (EPA 2007) with two separate general permits in 2015 and 2016 (ADEC 2015c, EPA 2016a). The development and production components of the 2007 general permit have been administratively extended to remain in effect until a general permit is issued by ADEC for these activities in Cook Inlet.

Under the ADEC general permit for mobile oil and gas exploration facilities (ADEC 2015c), standard 100-meter-diameter chronic mixing zones and 10-meter-diameter acute mixing zones (both cylindrically shaped) may be authorized for discharge streams that include drilling fluids and drilling cuttings and mud, cuttings, and cement at the seafloor, domestic wastewater and graywater, test fluids, and other miscellaneous discharges. The pollutants contained in the discharges for which mixing zones may be authorized include aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium, silver, thallium, zinc, TAH, TAqH, total residual chlorine, ammonia, and dissolved organic substances.

Mixing zones authorized under EPA's administratively extended 2007 general permit (EPA 2007) for discharge streams that include sanitary wastewater, chemically treated seawater, and produced water (EPA 2006a). The sizes of the mixing zones are in many cases facility-specific based on the effluent type and its dilution value. The largest (chronic) mixing zones are authorized for discharges of TAH and TAqH contained in produced water, for which sizes range in length from 36 to 3,016 m. The larger mixing zones for oil and gas facilities are typically defined with a narrow width reflecting the discharge plume. Other pollutants contained in the discharges for which mixing zones may be authorized under this general permit include arsenic, copper, manganese, mercury, zinc, ammonia, and total residual chlorine.



The mixing zones for the two industrial facilities that are not associated with oil and gas operations are authorized under two individual permits (ADEC 2012, 2017a). Across the two facilities, the pollutants contained in the discharges for which the mixing zones are authorized include pH, temperature, ammonia, total residual chlorine, arsenic, and copper.

#### **6.2.4 Discharge Characteristics**

We were unable to locate data on contaminant concentrations in aquatic organisms, the water column, or sediments for existing mixing zones within the action area. Therefore, to inform our identification of representative pollutants in discharges that may be authorized for exceedance of WQC within mixing zones under the MZR, we considered the information that is available on pollutants contained in the effluents discharged into these currently authorized mixing zones. APDES/NPDES permits set requirements for monitoring the quality of wastewater discharges and these monitoring data are reported to the permitting authority on discharge monitoring report (DMR) forms. DMR data were available for a subset of the municipal WWTFs and oil and gas and other industrial facilities with mixing zones authorized within state waters of Cook Inlet and its tributaries. Although the DMR data reflect end-of-pipe effluent quality, in the absence of information on contaminant concentrations for the mixing zones themselves, we instead rely in part on these records of measured discharge parameters to help identify and characterize some of the pollutants that may be present in mixing zones within these waters. Numeric data on seafood processing effluents are not available. For these facilities, we therefore rely primarily on the qualitative information on the characteristics of seafood waste discharges provided in the BE.

The DMR records that were available differ among facilities in terms of the reported discharge parameters, and in some cases also differ in the units of measurement reported for some parameters, reflecting the site and discharge-specific nature of the monitoring requirements specified in permits. As described above, the mixing zones for municipal WWTFs are authorized to exceed WQS for a distinctly different suite of water quality parameters as compared to mixing zones authorized for oil and gas and other industrial facilities. For example, exceedance of the WQC for TAH and TAqH is commonly authorized within mixing zones for oil and gas facilities, but such exceedances are not a basis for the mixing zones authorized for municipal WWTFs. The spatial distributions of these two categories of facilities are also rather distinct (Figure 14). All of the municipal WWTFs and most of the seafood processing facilities discharge effluents into Cook Inlet nearshore waters on the east side of the Inlet in proximity to anadromous tributaries to the Inlet. In contrast, oil and gas facilities discharge into offshore waters and into nearshore waters on the west side of Cook Inlet, primarily in areas that are not in close proximity to anadromous Inlet tributaries.

Scaling the analysis to the level of analyzing the discharge for each existing mixing zone individually is impractical and is unlikely to be necessary to reach conclusions regarding the effects of the proposed action. We therefore do not separately analyze the DMR data for each individual facility. But given the distinct differences in the mixing zones for municipal WWTFs as compared to oil and gas and other industrial facilities, we concluded that the best approach to evaluating the DMR data is to separately summarize and evaluate the DMR records for each of these two categories of facilities. These summaries are presented in Table 2 and Table 3. The DMR data summarized in the tables represent only values that were reported as maximum measurement types, e.g., daily maximum, weekly maximum, etc. These measurement types were

also the most commonly reported or the only types reported. For a few parameters, minimum measurement types are most relevant, e.g., DO, and were used instead. These exceptions are specifically indicated in the summary tables. The summarized parameter values do not, in many cases, represent values for an individual discharge into a specific existing mixing zone. Nevertheless, summarizing the information in this way does provide an overall profile of the monitored characteristics of the discharges. It should be noted that this information is not limited to just the specific pollutants for which the associated mixing zones were authorized. We further evaluate these data with respect to potential exposure in Section 6.3.

As noted above, EPA provided a description of the characteristics of seafood waste in the BE submitted for this consultation, which is summarized herein. Waste discharged by seafood processors is composed of a combination of a dissolved portion consisting of ammonia, fats, oils and grease, nutrients, and solids (particles of shell, muscle, skin, organs, and bone); these are considered the major pollutants in seafood waste discharges. Other contaminants may also be present. Regulations require that the solid fraction be ground to a particle size of 1.3 cm. Studies have found that high BOD, oil and grease, and nitrogen characterize effluents from seafood processing facilities. Most of the BOD and TSS, and approximately 60 percent of the oil and grease present in the discharge originate from the butchering process (Novatec and EVS Environment Consultants 1994). The chemical composition of this waste depends on the amount of protein, fat, bone, chitin, and connective tissue present. Elevated nitrogen content, for example, has been attributed to high blood and slime content in seafood processing effluents. In addition to the residues themselves, biological degradation of the organic component of the residue can release chemical compounds, such as ammonia or hydrogen sulfide, into the water and affect the level of DO in quiescent waters. These compounds will be present in various levels in both the water column and bottom sediment.



**Table 2. Summary of DMR parameter values reported for effluents discharged from municipal WWTFs with authorized mixing zones within state waters of Cook Inlet and its tributaries from 2009 to 2017.<sup>1</sup> Values reflect maximum measurement types (e.g., daily maximum, weekly maximum) unless otherwise indicated.**

DMR parameter <sup>2</sup>	Units	No. facilities with DMR data	<i>n</i>	$\bar{x}$	Standard deviation	95th percentile <sup>3</sup>
Arsenic, total recoverable	µg/L	1	10	5.79	3.90	11.37
BOD, 5-day, 20 deg. C	lb/d	6	638	70.51	63.64	183.48
BOD, 5-day, 20 deg. C	mg/L	6	638	14.32	11.52	35.00
BOD, 5-day, percent removal, minimum	%	4	427	95.85	3.51	99.00
Cadmium, total recoverable	µg/L	2	17	0.36	0.62	1.60
Chlorine, total residual	µg/L	4	223	58.17	90.69	100.00
Coliform, fecal general	no./100 mL	3	75	56.79	206.10	184.50
Coliform, fecal MF, MFC broth, 44.5 C	no./100 mL	3	241	338.58	3,408.13	644.00
Copper, total recoverable	lb/d	3	53	0.05	0.05	0.10
Copper, total recoverable	µg/L	3	73	11.50	5.97	19.40
Enterococci: group D, MF trans, M-E, EIA	no./100 mL	1	79	8.62	7.89	22.00
Fecal coliform, MPN, EC med, 44.5 C	no./100 mL	3	212	66.58	196.66	240.95
Lead, total recoverable	lb/d	1	12	0.01	0.01	0.01
Lead, total recoverable	µg/L	1	22	0.55	0.41	1.00
Nitrogen, ammonia total [as N]	lb/d	3	169	79.06	87.00	198.43
Nitrogen, ammonia total [as N]	mg/L	3	419	17.54	15.08	40.00
Oxygen, dissolved [DO], minimum	mg/L	1	72	9.15	2.57	4.43
pH	SU	5	535	7.46	0.34	8.12
pH, minimum	SU	5	535	6.96	0.25	6.58
Silver total recoverable	µg/L	1	10	0.20	0.63	0.00
Solids, total suspended	lb/d	6	639	65.74	110.38	158.04
Solids, total suspended	mg/L	6	639	13.12	23.38	30.00
Temperature, water deg. centigrade	C°	3	235	11.99	5.33	19.29
Zinc, total recoverable	µg/L	1	16	60.32	28.21	117.50

<sup>1</sup> Available data were obtained using EPA's online DMR data sets download service (EPA 2018) (the data are updated by EPA intermittently and records for 2017 in particular may be incomplete) and filtered to include only those within state waters Cook Inlet and its tributaries. These data included discharges from the following facilities (and associated permit numbers): Soldotna WWTF (AK0020036), Homer WWTF (AK0021245), Kenai WWTF (AK0021377), City of Palmer WWTF (AK0022497), Eagle River WWTF (AK0022543), and Girdwood WWTF (AK0047856).

<sup>2</sup> DMR parameters are listed as specified in EPA's Integrated Compliance Information System (ICIS).

<sup>3</sup> 95th percentile values were determined using Microsoft Excel® 2016 (PERCENTILE.INC function).

**Table 3. Summary of DMR parameter values reported for effluents discharged from oil and gas and other industrial facilities with authorized mixing zones within state waters of Cook Inlet and its tributaries from 2009 to 2017.<sup>1</sup> Values reflect maximum measurement types (e.g., daily maximum, weekly maximum) unless otherwise indicated.**

DMR parameter <sup>2</sup>	Units	No. facilities with DMR data	<i>n</i>	$\bar{x}$	Standard deviation	95th percentile <sup>3</sup>
2,3,7,8-Tetrachlorodibenzo-p-	pg/L	1	7	0.88	0.58	1.70
Arsenic, total recoverable	µg/L	2	63	38.11	15.49	44.40
BOD, 5-day, 20 deg. C	lb/d	2	189	62.74	118.37	189.60
BOD, 5-day, 20 deg. C	mg/L	9	386	19.96	59.70	73.83
Cadmium, dry weight	mg/kg	5	23	0.65	1.48	2.80
Chemical Oxygen Demand [COD]	lb/d	1	107	385.63	277.07	776.40
Chlorine, total residual	µg/L	10	268	610.67	893.16	2825.00
Chromium, hexavalent [as Cr]	lb/d	1	81	0.02	0.03	0.07
Chromium, total [as Cr]	lb/d	1	78	0.03	0.06	0.17
Coliform, fecal general	no./100 mL	2	53	327.91	1470.83	1029.80
Coliform, fecal MF, MFC broth,	no./100 mL	1	82	1.80	3.85	8.95
Copper, total recoverable	µg/L	5	286	12.38	23.68	56.78
Cyanide, total [as CN]	µg/L	1	5	2.66	3.59	6.66
Enterococci	no./100 mL	2	40	157.52	558.69	1261.00
Hydrocarbon, aqueous	mg/L	5	372	9.78	26.06	17.25
Hydrocarbons, aromatic	mg/L	5	297	9.54	4.57	16.47
Manganese, total recoverable	mg/L	3	238	1.45	1.52	2.37
Mercury, sludge, total, dry weight	mg/L	5	22	0.13	0.18	0.50
Mercury, total [as Hg]	µg/L	5	253	0.13	0.22	0.26
Nitrogen, ammonia total [as N]	lb/d	2	120	34.50	19.50	61.10
Nitrogen, ammonia total [as N]	mg/L	4	110	6.32	6.95	13.39
Nitrogen, organic total [as N]	lb/d	1	13	24.69	18.94	63.00
Oil and grease	lb/d	3	209	10.83	14.86	30.60
Oil and grease	mg/L	2	379	14.22	14.86	30.53
pH	SU	9	562	7.76	0.52	8.60
pH, minimum	SU	9	562	7.19	0.46	6.50
Phenolics, total recoverable	lb/d	1	106	0.04	0.05	0.12
Silver total recoverable	µg/L	3	241	3.92	6.37	20.00
Solids, total suspended	lb/d	3	215	46.98	62.44	185.10
Solids, total suspended	mg/L	10	414	41.04	336.79	88.40
Sulfide, total [as S]	lb/d	1	94	0.02	0.04	0.06
Temperature, water deg. centigrade	C°	5	99	17.73	7.13	25.60
Toxicity, Acute <sup>4</sup>	TU <sub>a</sub>	1	18	1.66	2.11	3.45
Toxicity, Chronic <sup>4</sup>	TU <sub>c</sub>	17	570	400.68	288.93	625.00
Zinc, total recoverable	µg/L	3	243	77.67	236.52	341.80

DMR parameter <sup>2</sup>	Units	No. facilities with DMR data	<i>n</i>	$\bar{x}$	Standard deviation	95th percentile <sup>3</sup>
<p><sup>1</sup> Available data were obtained using EPA's online DMR data sets download service (EPA 2018) (the data are updated by EPA intermittently and records for 2017 in particular may be incomplete) and filtered to include only those within state waters of Cook Inlet and its tributaries. These data included discharges from the following facilities (and associated permit numbers): Agrium U.S (AK0000507); Tesoro Nikiski Refinery (AK0000841); Kenai LNG Plant (AK0001155); Nikiski Combined Cycle Plant (AK0053619); Kitchen Lights Unit Julius R Platform (AK053686); Granite Point Production Facility (AKG315001); Trading Bay Production Facility II (AKG315002); MGS Onshore (AKG315003); Platform Anna (AKG315004); Platform Baker (AKG315005); Platform Bruce (AKG315006); Platform Dillon (AKG315007); Platform King Salmon (AKG315008); Platform Dolly Varden (AKG315009); Platform A (AKG315012); Platform C (AKG315013); Platform Granite Point (AKG315015); Platform Grayling (AKG315016); Platform Monopod (AKG315017); Platform Steelhead (AKG315019); Kitchen Lights Unit Spartan 151 Mobile Offshore Drilling Unit (AKG315022); Endeavour Spirit of Independence II (AKG315023); and Furie Kitchen Lights Unit Exploration (AKG315102).</p> <p><sup>2</sup> DMR parameters are listed as specified in EPA's ICIS.</p> <p><sup>3</sup> 95th percentile values were determined using Microsoft Excel® 2016 (PERCENTILE.INC function).</p> <p><sup>4</sup> Whole effluent.</p>						

### 6.3 Exposure Analysis

As discussed in the "Approach to the Assessment" section of this opinion, exposure analyses are designed to identify the listed resources that are likely to co-occur with the stressors associated with the proposed action in space and time and the nature of that co-occurrence. Following the exposure analysis is the response analysis. The response analyses determine how Cook Inlet beluga critical habitat is likely to respond after being exposed to the action's effects on the environment.

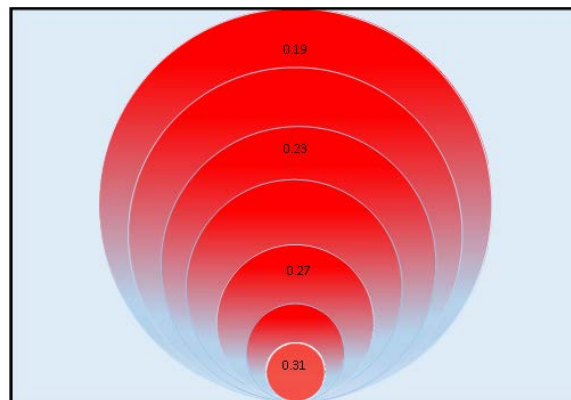
As discussed in Section 2.1, a mixing zone is a site-specific limited area or volume of water within which specified WQC may be exceeded, but beyond which all applicable WQC must be met. Thus, by definition, mixing zones are allocated areas where elevated levels of pollutants, which could have harmful effects on aquatic organisms, are expected to occur. In the BE, EPA analyzed the mixing zone authorized for the Kenai WWTF, which is situated at the mouth of a highly important salmonid production watershed (the Kenai River), to provide a specific example of the dilution of a particular pollutant (ammonia) within the footprint of a mixing zone and the corresponding toxicity to aquatic organisms within this zone. We include a summary of this analysis below. We then consider potential exposure of critical habitat to exceedances of WQC within mixing zones for a broader suite of chemicals, tiered from the analysis of "Stressors of the Action" presented in Section 6.2.

#### 6.3.1 Illustration of Exposure of to a Representative Pollutant (Ammonia) within a Mixing Zone

This section summarizes the modeling of exposure point concentrations and corresponding toxicity to aquatic organisms within the mixing zone for the Kenai WWTF, which is discussed in more detail in the BE. Information contained in the *Fact Sheet* issued for the permit (ADEC 2015b) was used to inform this analysis. The Kenai WWTF has a design flow of 1.3 mgpd and an average monthly flow of 0.54 mgpd discharged to Cook Inlet. The facility receives no significant industrial discharge, and the system has no combined sewers. The treated effluent discharges through a 30.5-centimeter (12-inch) outfall pipe that runs 457 m (1,300 ft) from the facility to MHW in Cook Inlet, on a line that runs perpendicular from the shoreline.

EPA focused its analysis of exposure and potential toxicity on ammonia, a representative pollutant that has a WQBEL established in the discharge permit and is one of the pollutants authorized to exceed WQC within the mixing zone. The total ammonia concentration is the sum of  $\text{NH}_3$  and  $\text{NH}_4^+$ . The toxicity of aqueous ammonia solutions to aquatic organisms is known to be primarily attributable to the un-ionized form (UIA), the ammonium ion being less toxic (Canadian Council of Ministers of the Environment 2010). Therefore, EOA ensured that all comparisons, WQBELs, toxicity test data, and effects levels were reported as UIA.

A worst-case scenario of the maximum daily discharge limit specified in the permit (i.e., the WQBEL of 38 milligrams per liter [mg/L] total ammonia) was used in the analysis, along with the receiving water background concentration, to predict dilution-with-distance using the CORMIX<sup>13</sup> model output (see EPA 2016b for additional technical details). To reflect changing currents over a tidal cycle the modeling was run using the following ambient current velocities: 0.2 m/s, 0.6 m/s, 1.0 m/s, and 1.7 m/s (ADEC 2015b). Rather than using one dilution level (18:1) to calculate exposure point concentrations for the entire mixing zone (method used by ADEC 2015b), EPA calculated the moving weighted average for UIA to account for exposure point concentrations for sessile or resident organisms that may be present within the mixing zone. The model output calculated UIA concentrations ranging from 1.2 mg/L to 0.2 mg/L, and an estimated 12.5 minutes for full dilution to occur at the edge of the 150-meter (492-foot) mixing zone. The UIA concentrations are illustrated at 20-meter intervals from the point of discharge in Figure 15.



**Figure 15. UIA concentrations (mg/L) at 20-meter intervals from the point of discharge to the edge of the 150-meter (492-foot) regulatory mixing zone for the Kenai WWTF (from EPA 2016b).**

EPA then identified available acute and chronic effect concentrations for saltwater organisms that may occur, or that represent those organisms that may occur, in the mixing zone and may also serve as beluga prey items. This was done to understand the organisms' relative sensitivity to pollutant (e.g., ammonia) exposures. By comparing effect concentrations to modeled mixing zone concentrations, EPA was then able to assess the potential impact of pollutant concentrations

<sup>13</sup> According to the MZR Guidance (ADEC 2009), ADEC primarily uses the CORMIX and PLUMES mixing zone models. Both models require site-specific hydrologic data about the discharge and receiving waters. CORMIX is a mathematical plume simulation model that can be used to assess water quality impacts from discharges. In short, it computes the size of the plume and the expected concentrations with distance from the discharge point.

within the mixing zone on a typical saltwater community, with additional emphasis on beluga prey items or close surrogate species.

Effect concentrations used in EPA's analysis were obtained from the open literature and primarily from EPA's latest available CWA section 304(a) ambient water quality criteria recommendations pertaining to aquatic life, which are based on the *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and their Uses* (Stephen et al. 1985). Broadly, these guidelines outline a methodology that assesses high-quality toxicity tests to acquire acute ( $LC_{50}$  = concentration that resulted in lethality to 50 percent of the test organisms) and/or chronic (such as NOEC = no observable effects concentration that was statistically different from control, and  $EC_{20}$  = concentration that resulted in an effect to 20 percent of the test organisms) effect concentrations and identifies the acute and/or chronic effect concentration associated with the 5th percentile of tested genera. The acute effect concentration, expressed as an  $LC_{50}$ , associated with the 5th percentile of tested genera (final acute value or FAV) is then divided by a factor of 2 to represent an acute low effect level (criterion maximum concentration or CMC), so acute criteria concentrations do not represent values that resulted in 50 percent mortality. Dividing the  $LC_{50}$  by 2 converts a value that represents 50 percent mortality to a value that is intended to represent a low level of mortality that is still statistically different than the control mortality ( $LC_{Low}$ ). The final chronic value (FCV) concentration associated with the 5th percentile of tested genera is generally derived by dividing the FAV by an appropriate acute to chronic ratio (ACR)<sup>14</sup>, and serves as the chronic criteria concentration (criterion continuous concentration or CCC) (Stephen et al. 1985). The FCV for the national saltwater ammonia aquatic life criteria recommendation was derived in this manner. EPA used this same method to determine an FCV concentration for each species included in the analysis. The methods used to determine an acute and a chronic effects concentration for each species are detailed in the BE.

The species for which toxicity data were available for UIA included flatfish (winter flounder), pelagic fish, crustaceans (prawns and shrimp) and drifters (amphipods and copepods). Fish and crustaceans were well represented among both the more sensitive and more resistant species, whereas mollusks were generally resistant.

Species sensitivity distributions (SSDs) were constructed to display the range of pollutant concentrations that result in acute, chronic, and low level mortality effects in aquatic organisms within the mixing zone. SSDs are generated by fitting a statistical or empirical distribution function to the proportion of species affected as a function of stressor concentration or dose (see EPA 2016b for technical details). Figure 16 illustrates the SSD constructed based on the low level mortality ( $LC_{Low}$ ) concentrations, along with the percentage of UIA low level mortality concentrations (for the individual species) that were estimated to be exceeded at 20-meter

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<sup>14</sup> EPA (2016b) explained the use and derivation of ACRs as follows. Typically, acute toxicity values are more prevalent than chronic toxicity due to the logistical challenges associated with long-term chronic toxicity testing. Consequently, Stephen et al. (1985) provide a method for estimating chronic effect concentrations from acute effect concentrations through the use of ACRs. ACRs relate the acute and chronic toxicities of a pollutant from toxicity studies in which both acute and chronic tests were conducted for the same species. By considering the distribution of all species-level ACRs, Stephen et al. (1985) describes various methods that can be used to select an appropriate final ACR. Specific methods used to determine final ACRs are based on the distribution and underlying trends across ACRs, and are further discussed in (Stephen et al. 1985).

distance increments from the point of discharge. Similar information is presented in Figure 17 based on the chronic concentrations.

The amount of low level mortality ( $LC_{Low}$ ) (percentage of species) ranges from 58 to less than 1 percent between the point of discharge and the edge of the chronic mixing zone (Figure 16). This low level mortality is dependent upon the duration of exposure, which is 96 hours in the standard toxicity tests considered in the analysis. Some level of toxicity occurs before 96 hours but data are unavailable to further evaluate this (EPA 2016b). Unless a species is fixed (e.g., mussels) or restricted to a small area in the vicinity of the outfall, mortality is unlikely.

The amount of chronic level mortality ranges from 96 to 75 percent between the point of discharge and the edge of the chronic mixing zone (Figure 17). However, it is necessary to consider the exposure duration to interpret this information relative to likely effects. Values for chronic effects concentrations are developed use life cycle, partial life cycle and early life stage tests all with extended exposure periods. Life cycle tests with fish last for at least 24 days and 90 days for salmonids after the hatching of the next generation. Life cycle tests with mysids continue until 7 days past the median time of first brood release in the controls. Partial life-cycle tests are allowed with fish species that require more than a year to reach sexual maturity, so that all major life stages can be exposed to the test material in less than 15 months. Early life-stage toxicity tests consist of 28- to 32-day (60 days post hatch for salmonids) exposures of the early life stages of a species of fish from shortly after fertilization through embryonic, larval, and early juvenile development (Stephen et al. 1985).

Given the exposure duration used to develop chronic effects levels, it is apparent that although the concentrations resulting in chronic effects are present within the mixing zone, the duration of the exposure necessary to experience those effects is unlikely except for sessile species or those with restricted ranges. Species with small home ranges (shrimp and prawns) or drifters (amphipods) are the most likely to be adversely affected. Juvenile fishes that remain in the nearshore or in estuaries to rear where mixing zones are allowed may be repeatedly exposed to pollutants prior to migrating out to sea. Salmonids and other adult pelagic fish would likely swim through the mixing zone and would not be exposed for a length of time that would cause them to experience chronic effects. Groundfish are exposed in much the same way as other benthic species and depending on the extent of their home range they could be exposed within a mixing zone for a longer period of time than pelagic fish species.

In summary, the analysis indicates that a low level of mortality would be expected when species are in close proximity to the point of discharge. These species include both fish (considered primary prey of Cook Inlet belugas) and invertebrates, however, the lower trophic level organisms would be most affected. Species with small home ranges (e.g., shrimps and prawn) or drifters (amphipods) are likely to experience acute and chronic effects depending on their location within the mixing zone and duration of exposure. The results indicate it is unlikely that adult pelagic fish would experience acute or chronic effects from exposure to UIA in the mixing zone due to their mobility. Depending on the home range and migratory behavior of demersal species, e.g., yellowfin sole, there is a possibility that they may be exposed to the mixing zone for longer periods and experience chronic effects. Demersal species also have a closer association with the sediments and pollutants that have partitioned out of the mixing zone.

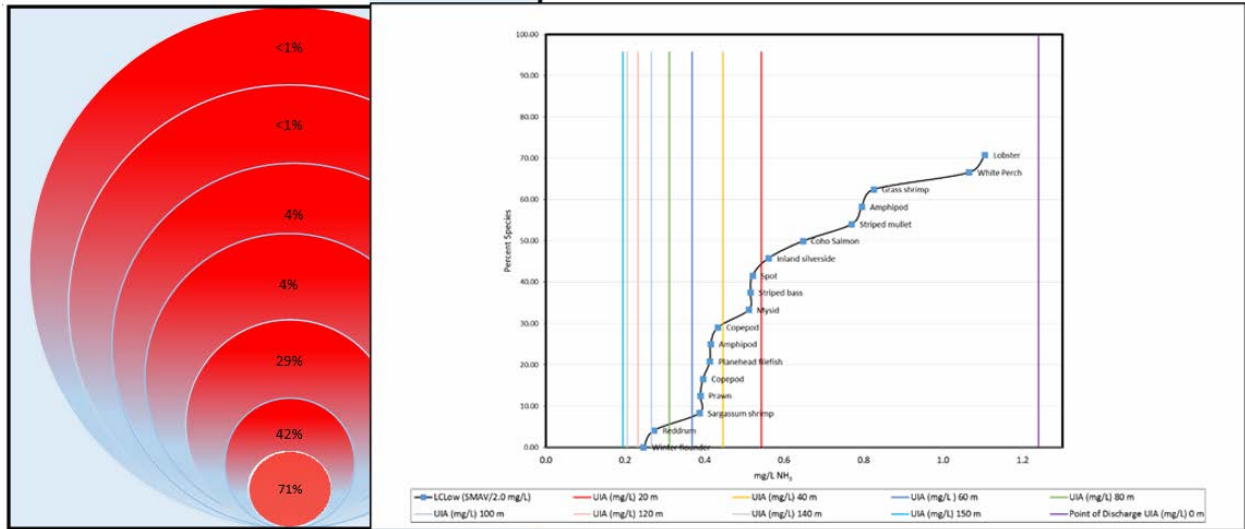


Figure 16. Percentage of UIA low level mortality concentrations (graphic to the right) estimated to be exceeded at 20-meter distance increments from the point of discharge (graphic to the left) for the Kenai WWTF (adapted from EPA 2016b).

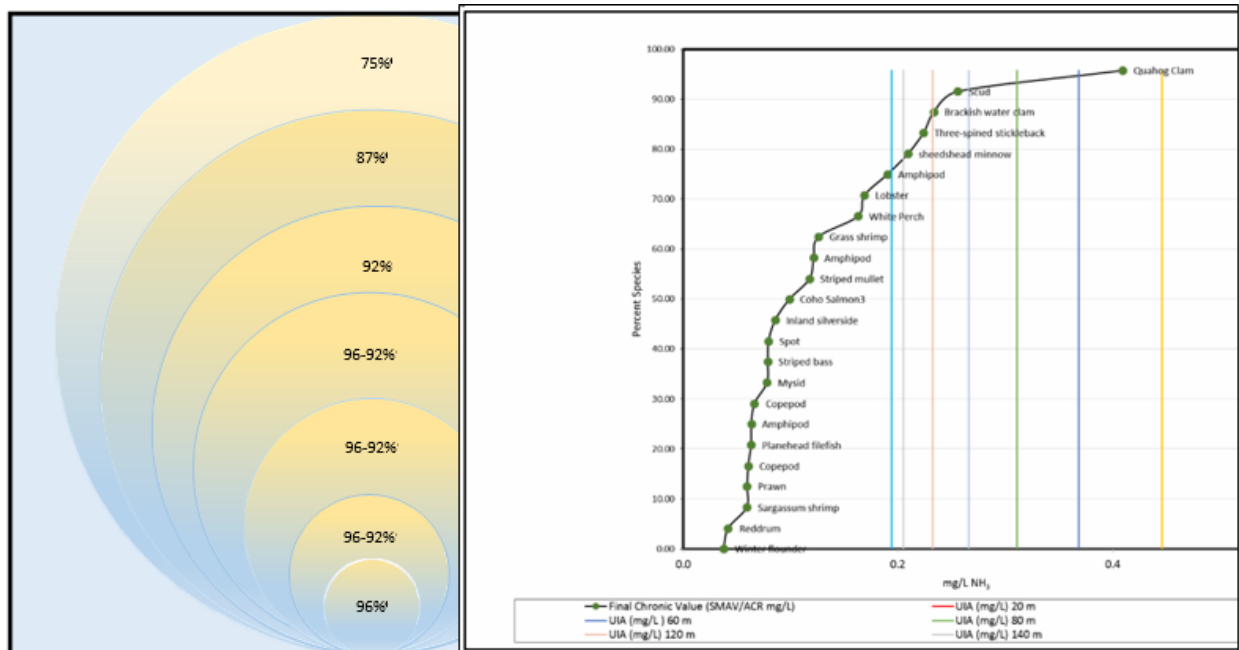


Figure 17. Percentage of UIA chronic effects concentrations (graphic to the right) estimated to be exceeded at 20-meter distance increments from the point of discharge (graphic to the left) for the Kenai WWTF (adapted from EPA 2016b).

## 6.3.2 Exceedance of Water Quality Criteria within Mixing Zones

### 6.3.2.1 Municipal Wastewater Treatment and Oil and Gas and Other Industrial Facilities

In Section 6.2.4, we provide summaries of the DMR data that were available for a subset of the municipal WWTFs and oil and gas and other industrial facilities with mixing zones within Cook Inlet to characterize some of the chemical and physical parameters of the effluents discharged by these facilities. Tiered from this characterization of the discharges, in this section we evaluate potential exposure of critical habitat to toxic substances reported in the discharges based on comparisons with Alaska WQC. The studies that form the basis for the WQC do not, however, account for as endpoints many sublethal effects on aquatic organisms that can be important to survival, e.g., behavioral changes and physiological stress. Therefore, at the end of this section, we consider one specific subset of sublethal effects that is of particular concern for mixing zones—effects of exposure to metals on salmonid olfaction and fish avoidance responses—based on information published in the scientific literature.

We discussed in Section 6.3.1 that WQC are generally defined in terms of the CMC (criterion maximum concentration) and the CCC (criterion continuous concentration). A permitted discharge with an authorized mixing zone may be allowed exceedances of the CCCs for specific pollutants within a chronic mixing zone and some may also be allowed exceedances of the CMCs for specific pollutants within an acute mixing zone (i.e., zone of initial dilution). In short, the CMC and CCC indicate the concentrations for a particular pollutant at which most aquatic organisms should not be affected unacceptably if the one-hour average concentration does not exceed the CMC and the four-day average concentration does not exceed the CCC more than once every three years on average, respectively (Stephen et al. 1985). The CMC is often applied to evaluate the potential for short-term, higher level releases, such as stormwater discharges, to adversely affect aquatic life. The CMC is typically derived from studies that measure acute toxicity based on organisms immobilized or killed. The CCC is applied to evaluate the potential for long-term exposure of aquatic life to result in adverse effects on survival, reproduction, or development of viable offspring (i.e., reproduction and growth).

As explained in Section 6.3.1, the CMC and CCC are determined based on effects concentrations associated with the 5th percentile of tested genera. As such, the CMC and CCC are intended to protect 95 percent of exposed aquatic taxa. Therefore, these criteria do not necessarily represent concentrations that are protective of the primary prey species of Cook Inlet belugas (i.e., PBF 2 of Cook Inlet beluga critical habitat) specifically. But we concluded that they are sufficient for evaluating which of the pollutants are at concentrations that have the most potential for effects from acute or chronic exposure.

The mean and 95th percentile concentrations summarized from the DMR dataset were used in comparisons with the corresponding WQC, as shown in Table 4 and Table 5, to represent worst-case (95th percentile) and potentially more realistic (mean) exposure concentrations within a mixing zone. The comparisons are highly conservative because they are based on data from collection of effluent at the end-of-pipe discharge point without consideration of dilution in mixing zones. It is, of course, recognized that the concentrations of pollutants discharged into receiving waters would lessen with distance from the outfall, as was modeled by EPA (2016b).



Nevertheless, if the values for the mean and 95th percentile concentrations summarized for a toxic pollutant contained in the discharges (i.e., at end-of-pipe) meet or are less than the corresponding CMC and CCC, it would be expected that there is limited potential for that pollutant to exceed the WQC in receiving waters. Exceedance of the CMC/CCC does not automatically mean that adverse effects will occur to exposed organisms, particularly given dilution in receiving waters, but it serves to identify those pollutants that are more likely to cause adverse effects. Given that the WQC for several of the pollutants considered in this analysis are dependent upon certain site-specific water quality parameters (e.g., hardness, pH) in fresh water, there are only a few mixing zones located in fresh water, and the primary area of concern is Cook Inlet, we evaluated the DMR data only on the basis of WQC for marine waters. However, there are a few metals for which the WQC concentrations in fresh water are considerably lower than in marine water. We include this consideration qualitatively in the below evaluation for metals. In addition to the pollutants compared with WQC in Table 4 and Table 5, we also evaluated pH, DO concentrations, and temperature relative to their respective WQC. These comparisons did not indicate any exceedances that would warrant further evaluation. Other discharge parameters that are authorized for exceedance of WQS in existing mixing zones within state waters of Cook Inlet are discussed below in the qualitative exposure analysis for seafood processing discharges (see Section 6.3.2.2).

The discharge concentrations for the following pollutants listed in Table 4 and Table 5 exceeded the corresponding CMC and/or CCC:

- Municipal WWTF discharges: total residual chlorine, ammonia, copper, and zinc; and
- Oil and gas and other industrial facility discharges: total residual chlorine, ammonia, arsenic, copper, silver, zinc, TAH, and TAqH.

As emphasized throughout this analysis, the DMR values represent effluent characteristics without dilution in receiving waters. Taking into consideration at least a minimal amount of dilution, the exceedance ratios for zinc in municipal WWTF discharges are low (1.24 and 1.36 times the CMC and CCC values, respectively), as are the exceedance ratios for arsenic in oil and gas and other industrial facility discharges (1.23 and 1.06 times the CMC and CCC values, respectively). The exceedance ratios for total residual chlorine, TAH, and TAqH in oil and gas and other industrial facility discharges are by far the highest, implying a clear potential for adverse effects on aquatic organisms found within the mixing zones associated with the discharges.

A significant additional source of uncertainty regarding these comparisons is that a mixture of pollutants are present in mixing zones. In general terms, mixtures of pollutants may have additive, more than additive, or less than additive effects, as compared to the toxicity of the individual pollutants in isolation. Although there has been a recent focus in the scientific community on investigating the toxicity of metal mixtures (e.g., Vijver et al. 2011, Meyer et al. 2015), it is clear that the topic of effects of mixtures of pollutants and incorporation into aquatic risk assessments (e.g., Nys et al. 2018) is complex. We do not attempt to estimate toxicity of mixtures of pollutants in the analysis of exposure that follows, but this potential is taken into consideration in Section 6.4.2, where we evaluate the likely responses of aquatic organisms to exposure to pollutants within mixing zones.

**Table 4. Comparisons of summarized pollutant concentrations in effluents discharged from municipal WWTFs (2009 to 2017) with marine WQC for aquatic life (CMC and CCC).**

DMR parameter <sup>1</sup>	Units	No. Facilities with DMR data	95th percentile <sup>1</sup>	$\bar{x}$ <sup>1</sup>	CMC <sup>2,3</sup>	CCC <sup>2,3</sup>	Ratio = 95th percentile / CMC	Ratio = $\bar{x}$ / CMC	Ratio = 95th percentile / CCC	Ratio = $\bar{x}$ / CCC
Arsenic, total recoverable	µg/L	1	11.37	5.79	68.55 <sup>4</sup>	36.05 <sup>4</sup>	0.17	0.08	0.32	0.16
Cadmium, total recoverable	µg/L	2	1.60	0.36	40.28 <sup>4</sup>	8.846 <sup>4</sup>	0.04	0.01	0.18	0.04
Chlorine, total residual	µg/L	4	100.00	58.17	13	7.5	7.69	4.47	13.33	7.76
Copper, total recoverable	µg/L	3	19.40	11.50	5.78 <sup>4</sup>	3.73 <sup>4</sup>	3.36	1.99	5.20	3.08
Lead, total recoverable	µg/L	1	1.00	0.55	217.16 <sup>4</sup>	8.468 <sup>4</sup>	0	0	0.12	0.06
Nitrogen, ammonia total [as N]	mg/L	3	40.00	17.54	8.1 <sup>5</sup>	1.2 <sup>5</sup>	4.94	2.17	33.33	14.62
Silver, total recoverable	µg/L	1	0	0.20	2.3 <sup>4</sup>	NA	0	0.09	NA	NA
Zinc, total recoverable	µg/L	1	117.50	60.32	95.10 <sup>4</sup>	86.14 <sup>4</sup>	1.24	0.63	1.36	0.70

<sup>1</sup> Values are from Table 2; only parameters with at least 10 DMR records of concentrations are included.

<sup>2</sup> NA indicates no numeric criterion is available.

<sup>3</sup> The CMC and CCC values are based on the criteria for aquatic life for marine water specified in the *Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances* (ADEC 2008).

<sup>4</sup> The CMC and CCC values for each metal are expressed in ADEC (2008) in terms of dissolved concentrations, and in some cases the corresponding total recoverable (dissolved + particulate) concentrations are indicated in footnotes. For the purpose of comparison with discharge concentrations reported as total recoverable metal, the CMC and CCC are expressed here similarly as total recoverable metal. If total recoverable concentrations were not indicated in ADEC (2008) in the footnotes for the CMC or CCC of a particular metal, the appropriate saltwater conversion factor specified in ADEC (2008) was applied to the dissolved metal criterion to derive the values listed in this table. Because it is typically only the dissolved phase that represents the bioavailable fraction to which aquatic organisms may be exposed (Prothro 1993), concentrations expressed as total recoverable metal likely overestimate potential exposure concentrations. The values expressed in the table in terms of total recoverable concentrations are (CMC/CCC): arsenic 69/36, cadmium 40/8, copper 4.8/3.1, lead 210/8.1, silver 1.9/NA, zinc 90/81.

<sup>5</sup> The total ammonia criteria specified in ADEC (2008) for aquatic life for marine water are pH, temperature, and salinity dependent. The CMC and CCC values specified reflect the criteria identified in ADEC (2008) for mid-range values of pH = 8.0, salinity = 20g/kg, and temperature = 15°C.

**Table 5. Comparisons of summarized pollutant concentrations in effluents discharged from oil and gas and other industrial facilities (2009 to 2017) with aquatic life criteria for marine water (CMC and CCC).**

DMR parameter <sup>1</sup>	Units	No. Facilities with DMR data	95th percentile <sup>1</sup>	$\bar{x}$ <sup>1</sup>	CMC <sup>2,3</sup>	CCC <sup>2,3</sup>	Ratio = 95th percentile / CMC	Ratio = $\bar{x}$ / CMC	Ratio = 95th percentile / CCC	Ratio = $\bar{x}$ / CCC
Arsenic, total recoverable	µg/L	2	44.40	38.11	68.55 <sup>4</sup>	36.05 <sup>4</sup>	0.65	0.56	1.23	1.06
Chlorine, total residual	µg/L	10	2,825.00	610.67	13	7.5	217.31	46.97	376.67	81.42
Copper, total recoverable	µg/L	5	56.78	12.38	5.78 <sup>4</sup>	3.73 <sup>4</sup>	9.82	2.14	15.22	3.32
Mercury, total [as Hg]	µg/L	5	0.26	0.13	2.062 <sup>4</sup>	1.106 <sup>4</sup>	0.12	0.06	0.23	0.12
Nitrogen, ammonia total [as N]	mg/L	4	13.39	6.32	8.1 <sup>5</sup>	1.2 <sup>5</sup>	1.65	0.78	11.15	5.27
Silver, total recoverable	µg/L	3	20.00	3.92	2.3 <sup>4</sup>	NA	8.70	1.71	NA	NA
Zinc, total recoverable	µg/L	3	341.80	77.67	95.10 <sup>4</sup>	86.14 <sup>4</sup>	3.59	0.82	3.97	0.90
Hydrocarbon, aqueous <sup>6</sup>	mg/L	5	17.25	9.78	1.5 <sup>6</sup>	0.015 <sup>6</sup>	11.50	6.52	1,150.09	651.83
Hydrocarbon, aromatic <sup>6</sup>	mg/L	5	16.47	9.54	1 <sup>6</sup>	0.01 <sup>6</sup>	16.47	9.54	1,647.00	954.00

<sup>1</sup> Values are from Table 3; only parameters with at least 10 DMR records of concentrations are included.

<sup>2</sup> NA indicates no numeric criterion is available.

<sup>3</sup> Unless otherwise specified, the CMC and CCC values are based on the aquatic life criteria for marine water specified in ADEC (2008).

<sup>4</sup> The CMC and CCC values for each metal are expressed in ADEC (2008) in terms of dissolved concentrations, and in some cases the corresponding total recoverable (dissolved + particulate) concentrations are indicated in footnotes. For the purpose of comparison with discharge concentrations reported as total recoverable metal, the CMC and CCC are expressed here similarly as total recoverable metal. If total recoverable concentrations were not indicated in ADEC (2008) in the footnotes for the CMC or CCC of a particular metal, the appropriate saltwater conversion factor specified in ADEC (2008) was applied to the dissolved metal criterion to derive the values listed in this table. Because it is typically only the dissolved phase that represents the bioavailable fraction to which aquatic organisms may be exposed (Prothro 1993), concentrations expressed as total recoverable metal likely overestimate potential exposure concentrations. The values for each metal listed in the table expressed in terms of total recoverable concentrations are (CMC/CCC): arsenic 69/36, copper 4.8/3.1, mercury 1.8/0.94, silver 1.9/NA, zinc 90/81.

<sup>5</sup> Total ammonia aquatic life criteria for marine water specified in ADEC (2008) are pH, temperature, and salinity dependent. The CMC and CCC values indicated reflect the criteria identified in ADEC (2008) for mid-range values of pH = 8.0, salinity = 20g/kg, and temperature = 15°C.

<sup>6</sup> The Alaska WQS at 18 AAC 70.020(b)(17)(A)(i) identify chronic aquatic life criteria for marine water as TAqH and TAH concentrations that are used here as the CCC values for the DMR parameters "hydrocarbon, aqueous", and "hydrocarbon, aromatic", respectively. For purposes of this analysis, the CMC value for TAH is based on the average LC50 value of 1 mg/L (concentration lethal to 50 percent of test organisms) reported for Alaskan larval crustaceans, which were determined to be one of the most sensitive marine species/life stage groups (ADEC 2015d); and the CMC value for TAqH was estimated based on the CCC value divided by the 0.01 safety factor used by EPA (2015d) to determine the CCC value for TAH based on the average LC50 value (i.e., ADEC 2015d derived the CCC value for TAH by multiplying the average LC50 value of 1 mg/L by a 0.01 safety factor). Safety factors are used to provide an extra measure of safety beyond the known or estimated sensitivities of organisms (Stephen et al. 1985).

Below we summarize key information regarding the mode of action and toxicity to aquatic organisms of each of the pollutants listed in Table 4 and Table 5 for which the summarized discharge concentrations exceed the CMC and/or CCC. We then consider potential sublethal effects of exposure to metals on salmonid olfaction and avoidance responses, which are not accounted for by the comparisons with the WQC.

As discussed in Section 6.3.1, the potential duration of exposure to pollutants within mixing zones differs for fish versus invertebrates, as well as for pelagic fish versus groundfish. Adult pelagic fish are exposed to pollutants within the water column while swimming through a mixing zone. Juvenile fish that remain in the nearshore or in estuaries to rear where a mixing zone is authorized may be repeatedly exposed to pollutants before migrating out to sea. Depending on the extent of their home range, groundfish may be exposed for a longer period of time than adult pelagic fish and they are also exposed to pollutants in the sediment similar to other benthic species. Sessile organisms (e.g., mussels), drifters (e.g., amphipods), and many benthic invertebrates, which are relatively sedentary, can undergo prolonged (chronic) exposure when their presence overlaps with a mixing zone. The impact of chronic exposure is directly related to the concentrations of pollutants discharged and the proximity of the organisms to the point of discharge. When these species are filter feeder (mollusks) or detritivores (crustaceans), exposure through the dietary pathway exists as well.

#### **6.3.2.1.1 Ammonia**

Ammonia is one of several forms of nitrogen in aquatic environments and is a key component in the nitrogen cycle. Because ammonia is continually recycled in the environment, bioaccumulation, as it is usually considered, does not occur (Agency for Toxic Substances and Disease Registry [ATSDR] 2004). As discussed in Section 6.3.1, total ammonia in aqueous solution consists of two primary forms, ionized ammonia, and UIA, with the latter being most toxic to aquatic organisms. Ammonia is extremely water soluble and under normal conditions is easily excreted by fish across the gills (Ip and Chew 2010). When ammonia is present at high enough levels in the water column, it is difficult for aquatic organisms to sufficiently excrete it, resulting in a buildup of ammonia in internal tissues and blood, which in fish can result in respiratory distress (Willingham 1976). Extended exposure (6 weeks) to low levels (0.002 mg/L) of UIA greatly affected the physiology of salmonids resulting in reduced stamina, performance, and growth (Burrows 1964). Gill hyperplasia (abnormal cell growth) affecting oxygen transport was also demonstrated in salmon exposed to 0.005 mg/L UIA. Gill hyperplasia reduces the surface area of the gills, reducing gas exchange and consequentially respiration. Gill infections are also common (Willingham 1976).

The CCC exceedance ratios based on the mean discharge concentrations are 14.62 for municipal WWTFs and 5.27 for oil and gas and other industrial facilities, whereas the CMC exceedance ratio is lower for municipal WWTFs (2.17) and is below the CMC for oil and gas and other industrial facilities. These results imply that within the mixing zones authorized for exceedance of the WQC for ammonia, there is primarily a potential for exposure of aquatic organisms to concentrations of this chemical that can cause chronic toxic effects; in particular, in less mobile species, as was modeled by EPA for the Kenai WWTF mixing zone specifically (see Section 6.3.1). Concentrations of ammonia that can cause acute toxic effects may also occur near the points of discharge.

### 6.3.2.1.2 Chlorine

The chemistry of chlorine in the aquatic environment is very complex. Although the toxicity of chlorine residuals can be high at low concentrations, they tend to decompose quickly (Canadian Council of Ministers of the Environment 1999).<sup>15</sup> The toxic mechanism(s) of action of residual chlorine to aquatic life are not fully understood, but are likely related to the ability of chlorine to oxidize organic matter (Singleton 1989). In fish, gills are believed to be the primary site of toxic action of chlorine. This is based on multiple observations of damage to gill epithelium following exposure to chlorine. Cairns et al. (1975) concluded that the mode of toxic action of chlorine to fish is gill tissue damage combined with accumulation of mucus on the gills. The combination of physical damage to gill tissue and coating of gill tissue by mucus inhibits oxygen uptake, resulting in suffocation of the fish. If the mechanism of toxic action proposed by Cairns et al. (1975) is correct, chlorine is one of the relatively few chemicals that does not require an internally bioaccumulated dose to elicit toxicity to aquatic life. The mechanism of toxic action of chlorine limits the exposure of both fully aquatic and aquatic-dependent species to chlorine, as it precludes exposure via the dietary ingestion exposure route, thus also making bioaccumulation risks unlikely (EPA 1985, Shephard et al. 2015).

Adverse effects in fish, such as gill injuries, reduction in respiration, damage to fish eggs and reduction in hatching success, and delay of larval development, as well as in aquatic invertebrates, have also been reported at concentrations lower than the CMC and CCC concentrations (Abarnou and Moissec 1992). In general, laboratory studies indicate that fish may avoid chlorinated waters under some circumstances, but the extent to which they may do so in the wild is unknown (Larson et al. 1978).

The CCC exceedance ratios based on the mean discharge concentrations are 7.76 for municipal WWTFs and 81.42 for oil and gas and other industrial facilities, and the CMC exceedance ratios are 4.47 and 46.97, respectively. We infer from these results that within the mixing zones authorized for exceedance of the WQC for total residual chlorine, there is a potential for exposure of aquatic organisms to concentrations of this chemical that can cause both acute and chronic toxicity, in particular within the mixing zones associated with oil and gas and other industrial facility discharges. Given the high exceedance ratios indicated for oil and gas and other industrial facilities, it is likely that, even when considering dilution, less mobile organisms would be particularly impacted. Organisms inhabiting areas near the outfalls would be the most susceptible to adverse effects.

### 6.3.2.1.3 Heavy Metals

The heavy metals are usually divided into essential (zinc, copper, chromium, selenium, nickel, aluminum) and non-essential metals (cadmium, mercury, and lead), with the latter being toxic even at low concentrations. Even essential metals, which are important constituents of enzymes,

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<sup>15</sup> Once introduced into a solution, chlorine is generally present in two forms of free chlorine: hypochlorous acid and the hypochlorite ion. If the solution contains ammonia, the solution will also likely contain two forms of combined chlorine: monochloramine and dichloramine. Because all four forms of chlorine can be toxic to aquatic organisms, the term "total residual chlorine" is used to refer to the sum of free chlorine in fresh water. However, because salt water contains bromide, addition of chlorine also produces hypobromous acid, hypobromous ion, and bromamines, which are referred to as chlorine-produced oxidants (Shephard et al. 2015).

become toxic at certain concentrations. The availability of metals in aquatic systems is complex and multi-faceted, with many variables affecting physical and biological processes preceding toxicity (McGeer et al. 2004). Metals interact with numerous compounds normally found in natural waters. Particulate matter in the water column will facilitate the removal of metal from solution by adsorption to suspended particles which in turn may be deposited and accumulate in sediments, though remobilization may occur when sediment is disturbed. The remaining dissolved metal in the water column may be present as either an organic complex or in the free ionic form, with the ionic form generally considered to be more toxic (McGeer et al. 2004). However many factors affect bioavailability and uptake by marine organisms, e.g., physical factors such as temperature, pH, and salinity, and toxicity is influenced by a variety of factors including the species and life stage exposed (Ansari et al. 2004, McGeer et al. 2004, Tchounwou et al. 2012). Organisms that demonstrate elevated concentrations of contaminants such as metals, e.g., lead, cadmium, selenium, and copper, may be at greater risk in mixing zones. We also note that the toxicity of certain metals, such as zinc, is in general terms higher in fresh water as compared to salt water (e.g., Wheeler et al. 2002)

Aquatic organisms can be exposed to metals through direct uptake via the gills or skin, and through consumption of metals in water, sediments, and prey. The toxic modes of action of metals in organisms and the biological systems affected are variable, but in general involve inhibition of many enzymes, as well as impairment of such functions as locomotion, osmoregulation, respiration, and reproduction (Atchison et al. 1987). Metals can bioaccumulate in the aquatic environment, but with few exceptions they do not appear to biomagnify to a significant extent, except in some cases in lower trophic levels (Burger 2008, Cardwell et al. 2013). Exposure to metals can also result in a variety of sublethal effects. In fish, examples include impaired swimming performance, changes in respiratory behavior, and changes in activity levels (Atchison et al. 1987). At the end of this section we consider in detail potential sublethal effects of metals on salmonid olfaction and avoidance responses, which as explained below, are not accounted for by the comparisons with the WQC.

The CCC exceedance ratios for copper based on mean discharge concentrations are 3.08 for municipal WWTFs and 3.32 for oil and gas and other industrial facilities, and the CMC exceedance ratios were a bit lower (1.99 and 2.14 times the CMC value, respectively), whereas the exceedance ratios based on 95th percentiles are higher, in particular for oil and gas and other industrial facilities (15.22 and 9.82 times the CCC and CMC values, respectively). These results imply that within the mixing zones authorized for exceedance of the WQC for copper, there is some potential for aquatic organisms to be exposed to concentrations of this metal that can cause chronic toxic effects, with the likelihood of such effects being higher for oil and gas and other industrial facilities (and depending upon the dilution dynamics within the individual mixing zones). Taking into consideration dilution, it appears that exposure of aquatic organisms to concentrations of copper at acutely toxic levels would be primarily limited to near oil and gas and other industrial facility outfalls. As with other pollutants, less mobile organisms would be most affected.

The two other metals for which exceedances of the WQC are indicated are silver and zinc in discharges from oil and gas and other industrial facilities. A CCC value was not available for silver. Taking into consideration dilution in receiving waters generally, the CMC exceedance ratio (1.71) for silver is low. The 95th percentile concentration for silver is 8.70 times the CMC

value. Similarly, for zinc, only the 95th percentile concentration exceeds the CMC and CCC values (3.59 and 3.97 times these values, respectively). We interpret these results as implying that there is a limited potential for aquatic organisms to be exposed to concentrations of zinc that can cause acute or chronic toxic effects, primarily in less mobile species inhabiting areas near the outfalls.

### ***Metals Relative to Salmonid Olfaction and Fish Avoidance***

Safe passage of migrating fish and other organisms through and around mixing zones is an important factor to consider in assessing the potential effects of mixing zones on Cook Inlet beluga critical habitat. In particular, migratory fish species like Pacific salmon and Pacific eulachon must have safe upstream and downstream passage between marine habitats and freshwater spawning areas, and for salmon, in rearing areas, to complete their life cycles. Barriers or blocks that prevent or interfere with migration can be created by water with inadequate chemical or physical quality (EPA 2014). Anadromous salmon and Pacific eulachon are obvious examples of migratory fish that require unimpeded passage; however, non-anadromous fish such as Pacific cod, walleye pollock, saffron cod, and yellowfin sole also migrate and could require passage through or around mixing zones. These fish inhabit naturally fragmented habitat patches and there is a need to maintain connectivity between these patches.

Above we addressed potential chronic or acute toxic effects of representative metals that may be authorized within mixing zones. However, as is demonstrated in the analysis below, certain metals have the potential to cause sublethal behavioral changes in salmonids at concentrations that are lower than their corresponding WQC, and such effects were therefore not accounted for in that part of the analysis.

Controlled preference-avoidance studies with fish have repeatedly shown that many chemicals or effluent mixtures are avoided by fish. Field observations of avoidance of natural waters containing waste discharges have also been reported (e.g., Sprague 1964, Sutterlin and Gray 1973, Geckler et al. 1976, Atchison et al. 1987, Damkaer and Dey 1989). But due to the lack of experimental control in most of the field studies and the natural complexity of territorial, social, predatory, and reproductive behavior, field verification of experimental concentration-response relationships is difficult (Little 1990). There is also a paucity of data on effects concentrations for many metals in salt water, in adult fish (studies are typically conducted using juveniles), and in the primary prey species or species that might be considered surrogates for most metals. This analysis therefore relies on the available data for each metal without in most cases narrowing the scope of information considered based on such factors. In addition, as was alluded to above, a variety of other factors can influence the toxicity of certain metals, e.g., pH, and would play a role in fish behavioral responses beyond simply the concentration of dissolved metal in the water column. Acknowledging these limitations, the review that follows attempts to evaluate potential effects and safe conditions for passage of Cook Inlet beluga primary prey species in relation to metals discharged into mixing zones within state waters of Cook Inlet and its tributaries.

Representative metals that may be authorized for exceedance of WQC within mixing zones in state waters of Cook Inlet and its tributaries, based on existing authorizations include: arsenic, cadmium, chromium, copper, nickel, lead, mercury, selenium, silver, and zinc. For each of the substances discussed below, fish passage thresholds are identified based on the available data, which in a number of cases are limited. Because laboratory-based thresholds may overestimate

the responsiveness of fish in the wild (Henry and Atchison 1991), with the exception of copper (see discussion below), estimated field thresholds are identified in addition to laboratory thresholds by applying the lowest laboratory-to-field ratio reported in the literature reviewed (i.e., 50 percent lower field threshold) (Hartwell et al. 1987). The passage thresholds and relevant values reported from the literature are expressed in the discussion and summary Table 6 below as dissolved metal. As noted in Table 4 and Table 5, the discharge concentrations were reported and summarized as total recoverable metal, and for this reason to make direct comparisons, the values for the WQC (based on the Alaska WQS for aquatic life for marine water) are also indicated in those tables as total recoverable metal. Because it is typically only the dissolved phase that represents the bioavailable fraction to which organisms may be exposed, the concentrations expressed as total recoverable metal likely overestimate potential exposure concentrations. We draw this distinction below where appropriate.

We also note that certain provisions of the MZR could provide a basis for moderating potential effects on fish passage through permit conditions or denial of mixing zones (see Appendix A). For example the MZR allows for a mixing zone to be approved only if available evidence reasonably demonstrates that it will not form a barrier to migratory species or fish passage” (18 AAC 70.240(c)(4)(G)). In addition, the MZR does not allow a mixing zone to be authorized in a spawning area of any of the five species of anadromous salmon found in the state, or to adversely affect the present and future capability of an area to support spawning, incubation, or rearing of these species (18 AAC 70.240(e)).

### ***Arsenic***

No reports of fish avoidance to arsenic were located for this analysis. The estimated threshold for sublethal, chronic effects of arsenic (as arsenite) on rainbow trout (*Oncorhynchus mykiss*) is 4,900 µg/L (Rankin and Dixon 1994), whereas the CCC specified in the Alaska WQS is 36 µg/L (dissolved metal). Given that the discharge concentrations for arsenic summarized in Table 4 and Table 5 are not appreciably higher than the Alaska WQC for arsenic (maximum 1.23 times the CCC), arsenic is unlikely to be a concern with respect to fish passage through mixing zones.

### ***Cadmium***

Cadmium has been reported to be toxic at concentrations lower than fish can detect and avoid (Atchison et al. 1987). Woodward et al. (1997) reported no response by cutthroat trout (*Oncorhynchus clarkii*) in avoidance testing with a cadmium concentration of 0.66 µg/L. Similarly, Hartwell et al. (1989) reported that golden shiner did not avoid cadmium at concentrations up to 68 µg/L. McNichol and Scherer (1993) reported that lake whitefish (*Coregonus clupeaformis*) avoided cadmium at 0.2µg/L; however, the avoidance was only significant at less than 1 and more than 8 µg/L. In further testing, lake whitefish showed a neutral response to cadmium at 0.2 µg/L, 1 µg/L, and 5 µg/L (McNichol and Scherer 1993). The laboratory passage threshold of 8 µg/L for cadmium identified in Table 6 is based on behaviors observed by McNichol and Scherer (1993) and is nearly the same as the CCC specified in the Alaska WQS (8.8 µg/L dissolved metal), but is lower than the CMC value (40 µg/L dissolved metal). The DMR data for cadmium levels in effluents were reported only as dry weights, so it is not possible to compare cadmium levels in the discharges to the Alaska WQC or the passage thresholds.



### **Chromium**

Avoidance of chromium (VI) by rainbow trout has been reported from laboratory studies at concentrations ranging from 10 µg/L to 80 µg/L, and with golden shiners (*Notemigonus crysoleucas*) at 58 µg/L to 95 µg/L (Anestis and Neufeld 1986, respectively, Hartwell et al. 1989). Based on this limited information, a laboratory passage threshold of 10 µg/L is conservatively identified for this analysis (Table 6). The laboratory and field passage thresholds are both lower than the CCC specified in the Alaska WQS (50 µg/L dissolved metal). The DMR data for chromium levels in effluents were reported as dry weights, so it is not possible to directly compare chromium levels in discharges to the Alaska WQC or the passage thresholds.

### **Copper**

A large body of scientific literature has shown that salmon behaviors can be disrupted at concentrations of copper that are at or slightly higher than ambient concentrations (e.g., Sandahl et al. 2004, Baldwin et al. 2011, Wang et al. 2013, Sommers et al. 2016). For example, Sandahl et al. (2004, 2005) studied the sublethal effects of copper and organophosphate pesticides on juvenile coho salmon. These contaminants are known neurotoxicants in salmon, but they have different mechanisms of toxic action. The authors concluded that salmon exposed to sublethal concentrations of these contaminants in their habitat could experience interference with olfactory function that supports behaviors important for survival and migration. In experiments with coho salmon, sublethal concentrations of copper were found to be broadly toxic to the olfactory nervous system; increases in copper concentrations of as little as 3 µg/L above background resulted in inhibition of the olfactory system within as little as 30 minutes (Baldwin et al. 2003). Based on those results, the authors concluded that transient exposures to copper concentrations typically found in urban runoff can significantly impair the sensory physiology of juvenile coho salmon and may also interfere with olfactory-mediated behaviors associated with migratory success. Sensory physiology and predator avoidance behaviors in coho salmon were significantly impaired at concentrations as low as 2 µg/L (Sandahl et al. 2007). Even relatively brief exposures (3 hours) of juvenile coho salmon to copper concentrations ranging from 5 µg/L to 20 µg/L eliminated the ability of the coho to respond to predators (McIntyre et al. 2012).

Impairment of sensory functions important to survival of juvenile salmonids is likely to be widespread in many freshwater aquatic habitats. Impairment of these essential behaviors may manifest within minutes and continue for hours to days depending on concentration and exposure duration (Hecht et al. 2007). In addition, neurotoxic effects of copper on salmonids can manifest over a period of minutes to hours and can persist for weeks (Hecht et al. 2007). In laboratory tests, copper and zinc mixtures have been shown to act together to cause a lower threshold of avoidance than would result from either metal alone (Sprague 1964). McIntyre et al. (2008) pointed out that substantial reductions in olfactory toxicity are seen as dissolved organic carbon (DOC) increases from 0.1 mg/L up to 6 mg/L. DOC in receiving waters binds dissolved copper, and makes it more complex such that its toxicity is materially reduced.

Recent research indicates that copper avoidance (olfactory) toxicity is also highly dependent on salinity, in addition to DOC, at least for juvenile salmon (Baldwin 2015). Baldwin (2015) reported results of two studies that were designed to understand the effects of changes in salmon physiology and water salinity on the olfactory toxicity of copper. One of these studies found that exposure to copper at 50 µg/L did not result in significant olfactory toxicity in seawater-phase juvenile Chinook salmon. The other follow-up study assessed the olfactory toxicity of copper in

both freshwater and seawater-phase juvenile coho salmon using three salinities: fresh water, 10 parts per thousand salinity water to represent estuarine water, and seawater. Freshwater-phase juveniles showed olfactory toxicity when exposed to 50 µg/L of copper in fresh water, consistent with previous studies. But exposure to the same concentration in estuarine water did not produce olfactory toxicity (i.e., the increased salinity removed the olfactory toxicity). The author reported that seawater-phase juveniles showed no olfactory toxicity to copper at concentrations of 100 µg/L in seawater, and noted that sensitivity was unlikely to decrease as the DOC varies. Olfactory toxicity of copper to adult salmon returning to spawn is unknown (Baldwin 2015).

Based on the internal consistency of responses reported within a study, consistency of responses reported between studies, similarity of test species to the species occurring in Alaska, a preference for more recent study results over older studies when comparing similar studies, and whether actual test concentrations were reported to have been measured via nominal concentrations, we consider the passage threshold for copper in fresh water to be 3 µg/L, with the caveat that the threshold is expected to increase with increases in DOC. Glass et al. (2004) reported DOC values for several Cook Inlet tributaries that ranged from 1 mg/L in the Kenai River below Skilak Lake to more than 5.5 mg/L in the Ninilchik and Deska Rivers. Therefore, the passage threshold within a specific freshwater mixing zone may be higher depending upon the local DOC level. The copper concentrations summarized for discharges within state waters of Cook Inlet and its tributaries are considerably lower than 100 µg/L; therefore, it appears unlikely that salmon passage through mixing zones in Cook Inlet would be affected by this metal, at least based on the information for representative mixing zones. The 3 µg/L passage threshold for fresh water is nearly equivalent to the CCC value specified in the Alaska WQS (3.1 µg/L dissolved metal), but is lower than the discharge concentrations summarized for copper in municipal WWTF discharges (5.20 and 3.08 times the CCC based on the 95th and maximum mean concentration, respectively) (see Table 4), implying possible concern with respect to fish passage through freshwater mixing zones. However, this is particularly uncertain given dilution and the potential mediating effect of DOC, as well as the MZR provisions discussed above and presented in Appendix A.

### ***Lead***

Limited data were located regarding fish avoidance of lead. Woodward et al. (1997) reported no response by cutthroat trout in avoidance testing with a lead concentration of 1.3 µg/L, and Scherer and McNichol (1998) reported 10 µg/L lead was avoided by lake whitefish. These values are higher than the CCC value of 8.1 µg/L (dissolved metal) specified in the Alaska WQS. The discharge concentrations for lead summarized for one WWTF are considerably lower (see Table 4), which based on the limited information suggests that lead is unlikely to be a concern with respect to fish passage.

### ***Mercury***

Methylmercury is the most bioavailable form of mercury, and can biomagnify at successive trophic levels in the aquatic food chain (ATSDR 1999, McGeer et al. 2004). The food web is the main pathway for exposure to mercury (Beckvar et al. 1996, Jewett and Duffy 2007). Higher trophic level species tend to accumulate the highest concentrations of mercury, with concentrations highest in fish-eating predators such as belugas.

There is little published information on fish avoidance of mercury. Atchison et al. (1987) cited one older unpublished study in which fish were able to detect and were attracted to low concentrations (0.2 µg/L) of mercury. Behavioral avoidance of methylmercury chloride by threespine stickleback (*Gasterosteus aculeatus*) was reported at 0.5 µg/l (Deakins 1973). Rehnberg and Schreck (1986) reported coho salmon avoided 20 µg/L and lost olfactory function to detect amino acids, which are potent odors related to chemoreception, homing, and pairing. Based on this information, laboratory and field passage thresholds of 0.2 µg/L and 0.4 µg/L, are identified in Table 6 (based on attraction rather than on avoidance). These threshold values are considerably lower than the CCC value for mercury specified in the Alaska WQS (0.94 µg/L dissolved metal). However, the discharge concentrations for mercury summarized for oil and gas and other industrial facilities are close to or below the laboratory threshold value (see Table 5), implying minimal concern with respect to fish passage.

### ***Nickel***

There is relatively little published information on fish avoidance of nickel, despite its iniquitousness as an urban and industrial pollutant of concern. Giattina et al. (1982) found an avoidance threshold for nickel in soft water of about 23.9 µg/l, regardless of whether the fish were exposed to an abrupt change in concentration or a gradual change. The CCC value for nickel identified in the Alaska WQS (8.2 µg/L dissolved metal) is lower than the one avoidance threshold report. Nickel concentrations in effluents were not reported in the DMR data summarized for this analysis.

### ***Selenium***

Cleveland et al. (1993) reported behavioral abnormalities and locomotor impairment after 18-day and 60-day exposures of juvenile bluegill (*Lepomis macrochirus*) to selenium concentrations of 160 µg/L. This potential effects concentration is higher, and exposure duration much longer, than would occur within a mixing zone. Watenpaugh and Beitingner (1985) reported that fathead minnow (*Pimephales promelas*) did not avoid selenite at concentrations of 300 to 11,200 µg/L, and Hartwell et al. (1989) reported similar lack of avoidance at concentrations up to 3,489 µg/L. In other words, tested fish failed to avoid acutely lethal concentrations of selenium.

### ***Silver***

No references on behavioral effects of silver on fish were located. Because silver can have similar forms to copper and zinc, which elicit a strong avoidance response in fish, silver is assumed to have the potential to cause avoidance behavior at concentrations greater than 3 µg/L, which is the lowest of the passage thresholds identified in Table 6 for copper and zinc. This surrogate passage threshold is higher than the CMC value specified in the Alaska WQS (1.9 µg/L dissolved metal), and is relatively similar to the mean discharge concentration for oil and gas and other industrial facilities (3.93 µg/L total recoverable metal). However, the 95th percentile concentration is considerably higher (20 µg/L total recoverable metal) than the surrogate passage threshold implying some potential concern with respect to fish passage.

### ***Zinc***

Zinc has been well documented to cause avoidance in laboratory and field conditions for three different species of trout. Juvenile rainbow trout avoidance has been documented at zinc concentrations as low as 5.6 µg/L at a hardness of 112 mg/L (Sprague 1968) and 47 µg/l at a hardness of 13 mg/L (Black and Birge 1980). Juvenile brown trout (*Salmo trutta*) avoidance has

been documented at 25 µg/L at a hardness of 100 mg/L (Woodward et al. 1995). Similarly, juvenile cutthroat trout avoidance has been documented at 28 µg/L at a hardness of 50 mg/L (Woodward et al. 1997). Based on the consistency of responses reported within a study, consistency of responses reported among studies, and similarity of test species to the species occurring in Cook Inlet, a conservative laboratory passage threshold of 6 µg/L is identified in Table 6. Both the laboratory and field passage thresholds are below the CCC specified in the Alaska WQS (81 µg/L dissolved metal). The mean discharge concentrations for zinc in both oil and gas and other industrial facility and municipal WWTF discharges are below the laboratory and field passage thresholds, whereas the 95th percentile concentrations are considerably greater (117.50 µg/L and 16.47 µg/L, respectively, both as total recoverable metal), implying some potential concern with respect to fish passage.

**Table 6. Summary of estimated fish passage threshold concentrations (µg/L dissolved metal) for certain metals present in discharges into authorized mixing zones based on the available data.**

Passage threshold <sup>1</sup>	Cadmium	Chromium	Copper	Mercury	Zinc
Laboratory	8	10	3 <sup>2</sup>	0.2	6
Field	16	20	3 <sup>2</sup>	0.4	12

<sup>1</sup> Estimates of fish passage thresholds were identified based on the available data discussed in Section 6.3.2.1. Laboratory thresholds from the literature review were multiplied by two, the lowest laboratory-to-field ratio reported for the literature reviewed (Hartwell et al. 1987), to obtain estimates of field avoidance thresholds, except for copper. The estimated threshold for copper is instead identified as 3 µg/L due to the ambiguity in the available data (discussed below). The estimated threshold for mercury is based on attraction rather than avoidance, which could also affect passage.

<sup>2</sup> Applicable only to fresh water; increasing DOC level is expected to increase this threshold.

#### 6.3.2.1.4 Petroleum Compounds (TAH and TAqH)

As noted above, the exceedance ratios for TAH and TAqH concentrations in oil and gas and other industrial facility discharges are by far the highest (see Table 5), implying a clear potential for acute and chronic exposure of aquatic organisms to these chemicals within the mixing zones associated with the discharges. TAH, which is the sum of the concentrations of individual BTEX compounds, is likely to exhibit pronounced, short-term fluctuations in the water column due to the extreme volatility of these low molecular weight (LMW) compounds (ADEC 2015d). The lighter components of TAH mixtures are not expected to persist in the water column, whereas the heavier components are expected to persist but would most likely adsorb to sediment. Given the short-term persistence of the lighter TAH components in the water column, it appears unlikely that the reported TAH concentrations (see Table 5) are high enough to imply significant acute exposure of aquatic organisms. Nevertheless, the much higher CCC exceedance ratios for TAH concentrations (954 and 1,647 times the CCC value, based on the mean and 95th percentile concentration, respectively) imply potential for chronic toxic effects and sublethal effects within the mixing zones authorized for exceedance of the WQC for TAH.

TAqH is composed of BTEX and PAH compounds. PAH compounds are less volatile and less soluble than BTEX compounds. PAHs are unlikely to persist in the water column for an extended period of time due to processes such as dilution, volatilization, photolysis, and

biodegradation (ADEC 2015d). High molecular weight (HMW) PAHs are potentially bioaccumulative in certain species of bivalves, but many species of fish and invertebrates are able to metabolize them (Eisler 1987, Johnson et al. 2008, Bleeker and Verbruggen 2009). In general, both LMW and HMW PAHs are expected to significantly adsorb to sediment due to their strong affinity for organically enriched substrates (i.e., organic carbon) and other ligands (e.g., sulfides), where they can persist for long periods of time under certain conditions. HMW PAH compounds have low water solubility and are relatively resistant to leaching from sediments, whereas LMW PAHs are more water soluble and do not persist in sediment to the same degree. Although many species of aquatic organisms rapidly bioaccumulate PAHs, uptake and depuration is highly species- and chemical-specific. LMW PAHs tend to demonstrate slightly more mobility and more solubility, but are more subject to degradation (Eisler 1987).

Bioaccumulation of PAHs is generally not significant for most fish species because fish are capable of transforming PAHs into compounds that are more soluble in water, which facilitates elimination (Bleeker and Verbruggen 2009), although juvenile salmonids have been shown to exhibit immune dysfunction as a result of PAH exposure (Yanagida et al. 2012). Bottom-dwelling fish exposed to PAHs that have partitioned to sediment would be more of a concern. Algae, mollusks and other invertebrates metabolize these compounds much more slowly and are more likely to accumulate PAHs (Eisler 1987, Lawal and Fantke 2017).

There is some uncertainty underlying the CCC value for TAqH that is specified in the Alaska WQS (and that is the basis for the CMC value derived for the purposes of this analysis; see footnote at Table 5). Specifically, the CCC value for TAqH was derived from a previous total hydrocarbon CCC value of 0.01 mg/L (that was based on toxicity for various fish exposed to crude oil) assuming a total hydrocarbons to TAH ratio of 1.5:1 (ADEC 2015d). This criterion was last reviewed by ADEC in 2005 (ADEC 2015d). Nevertheless, the CCC exceedance ratios for TAqH concentrations in oil and gas and other industrial facility discharges are quite high (1,150 and 652 times the CCC based on the 95th percentile and mean concentration, respectively), implying the potential for chronic toxic effects and sublethal effects within the mixing zones authorized for exceedance of the WQC for TAqH. Less mobile species are expected to be the most affected, particularly those organisms inhabiting areas near the outfalls. Overlap of the mixing zones associated with oil and gas and other industrial facilities with nearshore areas that are used as rearing habitat for many juvenile fishes is low (Figure 14), thus exposure of these areas to high concentrations of TAH appears to be limited.

As discussed in Section 4.2.5.3, an environmental monitoring project was undertaken in Cook Inlet in 2008 and 2009 that integrated several different studies that sampled Inlet waters and sediments at more than 50 sites, including sites located within the primary area of Cook Inlet oil and gas activities. The results of this project are relevant to consider with respect to the exceedance ratios for TAH and TAqH. Although the sampling sites were randomly selected, selection of sites was also stratified to include representative locations within the mixing zones for the Trading Bay Production Facility, which was authorized for the largest-volume produced water discharges into the Inlet (Saupe et al. 2012). Sediment PAHs were found to be low in the Inlet, more highly correlated with percent fine sediments than TOC, and from mixed sources (Driskell and Payne 2012, Savoie et al. 2012). There was no indication that water column hydrocarbons were associated with produced water discharges (Savoie et al. 2012). However, elevated BTEX concentrations relative to the Alaska WQS were found at three locations within

the primary area of oil and gas activities in Cook Inlet, including at two sites in outer Trading Bay well beyond the edge of the mixing zones for the Trading Bay Production Facility. The other site with elevated BTEX concentrations was located north of the Forelands on the east side of the Inlet. The sources for the elevated BTEX were unknown.

### **6.3.2.2 Seafood Processing Facility Discharges**

DMR data or other quantitative information on the concentrations of pollutants in seafood processing facility discharges within Cook Inlet are unavailable. However, we note that some of the pollutants discharged by seafood processing facilities are the same as those evaluated in Section 6.3.1 and 6.3.2.1 for the other types of facilities, e.g., ammonia and total residual chlorine. For these pollutants, similar exposure effects would be expected, depending upon the exposure concentrations. The following qualitative analysis of the types of pollutants, and related biochemically-generated pollutants, associated with seafood processing discharges is based on information provided in the BE.

EPA summarized information on the loading of seafood waste discharged into the lower Kenai River by five seafood processing facilities, which total an estimated 2.3 million kilograms (10 million pounds) per year. EPA also reported that one of the two facilities in the lower Kasilof River discharges an estimated 5 million pounds of seafood waste per year. Four of the mixing zones allocated for seafood waste discharges into the lower Kenai River near the mouth are located in shallow water (3 to 9 m [10 to 30 ft] deep) about 30 m (100 ft) from shore and are approximately 305 m (1,000 ft) apart. There are also mixing zones located further upriver in less close proximity to one another (Figure 14). According to the notices of intent for coverage under the statewide general permit, these facilities also discharge other wastes such as process disinfectants (surfactants), cooling water, boiler water, and transfer water and refrigeration condensate. Depending on the concentrations, organisms exposed to substances in the discharges (e.g., ammonia and chlorine) may experience harmful effects.

Potential impacts on receiving water quality and benthic habitat resulting from seafood processing waste include a reduction in water column DO due to the decay of particulate and soluble waste matter; the release of toxic levels of sulfide and ammonia from decaying waste, and nutrient enrichment. All of these biochemically-generated pollutants are likely to affect the biological communities present in mixing zones. In general, impacts of seafood processing wastes on receiving water quality and benthic habitat are inversely related to the assimilative properties of the receiving waters. In areas with strong currents and high tidal ranges, assimilation is high, waste materials disperse rapidly, and there is little impact on water quality. In areas of quieter waters, assimilation is lower, and waste materials can accumulate, resulting in solid waste piles, DO depressions, and associated aesthetic problems (Mazik et al. 2005, EPA 2016b).

In addition to water column impacts, there are effects on the benthic habitat and community from particulate matter that settles within the mixing zones. Once settled, suspended solids can form organic mats that can smother the underlying substrate and benthic communities within the mixing zone (unless the hydrology permits a localized deposition). The accumulation of these deposits in some areas indicates that the rate of discharge exceeds the assimilation capacity of some water bodies and more specifically, the assimilation capacity of the benthic community and

other aquatic life that metabolize this material. Many benthic invertebrates are relatively stationary and sensitive to environmental disturbance and pollutants.

Deposition of seafood waste particles is expected to smother biota in the area near the discharge, potentially reducing the abundance or eliminating entirely infauna such as polychaetes, mollusks, and crustaceans. Additionally, demersal eggs of various benthic species and fish may be smothered by settling solid waste. Within a limited area near the discharge, zooplankton, fish larvae, and juvenile fish may also experience temporary effects including altered respiratory or feeding ability due to stress, or clogging of the gills and feeding apparatus. In addition, phytoplankton entrained in the discharge plume may have reduced productivity due to decreased light availability.

DO is a key element in water that is necessary to support aquatic life. It is depleted during the breakdown of "oxygen-demanding" substances such as organic matter and ammonia. These substances are usually destroyed or converted to other compounds by bacteria if there is sufficient oxygen present in the water; however, DO needed to sustain fish life may be consumed in this breakdown process. DO depletion caused by decomposition of organic matter or nitrification of ammonia is often measured as BOD, which is a measure of the amount of oxygen consumed by the respiration of microorganisms while feeding on decomposing organic material. Organic seafood wastes can exert a large BOD in receiving waters. In areas of high BOD loads and low flushing, it is possible to reach conditions where DO in the water is totally exhausted, resulting in anaerobic conditions and the production of undesirable gases such as hydrogen sulfide and methane (Ahumada et al. 2004). Water with high BOD also has the potential for increased bacterial concentrations that degrade water quality (Mazik et al. 2005, EPA 2016b). High BOD loads coupled with low dispersive capability may cause low DO concentrations or the complete absence of DO, which can be lethal to marine organisms. It is unlikely that a large waterbody such as the lower Kenai River would become anaerobic. But there may be localized areas of anaerobic sediments within a mixing zone due to the breakdown of waste material that is not transported out of the immediate area.

Excessive nutrients can cause a multitude of problems in coastal areas including eutrophication, harmful algal blooms, fish kills, shellfish poisonings, loss of seagrass and kelp beds, coral reef destruction, and reduced DO. As stated above, nitrogen is a common pollutant found in seafood processing waste. Nitrogen is known to be particularly damaging to bays and coastal seas by boosting primary production (the production of algae). With excessive amounts of nitrogen, algae growth and increasing denitrifying bacteria make the water more turbid. As the algae die and decompose, DO can be depleted if there is insufficient mixing or a lack of other re-aeration mechanisms present (Howarth et al. 2000). High levels of living algae can also lead to depletions in oxygen over the nighttime hours due to their oxygen consumption. Low DO levels can cause direct mortality of organisms, or reduced efficiency of physiological processes (e.g. food processing, growth). These changes in nutrients, light, and oxygen, favor some species over others causing shifts in phytoplankton, zooplankton, and benthic communities (Novatec and EVS Environment Consultants 1994, Howarth et al. 2000). Unlike solid residues, nutrients are water soluble and can therefore be transported beyond areas of heavy deposition unless assimilated by aquatic life, sorbed to sediments, or released to the atmosphere (denitrification and volatilization of nitrogen).

### 6.3.3 Spatial Extent and Distribution of Mixing Zones and Related Physical Factors

As illustrated in Figure 14, currently most of the authorized mixing zones within state waters of Cook Inlet and its tributaries are located in Area 2 of Cook Inlet beluga critical habitat. Patterns evident in the spatial distribution of the existing mixing zones in Cook Inlet include:

- Mixing zones for municipal WWTFs are all located within (Girdwood and Kenai) or proximate to (Homer) areas that meet the definition of PBF 1<sup>16</sup> of the critical habitat and several are located in or near anadromous tributaries to Cook Inlet;
- A number of the mixing zones for seafood waste processing facilities are located within areas that meet the definition of PBF 1, most notably, seven of these facilities discharge into mixing zones in the lower Kenai and Kasilof Rivers;
- Mixing zones for oil and gas facilities are primarily clustered near mid-Inlet and in Trading Bay, where two of the permitted facilities have mixing zones that overlap with areas that meet the definition of PBF 1 of the critical habitat; and
- The majority of the mixing zones are located in Area 2 of the critical habitat.
- Notably, none of the existing authorized mixing zones considered in our analysis are located near areas in upper Cook Inlet where concentrations of belugas and their prey occur seasonally, including the Susitna Delta area.

Based on information compiled in the BE, the total area currently authorized for mixing zones overlaps with approximately 2 percent or less of the designated critical habitat for Cook Inlet belugas. We note that EPA also estimated in the BE that authorized mixing zones currently overlap with approximately 2 percent or less of the critical habitat areas that meet the definition of PBF 1, which we therefore consider to be a reasonable estimate of the overlap with PBF 1 that may occur for mixing zones authorized under the MZR. As explained in the introduction to the “Effects of the Action” section of this opinion, we assume that this will continue to be the case for mixing zones authorized under the MZR. Further, we assume that other characteristics of the existing mixing zones are generally representative of mixing zones that may be authorized within Cook Inlet beluga whale critical habitat under the MZR.

Because the configuration and positioning of the discharge plumes within the mixing zones are dictated by bathymetry and the hydrodynamics of the receiving water, the dimensions of the mixing zones authorized are often long and narrow. When narrow long dimensions were specified in a permit, the areal extent of the mixing zone was conservatively estimated using the length as the radius of a circle surrounding the point of discharge (in a few cases the area of the portion of the resulting circle that overlapped with land was subtracted).

As discussed in general terms in Section 5.8.3, mixing zones located in areas of low flushing such as Kachemak and Chinitna Bays, have more potential for buildup of pollutants locally, and therefore could be less effective at reducing pollutants in the effluent to “background” concentrations (for this discussion, “background” refers to concentrations of chemicals unaffected by any effluent discharge). Where discharges occur in tidally-influenced portions of rivers (e.g., seafood processing plants and municipal WWTFs), mixing zones may be influenced

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<sup>16</sup> PBF 1 of Cook Inlet beluga whale critical habitat is defined as intertidal and subtidal waters of Cook Inlet less than 30 ft (MLLW) and within 5 miles of high and medium flow anadromous fish streams.



annually by variability of river flows, and diurnally by tidal cycles. Flushing is expected to be greater during spring melts when river flows are at annual peaks. Mixing zones located in areas of high flushing, e.g., near channels or in deep water, will have better mixing because pollutants are flushed out of the area so pollutants at the edge of the mixing zone will be closer to “background.” Even in areas of low mixing, at the edge of the mixing zone the effluent concentration is expected to be reduced to close to ambient conditions. However, ambient conditions may be elevated above “background” due to the general buildup of pollutants. This could particularly be the case where mixing zones overlap or are in close proximity. In such cases, there is also potential for WQS to be exceeded outside the mixing zones due to the combined impact of multiple discharges. Overlapping or adjacent mixing zones may also involve some differing pollutants that when combined could result in adverse effects.

The mixing zone for the Kenai WWTF is located near one of the main rip currents to the west of the Kenai Peninsula (Figure 12). Rip currents form strong convergence zones where pollutants and debris can congregate. For example, oil spill trajectories are controlled more by tides and rip currents than by winds (Whitney 2000). Discharge in the summer runoff period is high and sourced from the Kenai River, to the northeast of the Kenai WWTF. Through CORMIX modeling conducted in developing the permit for this facility, ADEC estimated based on the higher tidal velocities that free-floating aquatic organisms would be exposed to the acute mixing zone for less than 1 minute and that it was improbable that any organisms would be present in the acute mixing zone for 15 minutes or longer (ADEC 2015b).

The mixing zone for the Kenai WWTF is unique in that due to the shallow receiving waters in Cook Inlet, the area near the end of the effluent line is exposed during negative low tides for approximately two hours during each 12-hour tidal cycle on those occasions when there are lower minus tides (less than 2.0 ft), which represent about 14 percent of all the low tides within a year. When the outfall is exposed, there is no dilution until the effluent reaches the receiving waters. The *Fact Sheet* for the APDES permit (ADEC 2015b) states that during these negative low tides, the mixing zone area is the half circle of the radius of the acute (7 m [23 ft]) (dilution ratio of 6.7:1) and chronic (150 m [492 ft]) (dilution ratio of 18:1) mixing zones, respectively. Within these exposed areas the pollutants in the effluent are discharged directly onto the sediments. EPA (2016b) estimated that given that the average monthly flow of the WWTF is 0.54 mgpd and the end of the outfall is exposed for 2 hours during each 12 hour tidal cycle for 14 percent of the yearly tidal cycles, then 4.1 million gallons per year of effluent are discharged directly onto the sediments. Based on maximum discharge, EPA (2016b) estimated that the amount of ammonia and copper that would be discharged directly onto the substrate is 71 kg (157 lb) and 88 kg (195 lb), respectively. When the average discharge is considered this amount drops considerably to 9.5 kg (21 lb) and 0.5 kg (1.2 lb) for ammonia and copper, respectively.

As described above, multiple oil and gas facilities and associated large mixing zones are located in Trading Bay near the terminal end of the Kalgin Island tidal rip (Figure 12), and rip currents continue along the eastern edge of the bay. Strong currents occur through the East and West Forelands at the “pinch point” at the southern edge of Trading Bay, with currents at peak ebb reaching 6 knots (3 m/s) (Whitney 2000). Along with the eastern edge rip currents, strong convergence zones and gyres occur within Trading Bay (Figure 18). Buoys released to the east of Trading Bay in the central rip current spent 5 days circling Trading Bay before reaching the Forelands to the south, and the next month traveling around Kalgin Island (Figure 19).

For fresh water mixing zones, in addition to the dilution in the mixing zone, there will typically be additional dilution downstream before the discharge reaches the marine environment. These mixing zones have a long narrow shape due to the nature of flows in rivers, which upstream of tidal influence, are only one direction (downstream) with reduced cross-channel mixing. The amount of additional dilution depends upon the ratio of the effluent flow rate to the river flow rate and the distance and turbulence of the river between the downstream edge of the mixing zone and Cook Inlet. Contrast this with mixing zones in a marine environment where flows can be upstream, downstream or transitioning between these directions. This results in a marine mixing zone that is more variable in the orientation of its long axis compared to riverine mixing zones.

Local bathymetry and characteristics of the bottom substrates are also significant factors with respect to potential buildup of pollutants in association with mixing zones. Mixing zones located in shallower waters generally have more potential for pollutants to settle and accumulate in sediments, and for those sediment-associated pollutants to potentially be remobilized when sediment is disturbed. The sediments of Cook Inlet are known to contain mostly gravel and sand due to strong currents and tidal flushing, with silts and clays mainly found in bays (Trefy et al. 2012). Highest concentrations of POPs and most hydrocarbons in sediments sampled in Cook Inlet were found in particular bays and shallow waters and were highly positively correlated with percent fine sediments and total organic carbon (Savoie et al. 2012). On the other hand, as noted in Section 4.2.5.3, metal levels evaluated in Cook Inlet sediments were found to be for the most part at background levels or below minimum sediment quality guidelines in samples from bays and other locations in the Inlet, though a few metals were above background levels due to natural physical and chemical processes (Trefy et al. 2012).

In summary, there are a number of physical factors that affect the hydrodynamic mixing of the effluents discharged into mixing zones. Consequently, the manner in which a discharge mixes within the receiving waters and pollutants in the discharge partition to sediment will be case-specific. As discussed in other sections of the exposure analysis, additional chemical, physical, and biological processes will also influence water and sediment concentrations and potential bioavailability of the discharged pollutants.

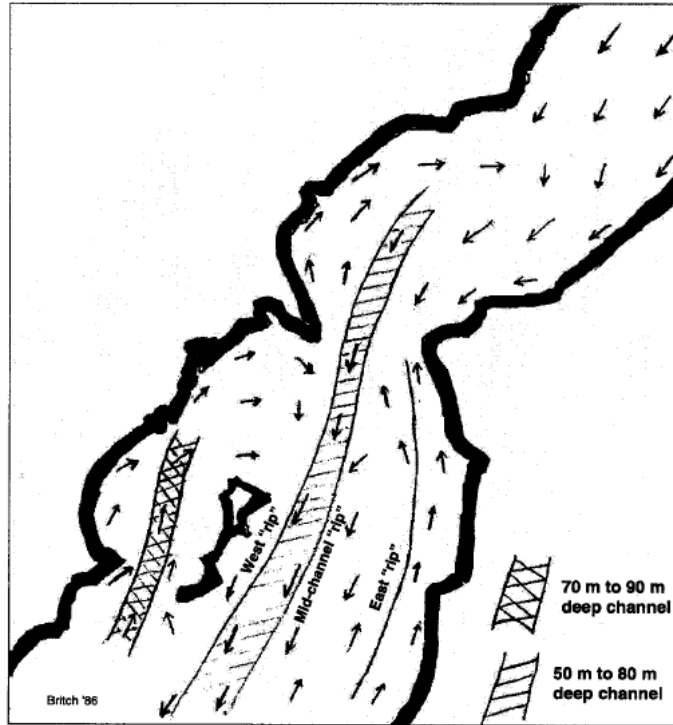


Figure 18. Middle Cook Inlet circulation and convergence zones near Trading and Redoubt Bays in Cook Inlet (from Whitney 2000).

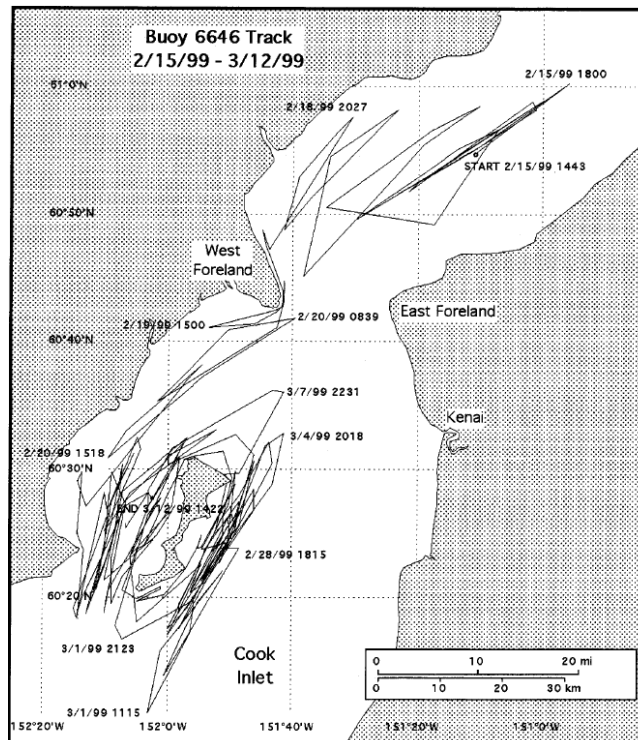


Figure 19. Buoy tracks showing retention in Trading Bay and near Kalgin Island in Cook Inlet (from Whitney 2000).

## 6.4 Response Analysis

As discussed in the “Approach to the Assessment” section of this opinion, our response analysis determines whether and how the quantity, quality, or availability of one or more of the physical or biological features that led us to conclude that the area was essential for the conservation of a listed species are likely to change in response to the exposure.

Based on the analysis of stressors and exposure in Sections 6.2 and 6.3, the primary potential effects on the PBFs of Cook Inlet beluga critical habitat from authorized mixing zones are summarized in Table 7. This list is not intended to be comprehensive of any and all possible effects, but for the purposes of this analysis it serves to identify the principal effects of concern with respect to implementation of the MZR. Below we evaluate these effects for each of the essential PBFs of Cook Inlet beluga critical habitat.

**Table 7. Summary of potential effects of mixing zones on the PBFs of Cook Inlet beluga whale critical habitat.**

Physical or biological feature (PBF)	Function	Potential effects due to mixing zones
1. Intertidal and subtidal waters of Cook Inlet with depths less than 30ft (MLLW) and within 5 miles of high and medium flow anadromous fish streams.	Cook Inlet beluga feeding habitat that supports essential life functions; shallow depths and bottom structure, act to concentrate prey and aid in feeding efficiency of the whales. Habitat areas that support other Cook Inlet biological needs, such as predator escape, calving, and molting.	<ul style="list-style-type: none"> <li>• Pollutants in the water column and sediments at levels that are acutely or chronically toxic to aquatic organisms, have sublethal effects on aquatic organisms, and may be bioaccumulative;</li> <li>• Increased pollutant loads in the water column and sediments;</li> <li>• Modification of benthic habitat and communities; and</li> <li>• Reduced quantity and/or quality of food sources that support PBF 2.</li> </ul>
2. Primary prey species consisting of four species of Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole.	The primary prey species constitute the most important food sources for Cook Inlet belugas and as such are essential to meeting their energetic requirements.	<ul style="list-style-type: none"> <li>• Bioaccumulation of contaminants in the primary prey species and their food sources;</li> <li>• Reductions in survival, growth, or reproduction;</li> <li>• Degradation or reductions in usable habitat;</li> <li>• Impaired habitat use (e.g., fish passage) as a result of avoidance of mixing zones.</li> <li>• Attraction to mixing zone resulting in increased exposure to pollutants.</li> </ul>
3: Waters free of toxins or other agents of a type and amount harmful to Cook Inlet beluga whales.	These water conditions are essential to the health of individual Cook Inlet belugas, in that they are apex predators with the potential for bioaccumulation and bioconcentration of toxic substances that could adversely affect the health of these animals. Cook Inlet beluga seasonal use of nearshore habitats and distributional shift and contraction into the Upper Inlet has resulted in increased proximity to anthropogenic activities, predisposing them to such potential effects.	<ul style="list-style-type: none"> <li>• Pollutants in the water column and sediments at levels that are acutely or chronically toxic to aquatic organisms, or have sublethal, effects on aquatic organisms, and may be bioaccumulative;</li> <li>• Contaminants in the sediments that can be released into the water column over time; and</li> <li>• Degradation of water quality, including effects such as reductions in DO.</li> </ul>
4: Unrestricted passage within or between the critical habitat areas.	The assurance of unrestricted passage within and between critical habitat areas is essential for Cook Inlet belugas to utilize this habitat in a manner that fully supports their biological needs.	None identified.

Physical or biological feature (PBF)	Function	Potential effects due to mixing zones
5: Waters with in-water noise below levels resulting in the abandonment of critical habitat areas by Cook Inlet beluga whales.	The assurance of in-water noise levels that do not cause Cook Inlet belugas to abandon or fail to access critical habitat areas, such as foraging sites at river mouths is essential for the whales to utilize this habitat in a manner that fully supports their biological needs.	None identified.

#### **6.4.1 PBF 1: Intertidal and subtidal waters of Cook Inlet with depths less than 30 feet (MLLW) and within 5 miles of high and medium flow anadromous fish streams.**

##### **6.4.1.1 Municipal Wastewater Treatment Facilities**

In determining the effects of the proposed action, our analysis focuses on facilities with existing mixing zones within state waters of Cook Inlet and its tributaries, including three mixing zones authorized for WWTFs in the Inlet, two of which overlap with PBF 1. The discharge of municipal wastewater effluent is known to affect water quality in the receiving water body. The degree to which water quality is diminished is directly related to the level of treatment and the baseline water quality. In addition to BOD, TSS, ammonia, phosphorus, chlorine, and metals, municipal effluents have been shown to contain trace amounts of many chemicals found in a variety of products that are disposed of via municipal sewer systems and through industrial discharges. The majority of these substances have no numeric WQC and monitoring is not required in NPDES permits.

As discussed in Section 6.2.1, pollutants authorized for exceedance of Alaska WQS within mixing zones for municipal WWTFs within state waters of Cook Inlet and its tributaries include several different metals, ammonia, and total residual chlorine. The available discharge data indicate that pollutants such as ammonia, chlorine, and copper may occur within the mixing zones at concentrations that can cause chronic or acute toxic effects in aquatic organisms. Concentrations of these pollutants may also be at levels that can cause sublethal effects. EPA's modeling results on ammonia concentrations with distance within the Kenai WWTF mixing zone (EPA 2016b) illustrate that depending on the concentration of a particular pollutant at the point of discharge, acutely toxic concentrations may be present only near the outfall. Based on the analysis presented in Section 6.3.2.1, we anticipate that this would likely be the case for all of the pollutants that were evaluated.

In addition to toxic and sublethal effects, pollutants such as metals may also be bioaccumulated in aquatic organisms within the mixing zones, in particular in less mobile species. The ability to detoxify certain contaminants may be lacking in some organisms (EPA 2006c), which would make them at greater risk of effects, as would existing contaminant loads in exposed organisms. Accumulation of contaminants in the sediments is also likely, which can result in release of contaminants over time through resuspension processes. As with the other pollutants and mixing zones considered in this analysis, potential effects of contaminants within the mixing zones overall are expected to be greatest in less mobile and sessile organisms, in particular near the outfalls.

As discussed in Section 6.3.3, the situation at the Kenai WWTF is unique in that the discharge pipe is exposed during some low tidal periods, at which time there is no dilution occurring until the effluent reaches the water. Pollutants within the discharge can accumulate in the sediments and may result in increased pollutant concentrations and bioaccumulation of pollutants in the aquatic food web. The BE indicated that EPA has not been able to locate sediment data for the exposed area that receives the discharge during negative tides, so it is not possible to characterize the chemical composition or quantify the pollutant concentrations in the sediments where there is no dilution occurring during some time periods. But given that millions of gallons of effluent are being discharged onto exposed sediments there annually, it is likely that some level of adverse effects to critical habitat are occurring there.

#### **6.4.1.2 Seafood Processing Facilities**

As discussed in Section 6.3.2.2, the discharge of large volumes of seafood waste can result in long-lasting adverse physical and biological effects on water quality and benthic habitat if not dispersed. Potential adverse impacts on receiving water quality and benthic habitat resulting from seafood processing waste discharges into mixing zones include reduction in water column DO due to the decay of particulate and soluble waste matter; the release of toxic levels of sulfide and ammonia from decaying waste; nutrient enrichment and stimulation of phytoplankton growth and alteration of the phytoplankton community; and the accumulation of waste solids and fish oils on the water surface, shorelines, and the bottom. Short- and long-term effects of seafood waste on benthic invertebrates within the mixing zones authorized for seafood processing facilities are expected to include temporary smothering of biota, especially by ground particulates in the area near the discharge. EPA (2001) also reported that mixing zones for seafood waste can attract fish. Deposition could potentially reduce and possibly eliminate abundances of infaunal benthos such as polychaetes, mollusks, and crustaceans, and may affect demersal eggs of various benthic species. Depending on the depth of burial, deposits of seafood waste particles can make the substrate inhospitable, or influence the species composition favoring opportunistic organisms that may out-compete the normal fauna affecting the natural community composition and food web (Germano & Associates 2004, as cited in EPA 2016b).

Currently six of the seafood processing facilities with mixing zones that overlap with PBF1 discharge wastes into the lower Kenai River. Four of the mixing zones for these discharges are located within a few hundred meters of each other near the mouth of the Kenai River. EPA (2016b) noted that it is possible that these mixing zones may be causing adverse effects on the benthic community if the discharged materials are not transported out of the lower river into Cook Inlet. Dispersion of seafood waste materials in the lower Kenai River is influenced by both the flow in the river and tidal flows, which carry the materials into Cook Inlet, but may also transport them upriver during incoming tides, potentially resulting in reflux of the seafood plumes if they are large enough and close enough to overlap under these conditions. However, no specific information about the flow in the lower Kenai River is available to predict the likelihood and level of dispersion of seafood waste there.

#### **6.4.1.3 Oil and Gas and Other Industrial Facilities**

As discussed in Section 6.2.1, pollutants authorized for exceedance of WQC within mixing zones for oil and gas and other industrial facilities located in Cook Inlet include a variety of metals,

ammonia, total residual chlorine, TAH, and TAqH. The available discharge data indicate that pollutants such as ammonia, chlorine, and copper may occur within the mixing zones at concentrations that can cause chronic or acute toxic effects in aquatic organisms. Concentrations of these pollutants may also be at levels that can cause sublethal effects. The exceedance ratios for chlorine, in particular, imply potential for concentrations to be at levels that can cause acute toxic effects within a portion of the mixing zones, in particular near the outfalls. The very high exceedance ratios for TAH and TAqH in comparison to the other pollutants for which discharge data were available imply these pollutants may pose the most hazard to aquatic organisms, including acute, chronic, and sublethal toxicity, and result in the most degradation of conditions in the water column and sediments. The hydrodynamics of Cook Inlet are expected to ameliorate these adverse effects to some degree.

The types of discharges for which exceedances of the Alaska WQS may be authorized include some waste streams, such as drill cuttings and mud, which may also be high in turbidity and TSS. A portion of these solids would be expected to accumulate on the sea floor, although the currents in Cook Inlet would limit deposition and it is most likely to occur near the points of discharge (EPA 2013). Possible burial of benthic organisms would thus be limited to relatively small areas of the benthic habitat.

Accumulation of contaminants in the sediments is also likely, at least within the mixing zones. As a result, particulate forms of toxicants (e.g., metals) can become released through resuspension processes at a later time. EPA (2013) cited field studies indicating that enrichment of certain metals may occur in surface sediments around platforms. In those studies, enrichment of metals that could be attributed to drilling activities was either generally distributed about 300 to 500 m around the platform, or distributed down-current with the discharge plume over a larger distance from the platform. However, these studies were not specific to Cook Inlet, and as noted in Section 4.2.5.3, sampling conducted in Cook Inlet at more than 50 sites did not show elevated metal concentrations in sediments (Trefy et al. 2012). As with the other pollutants and mixing zones considered in this analysis, potential effects of contaminants within the mixing zones are expected to be greatest in less mobile and sessile organisms, in particular near the outfalls.

In addition to toxic and sublethal effects, pollutants such as metals may also be bioaccumulated in aquatic organisms within the mixing zones, in particular in less mobile species. The ability to detoxify these contaminants may be lacking in some organisms, which would make them at greater risk of effects (EPA 2006c), as would existing contaminant loads in exposed organisms. For example, algae, mollusks and other invertebrates metabolize PAHs much more slowly and are therefore more likely to accumulate them (Eisler 1987, Lawal and Fantke 2017).

As currently regulated under general permits, oil and gas discharges are not authorized in most of Area 1 of Cook Inlet beluga critical habitat where belugas are seasonally concentrated. However, an applicant could potentially apply for an individual permit that would authorize discharges into waters excluded from coverage under the general permit, which would require a facility-specific analysis that would inform the determination of conditions placed on the discharges should a permit be issued. The MZR provides that a mixing zone will be approved only if the available evidence reasonably demonstrates that the mixing zone will not adversely affect threatened or endangered species except as authorized under ESA (18 AAC 70.240(c)(4)(F); see Appendix A), which implies that authorization of such mixing zones is unlikely. Nevertheless, we note that

given the potential effects on PBF 1 from mixing zones associated with oil and gas facility discharges and the seasonally concentrated use of the upper Inlet by belugas, any such mixing zone authorized within Area 1 of the critical habitat may cause effects that are not considered in this opinion.

#### **6.4.1.4 Summary of Effects on PBF 1**

According to the BE, authorized mixing zones currently overlap with only about 2 percent or less of the critical habitat that meets the definition of PBF 1. Although our assumption in the above analysis is that this will continue to be the case, it appears unlikely that a moderate increase in the overlap of mixing zones with PBF 1 would cause effects on this PBF that were not considered in this analysis, provided that the other characteristics of the mixing zones remain relatively similar to those considered above. However, we note that none of the existing authorized mixing zones considered in this analysis are located near areas in upper Cook Inlet where concentrations of belugas and their prey occur seasonally, including the Susitna Delta area. These waters are essential feeding areas and also serve other important habitat functions. As discussed above, the MZR provides that a mixing zone will be approved only if the available evidence reasonably demonstrates that the mixing zone will not adversely affect threatened or endangered species except as authorized under ESA (18 AAC 70.240(c)(4)(F); see Appendix A), which implies that authorization of mixing zones in such areas is unlikely. Nevertheless, we note that such authorizations of mixing zones may cause effects on PBF 1 that are not considered in this opinion.

Mixing zones may be authorized that remain in effect for many years and result in small localized areas of reduced water quality, accumulations of contaminants in the sediments, and degraded benthic habitat. These conditions can adversely affect the aquatic community within the mixing zone, including contributing to bioaccumulation of pollutants in aquatic organisms. As such, we conclude that the proposed action is likely to adversely affect PBF 1. The implications of this adverse effect to Cook Inlet beluga critical habitat is evaluated in the "Integration and Synthesis" section of this opinion.

#### **6.4.2 PBF 2: Primary prey species consisting of four species of Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole.**

As discussed in Sections 6.2 and 6.3, mixing zones within state waters of Cook Inlet and its tributaries are likely to contain pollutants in the water column at concentrations that can be acutely or chronically toxic to aquatic organisms, including the primary prey species of Cook Inlet belugas, and that can also cause a variety of sublethal effects. Accumulation of contaminants in the sediments is also likely, and as discussed above, contaminants (e.g., metals) can be released from the sediments over time. As discussed in Section 6.4.1, pollutants such as metals can be bioaccumulated in aquatic organisms, in particular lower trophic level species that may be part of the diet of Cook Inlet beluga prey. Less mobile and sessile organisms are expected to be the most affected within the mixing zones, in particular near the outfalls. As noted above, information on contaminant levels in aquatic organisms found in existing mixing zones within the Cook Inlet, including beluga whale prey species, is unavailable. However, EPA (2013) reported that most contaminants detected in Cook Inlet fish were at levels less than or



similar to those collected throughout Alaska and in national studies, as described in ATSDR (2009). In addition, Wetzel et al. (2010) reported that PAHs were detected in salmon, hooligan, and saffron cod collected in northern Cook Inlet in Eagle Bay, the Port of Anchorage/Ship Creek, and the mouths of the Big and Little Susitna Rivers. But the sources of these PAHs are unknown and the concentrations measured in whole fish were for the most part unremarkable.

Within state waters of Cook Inlet and its tributaries, the majority of the mixing zones currently authorized for municipal WWTFs and seafood processing facilities are located within or near the mouths of tributaries that provide important spawning and rearing habitats for anadromous fish. Therefore, Pacific salmon and Pacific eulachon appear more likely to be affected by the mixing zones for these facilities as compared to the mixing zones authorized in other locations for oil and gas and other industrial facilities. Notably, there are a number of mixing zones located within and near the lower Kenai River, a Cook Inlet watershed that provides important spawning and rearing habitat for Pacific salmon, and also provides habitat for Pacific eulachon.

A variety of factors can influence the extent to which the primary prey species of Cook Inlet belugas may experience adverse effects from mixing zones, including their distributions, life phase, mobility, home range size, diet, and species habitat associations (see Section 4.2.5.2).

#### **6.4.2.1 Pacific Salmon**

Adult salmon migrating to spawn may encounter mixing zones within state waters of Cook Inlet and in its tributaries. Given their mobility, it is expected that exposure to contaminants within mixing zones would be for the most part brief as they pass through. It is conceivable that contaminants in freshwater mixing zones could have adverse effects on the viability and development of salmon eggs within those zones should salmon spawn there.

Juvenile salmon rearing in fresh water could be repeatedly exposed to mixing zones. Juvenile coho salmon may also use estuarine waters as rearing habitat, in which case they migrate back upstream to fresh water overwinter. These juvenile fish could therefore be repeatedly exposed to mixing zones in fresh water as well as in estuarine waters while rearing. Juvenile salmon could also be exposed to freshwater mixing zones during outmigration. In addition, depending upon the species and stock, outmigrants may remain in estuaries and nearshore areas for weeks to months before continuing to the open ocean and may therefore be repeatedly exposed to mixing zones that are located close to shore. Exposure could be increased if fish are attracted to a mixing zone, e.g., seafood processing waste. Within the mixing zones, juvenile salmon could encounter reduced water quality and prey availability, degraded benthic habitat, and pollutants at concentration that can cause acute or chronic toxicity and sublethal effects. In addition, bioaccumulative substances such as metals may be present in the water column and sediments that could be accumulated in the fish and in their food items.

To avoid risk of interrupting the migration of salmonids due to avoidance of pollutants that may be present in elevated concentrations within mixing zones, a significant portion of the water quality for the width of a stream or passable area within Cook Inlet must be absent of chemicals in concentrations that could cause fish avoidance. Based on the limited data available, avoidance threshold concentrations for metals were evaluated in Section 6.3.2.1. Copper is a contaminant authorized for exceedance of Alaska WQS within mixing zones that is of particular concern with

respect to salmonid avoidance. As discussed in Section 6.3.2.1, the reported discharge concentrations for copper are well below the salmon avoidance threshold reported for salt water, but are above avoidance thresholds for fresh water. However, DOC in the water column is a significant factor that can increase this threshold, and the discharge concentrations do not account for dilution in receiving waters. In addition, the freshwater mixing zones authorized for municipal WWTFs within Cook Inlet tributaries are relatively long, but narrow. Therefore, it does not appear that fish avoidance of copper is likely to be a concern.

#### **6.4.2.2 Pacific Eulachon**

As with Pacific salmon, adult Pacific eulachon migrating to spawn could be exposed to mixing zones; however, it is expected that exposure would be brief as they pass through. Currently, there are no mixing zones authorized in or near the Susitna River or the Twentymile River where large eulachon runs are known to occur. Pacific eulachon are also found in the Kenai River and several other Cook Inlet tributaries. Although ADF&G's *Catalog of Waters Important for Spawning, Rearing or Migration of Anadromous Fishes* (Johnson and Blossom 2017) does not identify other tributaries such as the Kenai River as known spawning areas, it is likely that spawning takes place in streams where the species is known to occur. It is conceivable that eulachon egg viability and development could be adversely affected by freshwater mixing zones should eulachon spawn there. Eulachon eggs hatch during the summer after spawning occurs and eulachon larvae are carried downstream and develop in coastal marine waters. It is therefore possible that some eulachon larvae and juveniles could be briefly exposed to freshwater mixing zones while being swept downstream. In addition, developing eulachon could be repeatedly exposed to mixing zones located near shore. Within the mixing zones, eulachon could encounter reduced water quality and prey availability, degraded benthic habitat, and pollutants at concentration that can cause acute or chronic toxicity and sublethal effects. In addition, bioaccumulative substances such as metals may be present in the water column and sediments that could be accumulated in the fish and in their food items.

#### **6.4.2.3 Pacific Cod, Walleye Pollock, Saffron Cod, and Yellowfin Sole**

Information on the abundance and distribution of Pacific cod, walleye pollock, saffron cod, and yellowfin sole in Cook Inlet are relatively limited. The available data for saffron cod, in particular, suggests that they may be relatively more common in the northern part of the Inlet. All of these species except walleye pollock are demersal, and walleye pollock become increasingly so with age. Pacific cod are known to migrate seasonally from shallower summer feeding grounds to deeper spawning aggregation areas during winter to early spring. Pollock seasonally migrate from overwintering areas along the outer shelf to shallower waters, where they form seasonal spawning aggregations. Adult yellowfin sole also migrate annually in the spring from over-winter habitat near the shelf margins onto the inner shelf to spawn, primarily in shallow waters. Saffron cod occupy relatively shallow coastal waters year-round, where they also spawn. Saffron cod may also enter Cook Inlet tributaries within areas of tidal influence.

Given their association with the seafloor these species could be affected by both the reduced water quality and degraded benthic habitat within mixing zones. They are also expected to be more susceptible to accumulation of contaminants due to their contact with bottom sediments. Depending upon their home ranges and local habitat use patterns, these species may also be

exposed to these conditions, as well as possible reductions in prey availability, for longer periods of time than pelagic species. The eggs of those species that are adhesive and sink to the bottom are more likely to be exposed to contaminants in mixing zones for extended periods of time. Given their use of shallow coastal waters and tidally influenced portions of Cook Inlet tributaries, saffron cod may be more likely to encounter mixing zones located close to shore including those areas in Cook Inlet that meet the definition of PBF 1.

#### **6.4.2.4 Summary of Effects on PBF 2**

Authorized mixing zones are present within state waters of Cook Inlet and its tributaries within only small portions of the habitat used by these species, and we expect that this will continue to be the case. In addition, pelagic species, such as salmonids, are highly mobile and are for the most part not expected to be exposed to contaminants within mixing zones for extended periods of time. Therefore, it appears unlikely that a moderate increase in the overlap of mixing zones with portions of the habitat used by the beluga prey species that comprise PBF 2 would cause effects that were not considered in this analysis, provided that the other characteristics of the mixing zones remain relatively similar to those considered above. However, we note that none of the existing authorized mixing zones considered in this analysis are located near areas in upper Cook Inlet where concentrations of belugas and their prey occur seasonally, including the Susitna Delta area. These waters are essential feeding areas and also serve other important habitat functions. The MZR provides that a mixing zone will be approved only if the available evidence reasonably demonstrates that the mixing zone will not adversely affect threatened or endangered species except as authorized under ESA (18 AAC 70.240(c)(4)(F); see Appendix A), which implies that authorization of mixing zones in such areas is unlikely. Nevertheless, we note that such authorizations of mixing zones may cause effects on PBF 2 that are not considered in this opinion.

Mixing zones may be authorized that remain in effect for many years and result in small localized areas where the primary prey species of Cook Inlet belugas may be exposed to contaminants at concentrations that can cause reductions in survival, reproduction, and growth, and may also cause other sublethal effects. In addition, bioaccumulative substances such as metals may be present in the water column and sediments that could be accumulated in the fish and in their food items. As such, we conclude that the proposed action is likely to adversely affect PBF 2. The implications of this adverse effect to Cook Inlet beluga critical habitat is evaluated in the “Integration and Synthesis” section of this opinion.

#### **6.4.3 PBF 3: Waters free of toxins or other agents of a type and amount harmful to Cook Inlet beluga whales.**

As explained in the 2010 opinion, a “safe dose” should represent a chemical concentration in the environment or in the animal’s tissue that would not be likely to cause adverse effects on an individual. However, reliable and quantitative information that relates body burdens to adverse effects is lacking for many chemicals, especially within a dose-response context. Though the potential exists for some chemicals, such as PCBs, to be present at concentration ranges associated with possible disruption of endocrine and immune system functions in marine mammals, for the contaminants that have been studied, Cook Inlet belugas have generally had lower contaminant levels than belugas from other populations (NMFS 2010, NMFS 2016b).

Exposure of belugas to contaminants in the water column is most likely through ingestion of their prey species (NMFS 2016b). Based on the evidence available, we concluded that there will be adverse effects of the proposed action on these prey species, as well as on the intertidal and subtidal feeding habitats of the belugas due to reductions in water quality within authorized mixing zones (i.e., PBF 1 and PBF 2). Mixing zones may be authorized that remain in effect for many years and result in small localized areas where the primary prey species of Cook Inlet belugas may be exposed to contaminants at concentrations that can cause reductions in survival, reproduction, and growth, and may also cause other sublethal effects. In addition, bioaccumulative substances such as metals may be present in the water column and sediments that could be accumulated in the fish and in their food items.

Although there is insufficient evidence to indicate that exposure to contaminants has resulted in pathology and/or mortality in Cook Inlet belugas, considering the adverse effects on PBF 1 and PBF 2, including the localized reductions in water quality and increases in accumulations of contaminants in sediments, we conclude that the proposed action is likely to adversely affect PBF 3 of the critical habitat. We note that, it appears unlikely that a moderate increase in the overlap of mixing zones Cook Inlet beluga whale critical habitat would cause effects to PBF 3 that were not considered in this analysis, provided that the other characteristics of the mixing zones remain relatively similar to those considered above. However, none of the existing authorized mixing zones considered in this analysis are located near areas in upper Cook Inlet where concentrations of belugas and their prey occur seasonally, including the Susitna Delta area. These waters are essential feeding areas and also serve other important habitat functions. The MZR provides that a mixing zone will be approved only if the available evidence reasonably demonstrates that the mixing zone will not adversely affect threatened or endangered species except as authorized under ESA (18 AAC 70.240(c)(4)(F); see Appendix A), which implies that authorization of mixing zones in such areas is unlikely. Nevertheless, we note that such the authorization of such mixing zones may cause effects on PBF 3 that are not considered in this opinion. The implications of this adverse effect on PBF 3 to Cook Inlet beluga critical habitat is evaluated in the “Integration and Synthesis” section of this opinion.

#### **6.4.4 PBF 4: Unrestricted passage within or between the critical habitat areas.**

The proposed action is not expected to have any impact on PBF 4. Therefore, effects of the proposed action on PBF 4 are not further evaluated in this opinion.

#### **6.4.5 PBF 5: Waters with in-water noise below levels resulting in the abandonment of critical habitat areas by Cook Inlet beluga whales.**

The proposed action is not expected to have any impact on PBF 5. Therefore, effects of the proposed action on PBF 5 are not further evaluated in this opinion.

## **7 Cumulative Effects**

“Cumulative effects” are those effects of future state or private activities, not involving Federal activities, which are reasonably certain to occur within the action area (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. In formulating the

2010 opinion we considered cumulative effects with respect to analyzing effects of the action on Cook Inlet beluga whales. In this section, we focus on cumulative effects that are relevant to Cook Inlet beluga whale critical habitat. Therefore, we focus specifically on cumulative effects for state waters of Cook Inlet and its tributaries.

Some continuing non-Federal activities are reasonably certain to contribute to climate change within these waters. But it is difficult to distinguish between this area's future environmental conditions caused by global climate change that are properly part of the environmental baseline and cumulative effects. Therefore, all relevant future climate-related environmental conditions in state waters of Cook Inlet and its tributaries are described in the environmental baseline (Section 5.7).

### **7.1 Coastal Development**

Coastal development may result in the loss of habitat, increased vessel traffic, increased pollutants, and increased noise associated both with construction and with the activities associated with the projects after construction. Any projects with a Federal nexus (e.g., Chuitna Coal Mine, POA modernization) will require ESA section 7 consultation. But as the human population in the area increases, coastal development with unspecified impacts to Cook Inlet could increase, and vessel traffic in the area could increase.

### **7.2 Oil and Gas Development**

It is very likely that oil and gas development will continue in Cook Inlet with associated risks to marine mammals from seismic activity, vessel and air traffic, well drilling operations, wastewater discharges, habitat loss, and potential for oil spills and natural gas well blowouts. Any such proposed development would undergo ESA section 7 consultation. Therefore, the associated effects are not "cumulative effects" pursuant to the ESA.

### **7.3 Water Quality and Water Pollution**

As the population in urban areas around Cook Inlet continues to grow, an increase in pollutants entering Cook Inlet is likely to occur. Hazardous materials may be released into Cook Inlet from vessels, aircraft, and municipal runoff. Oil spills could occur from vessels traveling within state waters of Cook Inlet and its tributaries. In addition, oil spilled from outside these waters could migrate into Cook Inlet. There are many nonpoint sources of pollution within the action area; such pollution is not federally-regulated. Pollutants can pass from streets, construction and industrial areas, and airports into Cook Inlet beluga critical habitat. However, the EPA and ADEC will continue to regulate the amount of pollutants that enter Cook Inlet from point and nonpoint sources through NPDES/APDES permits. As a result, permittees will be required to renew their permits, verify they meet permit standards, and potentially upgrade facilities. However, EPOCs such as flame retardants and estrogen mimics are unregulated and are not monitored.

### **7.4 Fisheries**

Fishing, a major industry in Alaska, is expected to continue in Cook Inlet. As a result, there will be continued risk of reductions in the amount of available Cook Inlet beluga prey, and, perhaps

most notably, possible displacement from former summer foraging habitat of Cook Inlet belugas (e.g., waters within and near the outlets of the Kenai and Kasilof Rivers during salmon season). NMFS and ADF&G will continue to manage fish stocks and monitor and regulate fishing in Cook Inlet to maintain sustainable stocks. It remains unknown whether and to what extent Cook Inlet beluga prey may be less available due to commercial, subsistence, personal use, and sport fishing, especially near the mouths of tributaries to Cook Inlet up which salmon and eulachon migrate to spawning areas. The recovery plan for the Cook Inlet beluga whale (NMFS 2016b) considers reduction in availability of prey due to activities such as fishing to be a threat of moderate concern.

## **8 Integration and Synthesis**

The “Integration and Synthesis” section is the final step of NMFS’s assessment of the risks posed to Cook Inlet beluga whale critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 6) to the environmental baseline (Section 5) and the cumulative effects (Section 7) to formulate the agency’s biological opinion as to whether the proposed action is likely to result in the adverse modification or destruction of critical habitat as measured through potential reductions in the value of designated critical habitat for the conservation of the species. This assessment is made in full consideration of the status of the critical habitat (Section 4).

We note that considerable uncertainty remains concerning future mixing zones that may be authorized within the action area under the MZR. If effects of mixing zones within the action area on Cook Inlet beluga whale critical habitat will occur in a manner or to an extent not considered in this opinion, reinitiation of this consultation would be required.

Designated critical habitat for the Cook Inlet beluga whale includes five PBFs essential to the conservation of the species: (1) intertidal and subtidal waters of Cook Inlet with depths less than 30 ft and within five miles of high and medium flow anadromous fish streams; (2) primary prey species consisting of four species of Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole; (3) waters free of toxins or other agents of a type and amount harmful to Cook Inlet beluga whales; (4) unrestricted passage within or between critical habitat areas; and (5) waters with in-water noise below levels resulting in the abandonment of critical habitat areas by Cook Inlet beluga whales (50 CFR 226.220(c)). Anthropogenic threats to critical habitat include reductions in prey due to competition with fisheries, habitat loss or degradation resulting from pollution, presence of anthropogenic noise, continued coastal development, and oil and gas development (NMFS 2016b).

The Cook Inlet beluga whale population continues to decline slowly despite the removal of the threat from harvest that was assumed to have been the primary cause of the dramatic decline during the 1990s. Consequently, the status of the PBFs of critical habitat for Cook Inlet belugas with respect to their conservation function for these animals is rather unclear. Currently, the majority of coastal development in Cook Inlet is concentrated near Anchorage. As a result, much of the intertidal and subtidal critical habitat defined by PBF 1 is generally intact and relatively undisturbed. All of the primary prey species of Cook Inlet belugas (PBF 2) are harvested commercially, and some are also subject to subsistence and recreational harvest. It remains

unknown whether and to what extent Cook Inlet beluga prey may be less available due to this harvest, especially near the mouths of tributaries to Cook Inlet up which salmon and eulachon migrate to spawning areas. The recovery plan for the Cook Inlet beluga whale (NMFS 2016b) considers reduction in availability of prey due to activities such as fishing to be a threat of moderate concern to the population.

The area surrounding Cook Inlet is the most populated and industrialized region of Alaska. Therefore, its waters, and hence PBF 3, are influenced by urban (and a small amount of agricultural) runoff, oil and gas activities (accidental spills, discharges of drilling muds and cuttings, production waters, deck drainage), effluent from municipal sewage treatment facilities, oil and other chemical spills, offal from seafood processing, and other regulated discharges. Many of these pollutants are regulated by either EPA or ADEC, who may authorize certain discharges under the NPDES/APDES program. The recovery plan for the Cook Inlet beluga whale considers pollution to be a threat of low concern to the population.

In Cook Inlet, belugas must compete acoustically with natural and anthropogenic sounds. Anthropogenic sources of sounds in Cook Inlet that may affect PBF 5 include large and small vessels, aircraft, oil and gas drilling, marine seismic surveys, pile driving, and dredging. Noise from activities such as construction, oil and gas platforms, and other coastal activities also have the potential to restrict the movements of Cook Inlet belugas. However, currently, passage within or between the critical habitat areas (i.e., PBF 4) is unrestricted in Cook Inlet.

Based on our analysis of the evidence available, the proposed action is likely to adversely affect PBF 1, PBF 2, and PBF 3 of Cook Inlet beluga critical habitat. Authorized mixing zones overlapping with PBF 1 may remain in effect for many years and result in small localized areas of reduced water quality, accumulations of contaminants in the sediments, degraded benthic habitat, and related impacts on aquatic communities. Within authorized mixing zones, the primary prey species of Cook Inlet belugas (PBF 2) may be exposed to contaminants at concentrations that can cause reductions in survival, reproduction, and growth, and may also cause other sublethal effects. In addition, bioaccumulative substances such as metals may be present in the water column and sediments that could be accumulated in the fish and in their food items. These effects are due to the reduced water quality and contaminant accumulation in sediment within authorized mixing zones and thus PBF 3 will also be adversely affected.

Although the primary prey species of Cook Inlet belugas may be exposed to potentially harmful conditions within authorized mixing zones, as with PBF 1, this exposure is limited to very small areas relative to the habitats used by these species. In addition, the pelagic species, such as salmonids, are highly mobile and are for the most part not expected to be exposed to contaminants within mixing zones for extended periods of time. Given the anticipated limited overlap of mixing zones with the critical habitat, the limited nature of the effects on PBF 1 and PBF 2, and the lack of evidence to indicate that contaminants have resulted in pathology and/or mortality of Cook Inlet belugas, the effects of mixing zones on PBF 3 are also expected to be limited. We note that although we focused our analysis on the assumption that mixing zones may overlap overall with about 2 percent or less of the critical habitat and of portions of the critical habitat that meet the definition of PBF 1, it is unlikely that a moderate increase in this overlap would cause effects to the PBFs of Cook Inlet beluga whale critical habitat that were not considered in this opinion, provided that the other characteristics of the mixing zones remain

relatively similar to those considered in our effects analysis. However, none of the existing authorized mixing zones considered in this analysis are located near areas in upper Cook Inlet where concentrations of belugas and their prey occur seasonally, including the Susitna Delta area. As discussed in Section 6, the MZR provides that a mixing zone will be approved only if the available evidence reasonably demonstrates that the mixing zone will not adversely affect threatened or endangered species except as authorized under ESA (18 AAC 70.240(c)(4)(F); see Appendix A), which implies that authorization of mixing zones in such areas is unlikely. Nevertheless, we note that the authorization of mixing zones in such areas may cause effects on Cook Inlet beluga whale critical habitat that are not considered in this opinion.

Considering the localized nature of effects of mixing zones and the small portion of the overall critical habitat where mixing zones may be present, as well as the application of the provisions in the MZR, including those sections identified in Section 2.3 that generally serve to limit the impact of a mixing zone, such effects are not expected to appreciably diminish the value of critical habitat for the conservation of the Cook Inlet beluga whale.

## **9 Conclusion**

After reviewing the current status of the critical habitat, the environmental baseline within the action area, the effects of the proposed action, and cumulative effects, it is NMFS's biological opinion that EPA approval of the State of Alaska's 2006 mixing zone regulations (18 AAC 70.240) (MZR) is not likely to destroy or adversely modify designated Cook Inlet beluga whale critical habitat. As discussed in Section 1.2, NMFS previously issued an opinion on December 20, 2010, and concluded EPA approval of the MZR is not likely to jeopardize the continued existence of the Cook Inlet beluga whale (NMFS 2010). There is no new information that reveals effects of EPA's action on Cook Inlet belugas not considered in the 2010 opinion.

As discussed in Section 6.1.1 above, we assumed that dilution inside the perimeter of the mixing zone will allow for quick and even mixing to meet WQS and that contaminant concentrations outside the mixing zone will be reduced to levels that are not acutely or chronically toxic to aquatic life. We also assumed that the WQC set out in the Alaska WQS are sufficient in protecting a particular waterbody for the designated use of growth and propagation of fish, shellfish, other aquatic life, and wildlife. We based our effects analysis on the assumptions that mixing zones may overlap with approximately 2 percent of the critical habitat designated for Cook Inlet beluga whales, and that the characteristics of existing mixing zones are generally representative of mixing zones that may be authorized within Cook Inlet beluga whale critical habitat under the MZR. However, as discussed above, it appears that so long as the characteristics of mixing zones authorized under the MZR remain relatively similar to those considered in this opinion, it is unlikely that the effects on the PBFs of the critical habitat from a moderate increase in the overlap of mixing zones with the critical habitat would differ appreciably from the effects considered herein. Notably, none of the existing authorized mixing zones considered in our analysis are located near areas in upper Cook Inlet where concentrations of belugas and their prey occur seasonally, including the Susitna Delta area. These waters are essential feeding areas and also serve other important habitat functions. The MZR provides that a mixing zone will be approved only if the available evidence reasonably demonstrates that the mixing zone will not adversely affect threatened or endangered species except as authorized under ESA (18 AAC 70.240(c)(4)(F); see Appendix A), which implies that authorization of



mixing zones in such areas is unlikely. However, we note that if the characteristics of a future mixing zone authorized in accordance with the MZR differ appreciably from those considered in our analysis (e.g., if a mixing zone may be located in the Susitna Delta area or another location where concentrations of belugas and their prey occur seasonally), or the observed effects of a future mixing zone are different from those anticipated in this opinion, then consultation may need to be reinitiated.

As discussed in Section 1.2, there is no new information that reveals effects of EPA's action on bowhead whales, North Pacific right whales, blue whales, fin whales, sei whales, the western North Pacific and Mexico DPSs of humpback whales, sperm whales, the western DPS of Steller sea lions, Snake River sockeye salmon, Snake River spring/summer- and fall-run Chinook salmon, and critical habitat designated for North Pacific right whales and Steller sea lions that were not considered in our August 5, 2008, letter in which we concurred with EPA that the proposed action was not likely to adversely affect northern right, blue, fin, sei, and sperm whales, Snake River sockeye salmon, and Snake River spring/summer Chinook salmon. As explained in the letter, NMFS also determined that the action was not likely to adversely affect bowhead and humpback whales, Steller sea lions, Snake River fall Chinook salmon, and designated critical habitats for northern right whales and Steller sea lions (no critical habitat was designated in Alaska for any of the other listed species). As discussed in Section 4.1, in this opinion NMFS also concluded that the Western North Pacific DPS of gray whale, Beringia DPS of bearded seal, Arctic ringed seal, as well as the ESA-listed sea turtles and other fishes identified above in Table 1, are not likely to be adversely affected by EPA's action.

## **10 Incidental Take Statement**

The ITS section of the 2010 opinion remains in effect for Cook Inlet beluga whales.

## **11 Conservation Recommendations**

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02). Our 2010 opinion identified conservation recommendations with respect to minimizing or avoiding adverse effects on Cook Inlet beluga whales. For clarity, we have included those conservation recommendations below, along with additional recommendations we identified after analyzing the potential effects of the proposed action on Cook Inlet beluga whale critical habitat.

1. EPA should require that the authorization of new mixing zones by ADEC will be prohibited in areas of Cook Inlet beluga whale critical habitat where concentrations of the whales and their prey occur seasonally, including the Susitna Delta area. The authorization of mixing zones in such areas is likely to cause effects that are not considered in this opinion.
2. EPA should require that ADEC consider updated Cook Inlet beluga contaminant information, as it becomes available, in determining which effluent constituents may be allowed to exceed WQS in authorized mixing zones.

3. EPA should require ADEC to make authorization of mixing zones contingent upon regular ADEC-supervised contaminant sampling of water, sediment, and aquatic flora and fauna, including beluga whale prey species, within and adjacent to all mixing zones authorized within Cook Inlet beluga critical habitat. In addition to providing data needed to support development of realistic risk-based concentrations that would be protective of Cook Inlet belugas and their critical habitat, these data could support meaningful implementation of the MZR, in that authorizations of mixing zones and determinations regarding whether a mixing zone authorization or certification is terminated, modified, or denied are based on “available evidence” (MZR at 18 AAC 70.240(c) and 18 AAC 70.240(m)).
4. EPA should ensure that the MZR and permits that authorize mixing zones are properly implemented and enforced.
5. EPA should require ADEC to prohibit authorization of mixing zones for pollutants that could bioaccumulate, bioconcentrate, or persist above natural levels in sediments, water, or biota within Cook Inlet beluga critical habitat. This is of particular note with respect to substances that also biomagnify, e.g., mercury.
6. EPA should require ADEC to include Pacific eulachon, a primary prey species of Cook Inlet belugas, in the MZR provision at 18 AAC 70.240(e), which prohibits authorization of a mixing zone in a spawning area of any of the five species of anadromous Pacific salmon found in the state or that will adversely affect the present and future capability of an area to support spawning, incubation, or rearing.
7. EPA stated in the BE that the existing data used for dilution modeling in the central and upper Cook Inlet are sparse, in particular for salinity, temperature, stratification, and tidal current and direction, and that more realistic modeling of mixing zones could be achieved with improvements to these data. EPA should work with ADEC and other collaborators to improve the data needed to support more realistic modelling of mixing zones.

In order to keep NMFS informed of actions taken to minimize or avoid adverse effects or to benefit listed species or their habitats, EPA should notify the NMFS Alaska Region of any conservation recommendations that are implemented as part of the final action.

## **12 Reinitiation of Consultation**

As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the agency action on listed species or designated critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount of incidental take is exceeded, section 7 consultation must be reinitiated immediately.

### 13 Data Quality Act Documentation and Pre-Dissemination Review

Section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law 106-554) (Data Quality Act (DQA)) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

#### 13.1 Utility

This document records the results of an interagency consultation. The information presented in this document is useful to EPA and the general public. These consultations help to fulfill multiple legal obligations of the named agencies. The information is also useful and of interest to the general public as it describes the manner in which public trust resources are being managed and conserved. The information presented in these documents and used in the underlying consultations represents the best available scientific and commercial information and has been improved through interaction with the consulting agency.

This consultation will be posted on the NMFS website at: <https://www.fisheries.noaa.gov/resources/all-publications>. The format and name adhere to conventional standards for style.

#### 13.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

#### 13.3 Objectivity

**Standards:** This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the ESA Consultation Handbook, ESA Regulations, 50 CFR 402.01 et seq.

**Best Available Information:** This consultation and supporting documents use the best available information, as referenced in the "Literature Cited" section. The analyses in this opinion contain more background on information sources and quality.

**Referencing:** All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

**Review Process:** This consultation was drafted by NMFS staff with training in ESA implementation, and reviewed in accordance with Alaska Region ESA quality control and assurance processes.

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## 15 Appendix A

### State of Alaska Mixing Zone Regulations (2006):

**18 AAC 70.240. Mixing zones.** (a) Upon application, the department may authorize in a discharge permit or certification, a mixing zone or multiple mixing zones in which the water quality criteria and any limit set under this chapter may be exceeded. The applicant shall provide to the department all available evidence reasonably necessary to demonstrate that a mixing zone will comply with this section. The department will approve, approve with conditions, or deny a mixing zone application.

(b) In determining whether to authorize a mixing zone under this section, the department will consider

- (1) the characteristics of the receiving water, including biological, chemical, and physical characteristics such as volume, flow rate, and flushing and mixing characteristics;
- (2) the characteristics of the effluent, including volume, flow rate, dispersion, and quality after treatment;
- (3) the effects, if any, including cumulative effects of multiple discharges and diffuse, nonpoint source inputs, that the discharge will have on the uses of the receiving water;
- (4) any additional measures that would mitigate potential adverse effects to the aquatic resources present; and
- (5) any other factors the department finds must be considered to determine whether a mixing zone will comply with this section.

(c) The department will approve a mixing zone, as proposed or with conditions, only if the department finds that available evidence reasonably demonstrates that

- (1) an effluent or substance will be treated to remove, reduce, and disperse pollutants, using methods that the department finds to be the most effective, technologically and economically feasible, and at a minimum consistent with statutory and regulatory treatment requirements including
  - (A) any federal technology-based effluent limitation identified in 40 C.F.R. 122.29 and 40 C.F.R. 125.3, as revised as of July 1, 2005 and adopted by reference;
  - (B) minimum treatment standards in 18 AAC 72.050; and
  - (C) any treatment requirement imposed under another state statute or regulation that is more stringent than a requirement of this chapter;
- (2) designated and existing uses of the waterbody as a whole will be maintained and protected;
- (3) the overall biological integrity of the waterbody will not be impaired; and
- (4) the mixing zone will not
  - (A) result in an acute or chronic toxic effect in the water column, sediments, or biota outside the boundaries of the mixing zone;

- (B) create a public health hazard that would preclude or limit existing uses of the waterbody for water supply or contact recreation;
- (C) preclude or limit established processing activities or established commercial, sport, personal-use, or subsistence fish and shellfish harvesting;
- (D) result in a reduction in fish or shellfish population levels;
- (E) result in permanent or irreparable displacement of indigenous organisms;
- (F) adversely affect threatened or endangered species except as authorized under 16 U.S.C. 1531 - 1544 (Endangered Species Act); or
- (G) form a barrier to migratory species or fish passage.

(d) The department will approve a mixing zone, as proposed or with conditions, only if the department finds that available evidence reasonably demonstrates that within the mixing zone the pollutants discharged will not

- (1) bioaccumulate, bioconcentrate, or persist above natural levels in sediments, water, or biota to significantly adverse levels, based on consideration of bioaccumulation and bioconcentration factors, toxicity, and exposure;
- (2) present an unacceptable risk to human health from carcinogenic, mutagenic, teratogenic, or other effects as determined using risk assessment methods approved by the department and consistent with 18 AAC 70.025;
- (3) settle to form objectionable deposits, except as authorized under 18 AAC 70.210;
- (4) produce floating debris, oil, scum and other material in concentrations that form nuisances;
- (5) result in undesirable or nuisance aquatic life;
- (6) produce objectionable color, taste, or odor in aquatic resources harvested from the area for human consumption;
- (7) cause lethality to passing organisms; or
- (8) exceed acute aquatic life criteria at and beyond the boundaries of a smaller initial mixing zone surrounding the outfall, the size of which shall be determined using methods approved by the department.

(e) In lakes, streams, rivers, or other flowing fresh waters, a mixing zone will not be

- (1) authorized in a spawning area of any of the five species of anadromous Pacific salmon found in the state; or
- (2) allowed to adversely affect the present and future capability of an area to support spawning, incubation, or rearing of any of the five species of anadromous Pacific salmon found in the state.

(f) In lakes, streams, rivers, or other flowing fresh waters, except as provided in (g) of this section, a mixing zone will not be authorized in a spawning area for

- (1) Arctic grayling;
- (2) northern pike;



- (3) lake trout;
  - (4) brook trout;
  - (5) sheefish;
  - (6) burbot;
  - (7) landlocked coho salmon, chinook salmon, or sockeye salmon; or
  - (8) anadromous or resident rainbow trout, Arctic char, Dolly Varden, whitefish, or cutthroat trout.
- (g) The department may authorize a mixing zone in a spawning area of a lake, stream, river, or other flowing fresh water for the species listed in (f) of this section if
- (1) after consultation with the Department of Fish and Game, the department finds that the applicant has demonstrated that the discharge
    - (A) does not contain pollutants at concentrations that exceed the criteria for growth and propagation of fish, shellfish, other aquatic life, and wildlife established in 18 AAC 70.020(b)(1) - (12); and
    - (B) will not adversely affect the capability of the area to support future spawning, incubation, and rearing activities;
  - (2) the applicant has submitted to the department a mitigation plan approved by the Department of Fish and Game under 5 AAC 95.900 if the spawning area is within a special area;
  - (3) the applicant has submitted to the department a mitigation plan approved by the Department of Fish and Game under AS 16.05.871 – 16.05.901, if the spawning area is within waters included in the *Catalog of Waters Important for Spawning, Rearing or Migration of Anadromous Fishes*, adopted by reference in 5 AAC 95.011; the department will incorporate the mitigation plan as part of the discharge authorization; or
  - (4) the applicant has submitted to the department a mitigation plan approved by the department, after consultation with the Department of Fish and Game, if the spawning area is not within waters described in (2) or (3) of this subsection; the mitigation plan must use measures described in the *Catalog of Waters Important for Spawning, Rearing or Migration of Anadromous Fishes*, adopted by reference in 5 AAC 95.011; the department will incorporate the mitigation plan as part of the discharge authorization.
- (h) In a mixing zone authorization under (g) of this section, the department may require the applicant to monitor effluent, ambient water quality, and biological conditions to determine whether unanticipated adverse effects on spawning, incubation, and rearing of species identified in (f) of this section are occurring.
- (i) The provisions of (e), (f), and (g) of this section do not apply to the renewal of a mixing zone authorization where spawning was not occurring at the time of the initial authorization, but successful spawning, incubation, and rearing has occurred within the mixing zone after the initial authorization of that mixing zone.
- (j) When determining whether to authorize a mixing zone under (e), (f), or (g) of this section, the department will make that determination

- (1) in conformance with the determination of the Department of Fish and Game, acting under AS 16.20, of the location and time of a spawning area within a special area;
  - (2) in conformance with the determination of the Department of Fish and Game, acting under AS 16.05.871 – 16.05.901, of the location and time of a spawning area within waters included in the *Catalog of Waters Important for Spawning, Rearing or Migration of Anadromous Fishes*, adopted by reference in 5 AAC 95.011; or
  - (3) after consultation with the Department of Fish and Game, as to what the Department of Fish and Game considers the location and time of a spawning area not within waters described in (1) or (2) of this subsection.
- (k) The department will approve a mixing zone, as proposed or with conditions, only if it finds that the mixing zone is as small as practicable and will comply with the following size restrictions, unless the department finds that evidence is sufficient to reasonably demonstrate that these size restrictions can be safely increased:
- (1) for estuarine and marine waters, measured at mean lower low water,
    - (A) the cumulative linear length of all mixing zones intersected on any given cross section of an estuary, inlet, cove, channel, or other marine water may not exceed 10 percent of the total length of that cross section; and
    - (B) the total horizontal area allocated to all mixing zones at any depth may not exceed 10 percent of the surface area;
  - (2) for lakes, the total horizontal area allocated to all mixing zones at any depth may not exceed 10 percent of the lake's surface area;
  - (3) for streams, rivers, or other flowing fresh waters, the length of a mixing zone may not extend beyond the computed point of complete mixing, as determined using a standard river flow mixing model or other methods accepted by the department;
  - (4) for streams, rivers, or other flowing fresh waters, the length of a mixing zone may not extend downstream beyond the location where the department determines that a public health hazard reasonably could be expected to occur.
- (l) For streams, rivers, or other flowing fresh waters, in calculating the maximum pollutant discharge limitation, the volume of flow available for dilution must be determined using
- (1) the actual flow data collected concurrent with the discharge; or
  - (2) for conventional and nontoxic substances, the 10-year, 7-day low flow (7Q10) as the criteria design flow; for the protection of aquatic life, the 10-year, 7-day low flow (7Q10) as the chronic criteria design flow and the 10-year, 1-day low flow (1Q10) as the acute criteria design flow; and for the protection of human health, the 5-year, 30-day low flow (30Q5) as the noncarcinogenic criteria design flow and the harmonic mean flow as the carcinogenic criteria design flow; these low flows must be calculated using methods approved by the department.
- (m) If the department finds that available evidence reasonably demonstrates that a mixing zone authorized by the department has had or is having a significant unforeseen adverse environmental effect, the department will terminate, modify, or deny renewal of the permit or certification authorizing the mixing zone.

(n) When consulting with an agency under (g) or (j) of this section, the department will give appropriate weight to any information received from the agency, considering the agency's expertise.

(o) For purposes of this section, the five species of anadromous Pacific salmon found in the state are chinook salmon, coho salmon, sockeye salmon, pink salmon, and chum salmon.

(p) In this section, "special area" means a state game refuge, a state game sanctuary, or a state fish and game critical habitat area, established under AS 16.20. (Eff. 11/1/97, Register 143; am 3/23/2006, Register 177)

**Authority:** AS 46.03.010, AS 46.03.080, AS 46.03.720, AS 46.03.020, AS 46.03.100, AS 46.03.050, AS 46.03.110, AS 46.03.070, AS 46.03.710

**Editor's note:** As of Register 186 (July 2008), and acting under AS 44.62.125(b)(6), the regulation attorney made a technical change to 18 AAC 70.240(g) and (j), to reflect Executive Order 114 (2008). Executive Order 114 transferred functions related to protection of fish habitat in rivers, lakes and streams from the Department of Natural Resources to the Department of Fish and Game.

**18 AAC 70.245. Mixing zones: appropriateness and size determination.** Repealed. (11/1/97, Register 143; repealed 3/23/2006, Register 177)

**18 AAC 70.250. Mixing zones: general conditions.** Repealed. (Eff. 11/1/97, Register 143; repealed 3/23/2006, Register 177)

**18 AAC 70.255. Mixing zones: in-zone quality and size specifications.** Repealed. (Eff. 1/1/97, Register 143; repealed 3/23/2006, Register 177)

**18 AAC 70.260. Mixing zones: application requirements.** Repealed (Eff. 11/1/97, Register 143; repealed 3/23/2006, Register 177)

**18 AAC 70.270. Mixing zones: termination, modification, or denial of renewal.** Repealed. (Eff. 11/1/97, Register 143; repealed 3/23/2006, Register 177)